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Contract No. 7-35087

Government Patent Policy Study

Final Report Volumes II--IV

by
Harbridge House, Inc.
Boston, Massachusetts

For the
F C S T Committee on
Government Patent Policy

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HARBRIDGE HOUSE INC
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MICHAEL BERGNER
Vice President

17 May 1968

Assistant Commissioner of Patents O'Brien
Chairman, Committee on Government Patent Policy
U.S. Patent Office
Department of Commerce
Crystal Plaza
Arlington, Virginia 22202

Dear Mr. O'Brien:

Harbridge House is pleased to submit a final report on the government patent policy study in fulfillment of Contract No. 7-35087.

The final report consists of four volumes. This Volume I summarizes the results of research on the three study questions. Volumes II through IV are research reports which provide back up data to Volume I. Volume II is a more detailed report on the effect of patent policy on industry participation in government research programs. Volume III describes the efforts of eight government agencies to promote commercial utilization of government-sponsored inventions. And, Volume IV reports on the effect of government patent policy on commercial utilization and business competition.

Harbridge House has appreciated the opportunity to work with the Committee on Government Patent Policy in this important area of government policy. We wish to thank the Committee for their truly fine assistance and support over the eighteen months of the study effort.

Sincerely,

Michael Bergner

Michael Bergner
Vice President

MB/mh

Government Patent Policy Study

Final Report

Volume II

Effect of Patent Policy on Government R & D Programs

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PART I. Introduction

In September 1966, the Committee on Government Patent Policy of the Federal Council for Science and Technology entered into a study of the effects of government patent policy. Prior to then, little data were available to measure how well the government's policy was achieving its objectives. The Committee and the Council decided that such information should be secured, if possible, to serve as a basis for recommendation to the President and Congress as to what policy changes, if any, should be made.

To bridge this gap, the Committee commissioned Harbridge House to gather and analyze data which could explain the effects of government patent policy on three major areas of concern to the government: (i) industry participation in federal research and development programs; (ii) commercial utilization of federally sponsored inventions; and (iii) business competition. These data, gathered from industry, nonprofit institutions, and the government over an eighteen-month period, represent a unique body of information on the role of patent policy in government and industry, and are presented in the form of a final report and a series of research reports which provide detailed research data on the three study questions. This Volume II covers research on the effects of patent policy on industry participation in government R&D programs.

In order to determine the effect of patent incentives on industry participation in government R&D programs, Harbridge House undertook three tasks. The first task was an investigation of reluctance or refusal to participate in R&D programs of the National Institutes of Health (NIH) and the Department of the Interior. These agencies were selected because of specific transactions in which difficulties had arisen under their patent policies. Such cases are difficult to find because of the general reluctance of contractors to attribute their refusal to a general policy of the prospective customer. Their experiences, therefore, provided an opportunity to understand how patent policy and practice were affecting industry participation in government R&D programs.

We do not suggest that the experiences of these two agencies are typical of all agencies, nor even representative of the overall contractor relationships of the particular agencies under discussion. Rather, through the investigation of the cases—24 Department of the Interior contracts and 21 NIH grants—we sought to discover and understand the actual role of patent rights when there had been a known reluctance or refusal to contract with the government. Case data were gathered from government files and interviews with government personnel familiar with the transactions. Parts II and IV below present findings on the research performed at NIH and the Department of the Interior.

The second task grew out of the first. Nineteen of the 21 NIH cases involved refusals of drug firms to collaborate with university scientists working under NIH grants. Accordingly, we undertook a detailed investigation of the effect of the Department of Health, Education, and Welfare's (HEW) patent policy on the medicinal chemistry program; the resulting consequences of the withdrawal of drug industry testing/screening services to NIH-sponsored university research programs; and the alternatives available to the government for testing/screening compounds conceived or developed under support from NIH. Data for this task were gathered from drug firms, grantee universities, and government personnel. Our findings on the drug study are presented in Part III.

The third task was suggested by an analysis of statistical data gathered from invention utilization questionnaires employed in the study. Data for this task were gathered from the utilization questionnaires and from interviews with selected companies reporting high or low commercial utilization of government-sponsored inventions. These revealed that not only was invention utilization heavily concentrated in a small number of firms which held a large number of patents, but also that an equal number of firms with large patent holdings reported little or no commercial utilization of inventions. In view of these business patterns, we sought to define in greater detail the reasons for high or low utilization in 21 companies selected from our questionnaire sample. Among our findings was that a number of firms in the sample no longer looked to inventions made under government R&D programs as a potential source of commercial products. This aspect of the task is discussed in Part V, *Industrial Disenchantment.* The balance of the high and low utilization analysis is included in Volume IV, Research Report: *Effect of Government Patent Policy on Commercial Utilization and Business Competition.* Names of organizations and confidential data are omitted where necessary to protect information provided in confidence to Harbridge House.

FIGURE II-2
STUDY SECTIONS
DIVISION OF RESEARCH GRANTS

May 25, 1966

Accident Prevention Research

Allergy & Immunology A

Allergy & Immunology B

Applied Physiology

Bacteriology & Mycology A

Bacteriology & Mycology B

Behavioral Sciences

Biochemistry

Biophysics & Biophysical Chemistry A

Biophysics & Biophysical Chemistry B

Cardiovascular A

Cardiovascular B

Cell Biology A

Cell Biology B

Communicative Sciences

Computer Research

Dental

Endocrinology
(Hormone Distribution Program)

Environmental Sciences & Engineering A

Environmental Sciences & Engineering B

Environmental Sciences Review Committee

Epidemiology & Disease Control

Experimental Psychology A

Experimental Psychology B

General Medicine A

General Medicine B

Genetics

Health Services Research

Hematology

History of the Life Sciences

Human Embryology & Development

Medicinal Chemistry A

Medicinal Chemistry B

Mental Health A

Mental Health B

Metabolism

Neurology A

Neurology B

Nursing Research

Nutrition

Pathology A

Pathology B

Pharmacology & Experimental Therapeutics A

Pharmacology & Experimental Therapeutics B

Physiological Chemistry

Physiology

Psychopharmacology

Radiation

Reproductive Biology

Scientific Publications Advisory Committee

Surgery A

Surgery B

Toxicology

Tropical Medicine and Parasitology

Virology & Rickettsiology

Visual Sciences

Source: Division of Research Grants, National Institutes of Health.

1955 Version	1957 Changes	1958 Changes

of research activities which also receive substantial support from other sources, as well as from the Federal grant. It would not be consistent with the cooperative nature of such activities to attribute a particular invention primarily to support received from any one source. In all these cases the Department has a responsibility to see that the public use of the fruits of the research will not be unduly restricted or denied.

(d) The following conditions have been adopted to govern the treatment of inventions made in these various types of situations. They are designed to afford suitable protection to the public interest while giving appropriate recognition to the legitimate interests of others who have contributed to the invention.

8.1 Conditions to be included in research grants. Subject to legislative directives or Executive orders providing otherwise, all grants in aid of research shall provide as a condition that any invention arising out of the activities assisted by the grant shall be promptly and fully reported, and shall provide, as the head of the constituent unit may determine, either

(a) That the ownership and manner of disposition of all rights in and to such invention shall be subject to determination by the head of the constituent unit responsible for the grant, or

(b) That the ownership and disposition of all domestic rights shall be left for determination by the grantee institution in accordance with the grantee's established policies and procedures, with such modifications as may be agreed upon and specified in the grant, provided the head of the constituent unit finds that these are such as to assure that the invention will be made available without unreasonable restrictions or excessive royalties, and provided the Government shall receive a royalty-free license, with a right to issue sublicenses as provided in 8.3, under any patent applied for or obtained upon the invention.

(c) Wherever practicable, any arrangement with the grantee pursuant to paragraph (b) of this section shall provide in accordance with Executive Order 9865 that there be reserved to the Government an option, for a period to be prescribed, to file foreign patent applications upon the invention.

1955 Version

thereunder, an option to require the assignment of all rights in the invention in all or in any specified foreign countries. In any case where the inventor is not required to assign the patent rights in any foreign country or countries to the Government, or the Government fails to exercise its option within such period of time as may be provided by regulations issued by the Chairman of the Government Patents Board; any application for a patent which may be filed in such country or countries by the inventor or his assignee shall nevertheless be subject to a non-exclusive, irrevocable, royalty-free license to the Government for all governmental purposes, including the power to sublicense for all governmental purposes.

8.5 Arrangements other than grants; fellowships. In the event of an invention arising from research activities assisted by the Department, other than inventions by Government employees or inventions arising from activities assisted by a research grant, ownership thereof shall be governed by the terms of the agreement or contract and shall be in accordance with any applicable law or regulation. In the discretion of the head of the responsible constituent organization, the award of a fellowship to a person not a Government employee, as so defined, may provide for the reporting of any invention made during the term thereof, and for its disposition in accordance with the provisions of paragraph (a) of 8.1, or for its disposition by the institution at which the research was performed in accordance with its established policies, if applicable to such an invention, which (with any agreed modifications of such policies) meet the requirements of paragraph (b) or (c) of such section.

Since these parts deal with matters of internal management or personnel, and with grants, benefits, or contracts, notice of proposed rule-making is not required.

1957 Changes

2. Section 8.5 is amended to read as follows:

8.5 Fellowships: In the discretion of the head of the responsible constituent organization, the award of a fellowship to a person not a Government employee may provide for the reporting of any invention made during the term thereof, and for its disposition in accordance with the provisions of paragraph (a) of 8.1, or for its disposition by the institution at which the research was performed in accordance with its established policies, if applicable to such an invention, which meet the requirements of paragraph (b) of such section.

3. Part 8 is further amended by the addition of the following section:

8.6 Contracts for research. Contracts for research, whether or not with nonprofit organizations, shall provide that any invention first conceived or actually reduced to practice in the course of the performance of the contract shall be promptly and fully reported to the head of the constituent organization responsible for the contract, for determination by him as to the manner of disposition of all rights in and to such invention, including the right to require assignment to all rights to the United States or dedication to the public. In the exercise of this power the organization head will be guided by the policy specified in 8.2 with respect to grants.

4. Part 8 is further amended by the addition of the following new section:

8.7 Cancer chemotherapy industrial research contracts. Notwithstanding the

1958 Changes

Section 8.6 is amended to read as follows:

8.6 Contracts for research. (a) Contracts for research, with other than nonprofit institutions, shall provide that any invention first conceived or actually reduced to practice in the course of the performance of the contract shall be promptly and fully reported to the head of the constituent organization responsible for the contract, for determination by him as to the manner of disposition of all rights in and to such invention, including the right to require assignment of all rights to the United States or dedication to the public. In the exercise of this power the organization head will be guided by the policy specified in 8.2 with respect to grants.

(b) Contracts for research with nonprofit institutions shall contain provisions as in paragraph (a) of this section except that, if it is determined that the institution's policies and procedures are acceptable as meeting the requirements of

FIGURE II-4
GRANTEE INSTITUTIONS HAVING BLANKET PATENT AGREEMENTS WITH THE PUBLIC HEALTH SERVICE

California Institute of Technology

Cornell University

Florida State University

Harvard University[1]

Iowa State University

Massachusetts Institute of Technology

Michigan State College

Mt. Sinai Hospital (New York City)

Ohio State University

Princeton University

Purdue University

Tufts University

University of California

University of Illinois

University of Kansas (Lawrence campus only)

University of Minnesota

University of Washington

Washington State University

Source: NIH Records.

[1]The agreement with Harvard University has been cancelled since the initial date of the study.

FIGURE II-5 (Cont'd)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

ANNUAL INVENTION STATEMENT ON PUBLIC HEALTH SERVICE GRANT OR AWARD

I hereby certify that, to the best of my knowledge and belief, all inventions are listed below which might possibly be construed in any manner to be Public Health Service grant or award supported or related and which were conceived and/or reduced to practice, or made the subject of patent application by persons engaged in the performance of work under Public Health Service grant or award

No. ____________, for the period ____________ through ____________

(Period dates should NOT extend beyond the date Statement is submitted to The Public Health Service)

(For General Research Support grants the Annual Invention Statement would include only those inventions related to a specific research project aided by such funds. If no inventions have been made under any Public Health Service grant or award, insert the word "None" under Title of Invention.)

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO PHS

Use Continuation Sheet if Necessary

Signature, in ink, is required in the space provided below, appropriate to the type of grant or award being supported:
SIGNATURE OF INSTITUTIONAL OFFICIAL REQUIRED IN ALL INSTANCES.

TYPE OF GRANT OR AWARD	SIGNATURES
1. FOR A RESEARCH GRANT	(PRINCIPAL INVESTIGATOR OR PROJECT DIRECTOR)
2. FOR A HEALTH SERVICES GRANT	(DIRECTOR)
3. FOR A TRAINING GRANT	(PROGRAM DIRECTOR)
4. FOR THE RESEARCH CAREER AWARD PROGRAM	(AWARDEE)
5. FOR A FELLOWSHIP AWARD	(a) (FELLOW) (b) (SPONSOR)
6. FOR A GENERAL RESEARCH SUPPORT GRANT (SEPARATE INVENTION STATEMENT FOR EACH IDENTIFIABLE RESEARCH PROJECT)	(PRINCIPAL INVESTIGATOR)

APPROVED:	SIGNATURE (Institution Official Responsible for Patent Matters)	TITLE	DATE
	TYPE NAME		
	NAME OF INSTITUTION	MAILING ADDRESS	

PHS-3945
(Rev. 11-64)

Form Approved
Budget Bureau No. 68-R773

FIGURE II-7

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
National Institutes of Health
Bethesda 14, Md.

PATENT AGREEMENT[1]
(substitute for

Institution:

Investigator(s):

Title of Research Proposal:

The following amended patent agreement is accepted by

and becomes a part of the official application for Public Health Service support, identified as :

"if any invention arises or is developed in the course of the work aided by the grant, the undersigned will refer to the Surgeon General for determination as to whether patent protection shall be sought and how the rights in the invention, including rights under any patent issued thereon, shall be disposed of and administered in order to protect the public interest.

In connection with the compounds to be synthesized and/or developed under the subject grant, which are submitted to a pharmaceutical company for screening purposes, the grantee and the pharmaceutical company hereby agree to the following conditions:

1. The pharmaceutical company shall not make disclosures of the results of testing for a period of 12 months, except with the consent of all parties concerned.

2. The pharmaceutical company shall report the results of testing promptly to the investigator and will furnish to him, for use by the PHS in connection with any application for patent which the PHS may file, the information demonstrating any utility or new use of the compound.

3. The pharmaceutical company shall be permitted to obtain patent rights to new uses of the compounds developed at its own expense, except where the grantee contributed or participated in the conception or reduction to practice of such new use, or where such new use patent would hamper, impede or infringe on the intended use of the invention covered by the product application, or where such new use is within the field of research work supported by the grant.

4. There shall be reserved to the Government under any new use patent obtained by the pharmaceutical company a nonexclusive, irrevocable, royalty-free license to the Government, with power to sublicense for all Governmental purposes."

(Accepted)______________________________
(Pharmaceutical Company)

(Title)______________________________

(Date)______________________________

(Signed)______________________________
(Principal Investigator or
Project Director)

(Accepted)______________________________
(Institution official responsible for
patent matters)

(Title)______________________________

(Date)______________________________

[1] Revised in December 1966.

PART III. A Closer View of the Problem: Withdrawal of the Pharmaceutical Industry From Participation in National Institutes of Health Programs

A. Background of the Drug Study

As noted in Part II above, the breakdown in drug industry/academic community collaboration occurred when the Department of Health, Education, and Welfare (HEW) began in 1962 to implement more stringent procedures for reporting inventions and determining rights in inventions. Obtaining the drug firm's signature to the amended patent agreement was set forth in the new enforcement procedures as the responsibility of the principal investigator and his university. This responsibility was viewed by university faculty as mandatory whether or not their particular institution was one of the 18 universities already operating under a blanket patent agreement with HEW that left patent rights for disposition by the university.

The drug firms almost unanimously rejected the amended patent agreement from the beginning for several reasons:

(i) They refused to accept the loss of prospective proprietary rights.

(ii) They feared the contamination[1] on in-house research that would result from taking in compounds arising from NIH-sponsored research.

(iii) They thought that they might lose control over the testing and the reporting of results.

The effect of the drug firms' refusal to sign the amended patent agreement was their complete withdrawal from screening compounds resulting from NIH-sponsored research.

These factors in the NIH task discussed in Part II above indicated that a broad-based study of drug research would help explain the effects of government patent policy on commercial utilization in an important area involving the government, the academic research community, commercial developers, and the public. Drug research is an important aspect of the government's health program, and utilization of results on behalf of the general public is a basic objective. The drug industry, a vital link in the utilization chain, is highly patent-sensitive because of its large expenditures for research and development and the relatively low yield of new products. Patents are therefore viewed in the industry as a necessary protection to insure amortization of investment and an adequate return on expenditures for research and development.[2]

Accordingly, the Drug Study sought to answer three questions:

(i) What were the costs and the benefits to drug firms of screening NIH-sponsored compounds prior to the 1962 implementation of more stringent HEW patent policy enforcement procedures?

(ii) What effects did the withdrawal of drug industry screening services for NIH-sponsored compounds have on university research programs and on university research scientists?

(iii) What alternatives are available to the government for screening compounds conceived or developed under support from NIH?

B. Research Approach

The data necessary to answer these questions were obtained through individual and group interviews with personnel from drug firms, universities, a commercial testing laboratory, and pertinent government agencies. Specifically, the interviewees included:

(i) Personnel from five drug firms—men from top management or senior staff, research men, and, in one firm, the managers of financial planning and long-range planning, respectively. One drug firm, which has asked to remain anonymous, provided most of the detailed data, but the significant trends were confirmed by interviews at the other four firms.

(ii) Faculty members from seven universities and administrators from six of these universities. At one university, almost all of the faculty members of the chemistry department of the College of Pharmacy were interviewees.

[1] As used by the drug industry and university investigators, "contamination" means the potential compromise of rights in proprietary research resulting from exposure of an individual or organization to ideas, compounds, and/or test results arising from government-sponsored research. For example, a compound developed under NIH-sponsored research comes into a drug firm for screening and is found to be useful in a therapeutic area in which the company has conducted prior research; the company incorporates into its research program some of the research findings from the screening of the NIH compound, and the company then develops a marketable product. The company is afraid that HEW is in a position to assert claims to that product.

[2] Figures promulgated by the Pharmaceutical Manufacturers Association show that the drug industry supports the greatest research and development effort per sales dollar (8.7 percent of sales in 1964) of any industry class.

FIGURE III-1

PATENT POLICY ISSUES AFFECTING DRUG FIRMS' DECISIONS TO SCREEN AND DEVELOP A COMPOUND

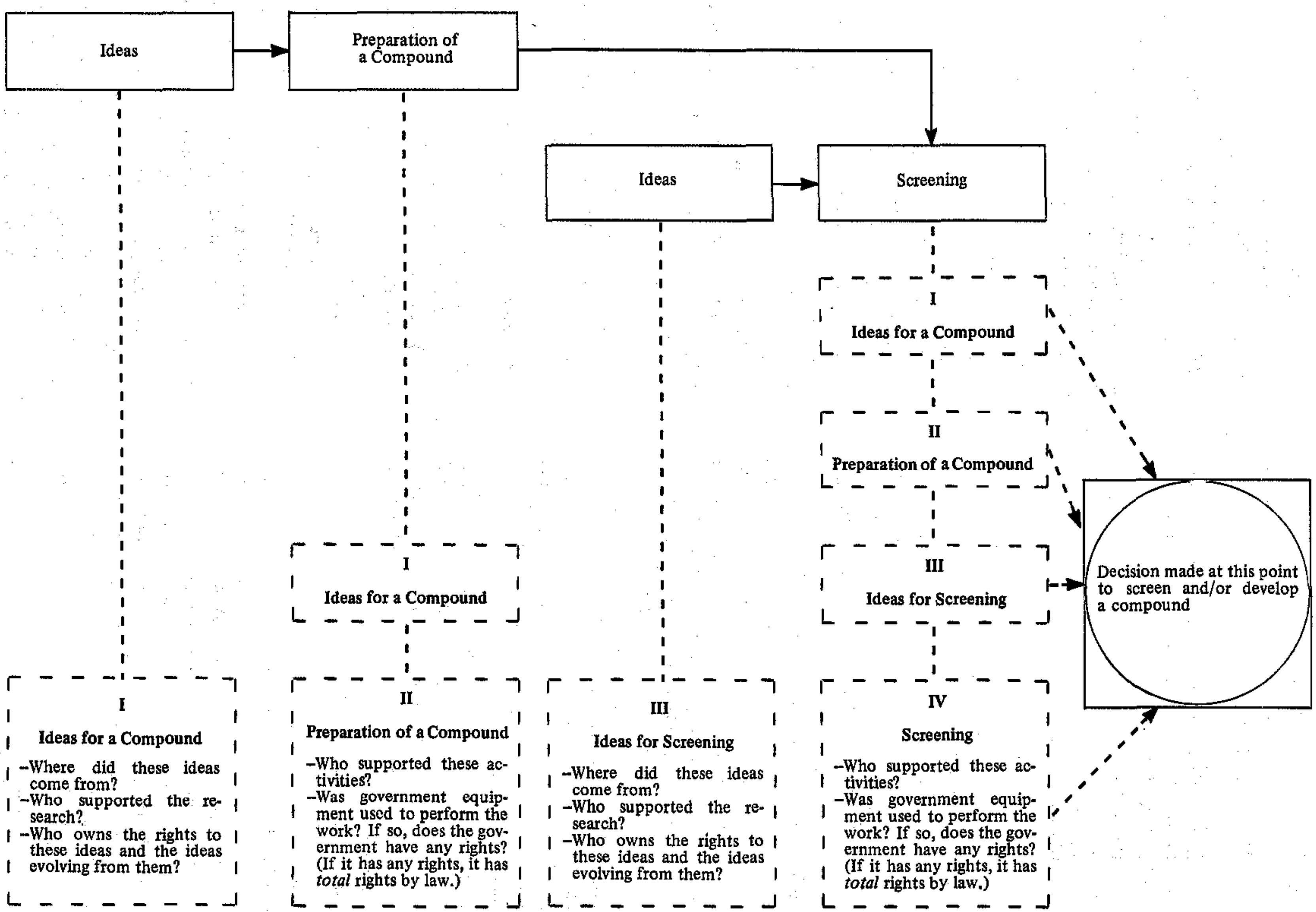


FIGURE III - 2
SOURCES OF SCREENING–
COMPARISON OF COSTS, EFFECTIVENESS, AND FEASIBILITY

Source ↓	Costs* (per compound)		Effectiveness		Flexibility	
	Test	Screen	Test	Screen	Test	Screen
Government			–Broad search for specific cures of cancer.		–Performed on contract basis.	
CCNSC	$ 9**	$ 78**	–Develops approximately 20 compounds per year for clinical testing.		–Government in-house capability only in progress management.	
WRAIR	17**	200**	–Very broad search for specific cures of malaria. –Develops approximately 20 - 30 compounds per year for clinical testing.		–Pharmacology talent for new efforts is scarce.	
Academic Community	$10-20***	Not Available	Performed in close proximity to academic research; permits research flexibility.	When performed, objectives are aimed at science rather than utilization.	Performed by some institutions on a routine basis.	Sometimes performed in departments of pharmacology that are available and interested.
Pharmaceutical Industry	$50 ‡	$500 ‡	–Array of both broad and specific procedures that are highly developed. –Easy path to utilization.		Performed on a routine basis except when patent rights issue intervenes.	
Commercial and Nonprofit Testing Laboratories	$500-2000		Specific programs carried out effectively for specific needs.		–Highest cost alternative for individual investigator. –Although costs for individual small projects tend to be high, they decrease to levels shown under CCNSC and WRAIR for large projects (around $100,000 and up).	

*The text of this report presents detailed cost information that includes the assumptions on which the costs are based and allows more precise comparability of costs for the different screening sources.
**These figures are based on an analysis of budgetary data.
***These figures are based on an analysis of faculty cost estimates.
‡ These figures are based on an industry estimate. (Precise figures were not available.)

time, because they operate on a contract testing basis, their costs tend to be high for specific tests on specific compounds, and they have not had the occasion or the incentive to develop the capability of selecting candidate compounds for specific screens from among the thousands that might be presented.

The academic testing laboratories tend to be uninterested in development work for its own sake. Their primary objective is to obtain enough biological data for publishing pharmacological findings and sometimes explanning pharmacological mechanisms. In addition, their emphasis is on scientific knowledge, not on utilization. One could not expect this source to supply either the data necessary to satisfy Federal Drug Administration (FDA) requirements or the management capability required to get the data.

D. Detailed Findings Relating to the Three Study Questions

1. Background

a. *History of Collaboration Between the Pharmaceutical Industry and the Academic Community.* When the drug firms stopped screening NIH-sponsored compounds for academic investigators, their action severed a long-standing bond with the academic community. The drug industry and the academic community had had a strong

FIGURE III-4
NIH RESEARCH GRANTS TO
ACADEMIC INSTITUTIONS
($ in millions)

Fiscal Year	Amount of Grants
1946	$ 0.78
1950	14.10
1955	33.90
1957	89.80
1960	202.90
1961	293.90
1962	433.70
1963	492.80
1964	529.20
1965	545.20
1966 (est.)	604.40

Source: NIH.

FIGURE III-5
COMPARISON OF THE GROWTH OF
PRIVATE AND GOVERNMENT-SPONSORED RESEARCH
AT A TYPICAL COLLEGE OF PHARMACY
OF A LARGE STATE UNIVERSITY
($ in thousands)

Fiscal Year	Private Research	Government Research
1957	$2.2	$ 0.0
1958	4.2	0.0
1959	1.5	14.4
1960	0.6	45.6
1961	3.7	74.6
1962	2.3	84.7
1963	0.0	130.3
1964	1.0	154.0
1965	5.3	162.5
1966	0.3	156.8

Source: Business office of the university

Chemistry Study Sections estimate that about $8 million per year is being used to fund medicinal chemistry research in more than 500 grants. This represents approximately 1.3 percent of the NIH budget for grants.

Figure III-5 shows the buildup in sponsored research at a typical college of pharmacy. The research funds given to the college for private research are usually composed of grants and fellowship awards from drug firms. The government research funds usually come from the National Science Foundation, the National Institutes of Health, and the Department of Defense, with funds from the National Institutes of Health predominating. In fact, NIH support has now reached the point where it dominates university-sponsored health research. Grants to university chemistry departments and departments of pharmacology follow the same pattern as grants to colleges of pharmacy.

2. Costs and Benefits to Drug Firms of Screening NIH-Sponsored Compounds

a. *Costs.* Prior to the 1962 Amended Patent Agreement, drug firms tested compounds for academic investigators free of charge, no matter who had sponsored the research. The agreement between an academic investigator and a firm was usually a verbal, gentleman's agreement in which the drug firm agreed to test compounds and report back on results in order to help the academic investigator in his research. In return, the drug firm received certain rights that are discussed below in the section on benefits to drug firms.

The costs to a drug firm for screening a compound vary considerably, since each compound is an individual problem of evaluation and development. For example, one drug firm contacted in this study said that although it has 12 screening areas, relatively few of the 4,000 compounds it screens yearly are screened in all 12 areas. A compound with either initial interesting biological activity or a very novel structure, however, is usually put through at least several screens.

According to this firm, its basic neurological screening program is perhaps its simplest, with the following estimated costs (average cost per compound):

- Cost of logging-in compound $50
- Cost of dose range in one species $50
- Cost of primary screening $500 - 700
- Secondary testing $10,000
- Work-up for clinical trial short of toxicity studies $25,000 - 100,000

In many cases, however, instead of an average cost per compound, a better measure of the cost to the drug firm for screening the university investigator's compounds was probably the marginal cost to include those compounds in a screen that had already been set up for the firm's in-house compounds, which were always in the majority. This marginal cost would include the cost of such items as the additional test animals, glassware, space, technician and professional time spent in observing the increased number of animal subjects, and the test report furnished to the university investigator. Since the distinction between average costs and marginal costs was not recognized by the research personnel interviewed by Harbridge House and the drug firms do not keep data on marginal costs of testing compounds, no estimates of marginal costs were obtainable.

expenses of $36,000 can turn out approximately 12 compounds a year, each compound synthesized costs an average of $36,000 ÷ 12 or $3,000.

(iv) *Closeness to academic investigators and their graduate students for purposes of recruitment.* Drug firms have used the screening services provided to academic investigators as, in effect, a recruitment device. Compounds which otherwise might be of no interest have been screened as a courtesy to academic investigators in order to get to know them better, get a closer look at their research, and get to know their graduate students. When the relationship between the drug firm and the investigator was a fruitful one, the investigator was often hired as a consultant to the firm. When the investigator believed the drug firm's work to be interesting, he often referred graduate students to the firm. One firm contacted in this study used its close ties to a leading university to obtain several of its biochemists now in technical management.

3. Effects of Withdrawal of Screening Services for NIH-Sponsored Compounds on University Research Programs and Scientists

a. *Factors Considered.* The discussion of this study question considers more than the original assumption behind the question: that the withdrawal of screening services by the drug industry constituted the sole cause of reported effects on university research. During the course of our research, we discovered an independent and equally significant issue: that the revised procedures for patent policy administration, quite apart from the withdrawal of drug industry screening services, may be directly responsible for reduced effectiveness of individual academic investigators. The discussion here has been amplified to reflect this expanded perspective, but only with regard to administrative difficulties and incentives for circumvention posed by the revised procedures. Section E provides a graphic analysis of the major effects that the revised procedures seem to have had on the entire drug development process.

b. *Effects of the Withdrawal of Drug Industry Screening Services.* The major effects can be discussed in terms of what happens to academic investigators when they have to do without the large-scale screening services that were provided by the drug industry before 1962:

(i) *Buildup of compounds in the offices of academic investigators.* When the pharmaceutical firms discontinued the screening of compounds developed by academic investigators under NIH-sponsored research, and at the same time this research continued to grow, one would expect to see a large buildup of untested NIH-sponsored compounds in the investigators' offices. This has, in fact, happened with some academic researchers—those who have not switched their field of research to one of the two fields (cancer and malaria) where utilization of compounds has not been blocked. One senior researcher interviewed in this study pointed out several dozen cartons filled with 25 mg. bottles (he estimated that there were 750 items in all), each containing untested compounds that had come from his NIH research during the past several years. This man has several Ph.D. and postdoctoral candidates working for him, each of whom is annually synthesizing 30 to 40 compounds for which biological or pharmacological screening is not available.

(ii) *Lack of biological data relevant to the potential usefulness of a compound.* Many of the compounds that are screened at such sources as the government laboratories (CCNSC and WRAIR) just to obtain *any* biological data do not receive the type of screening most appropriate to their nature and potential usefulness. The pressure to obtain any biological data, regardless of relevancy, is a result of the requirements of such journals as the *Journal of Medicinal Chemistry* that papers submitted for publication contain the results of some pharmacological or biological testing of compounds.

To illustrate this effect, one academic investigator used what he termed a typical article from the *Journal of Pharmaceutical Sciences,* "Cylcic-methal-dopa Analogues as Potential Anti-Hypertensive and Anti-Neoplastic Agents." The introductory paragraphs say that certain amino acids are recognized drugs for hypertension, and that their structure suggests amino acids of new chemical structures which might be potentially more effective anti-hypertensive agents. The compounds (amino acids) described in the article were screened by the Southern Research Institute of Birmingham, Alabama, for CCNSC and were found to be nontoxic and inactive against the four test systems used by CCNSC. However, "owing to the difficulty of obtaining screening of compounds obtained under a grant from the National Institutes of Health, no data are keeping the equipment, material, animals, and other facilities carefully segregated for each project was a difficult administrative task—one, it seemed to him, that sometimes required half of the time he had allowed for research. Also, on one of his NIH grants, he had purchased expensive special equipment that had general application, but he felt that the then current HEW procedures for patent policy administration prevented him from using this special equipment for research under industrial grants.

At a third institution, the faculty operated under different procedures. All chemicals and other expendable materials purchased under grants were considered to be expended when received at the receiving dock, thereby eliminating the necessity to account for expendable material item by item. However, even in this institution, special capital equipment was kept segregated.

At still another institution, an investigator said that, although he had separate charge numbers from the business office for each of his grants, he pooled all money given to him for sponsored research. In one case when he needed a piece of capital equipment that would be used on both NIH and industrial grants, he took the $150 that the equipment cost out of the industrial grants because it made the procurement problems simpler (no $100 limitation on capital equipment), and he bought his chemicals and other expendables with NIH-furnished money. This man conceded that such commingling of funds might enable the Surgeon General to assert a claim to any work done under his direction, but he believed the chances that his research would result in an interesting series of compounds were small. And, he added, even in the event that he found significant leads, the Surgeon General was not likely to find out about his administrative procedures.

One academic investigator interviewed in this study had set up a complex system for keeping notebooks, compounds, and personnel segregated to the maximum practical extent in order to separate his industrial research projects from his government-sponsored research. His personnel were separated—even so far as to work in separate labs—according to whether they worked on industrial or on government projects. Consequently, he said, it was easy to separate purchases of equipment and expendables by grant number and to maintain this segregation of funds. He stopped short, however, of keeping the professional people under him from talking to each other, and he assumed that many of them, when the occasion arose, felt perfectly free to exchange ideas and intermediate compounds and even to process their compounds on each other's equipment when this seemed desirable in the interests of research.

The compounds coming out of the research were keyed by a serial number to a card file maintained by the professor which showed the name of the synthesizer, the pertinent page of his notebook, and the name of the sponsor of the research. Thus, when compounds were sent out for testing, this card file enabled the researcher to segregate quickly those compounds that could go to pharmaceutical firms from those that were restricted to government screeners or university screeners.

Because of his large number of research grants, this man had been audited by government teams sent out to establish that his procedures were effective. Although the auditors approved of his procedures, there still remained some questions as to whether the government could not aggressively assert claims to inventions if it wanted to do so, because of the intermingling of his personnel.

4. Alternative Screening Sources

a. *General.* There appear to be three alternative screening sources available to NIH as a substitute for drug industry screening services:

(i) *Government laboratories.* These include both the Cancer Chemotherapy National Service Center (CCNSC) and the Walter Reed Army Institute of Research (WRAIR).

(ii) *Commercial and nonprofit testing laboratories.*

(iii) *Academic screening services.* These include both those set up on an organized, continuing basis (for example, those operated by the Colleges of Pharmacy of the Universities of Illinois and Minnesota) and those functioning on a relatively random and *ad hoc* basis (for example, those operated by the chemistry and/or pharmacology departments of many institutions).

(For a summary assessment of the relative costs, effectiveness, and feasibility of the various screening sources, see Figure III-2.)

b. *Government Laboratories.* The government's screening operations are part of its programs in the fields of cancer and malaria research; CCNSC oversees the screening activities connected with cancer research, while WRAIR has the same function with regard to malaria research. Both CCNSC and WRAIR accomplish their testing largely through contracts with industry, and nonprofit and educational organizations, which perform most of the work involved in screening.

(i) *The Cancer Chemotherapy National Service Center.* The mission of CCNSC, which is directed by the National Cancer Institute, is to seek chemical cures for cancer. Aimed at controlling and

Full rights (except for a license to the government for medical research and certain march-in rights) to compounds submitted to the CCNSC for screening are normally left with the submitter. Thus, CCNSC screening procedures must provide for confidential, yet safe, handling of compounds and test results. For example, a candidate compound could be the proprietary result of a new pharmaceutical approach being worked on in secrecy by one firm. If this compound is unstable, highly flammable, explosive, toxic, corrosive, or dangerous in other ways, enough information must be conveyed to ensure proper handling and testing while, at the same time, protecting the proprietary position of the firm.

(ii) *The Walter Reed Army Institute of Research.* The annual budget for the Malaria Program at WRAIR is approximately $12 million, with about $4 million of this total being spent on screening. The primary screen for the Malaria Program is a mouse screen in which 1,000 compounds are tested each week by a contractor (the Malaria Program involves approximately 148 contracts). Because of the special nature of malaria, a screen involving mosquito tests is also used in the Malaria Program. In addition to mice, the Malaria Program uses a number of other species, including certain birds, swine, and gibbons, because of particular relationships in the mosquito life cycle that can be induced or observed only in these species. Problems associated with screening have led the Malaria Program to establish a colony of gibbons on an island in Southeast Asia and to hand-mate and genetically document special strains of mosquitoes.

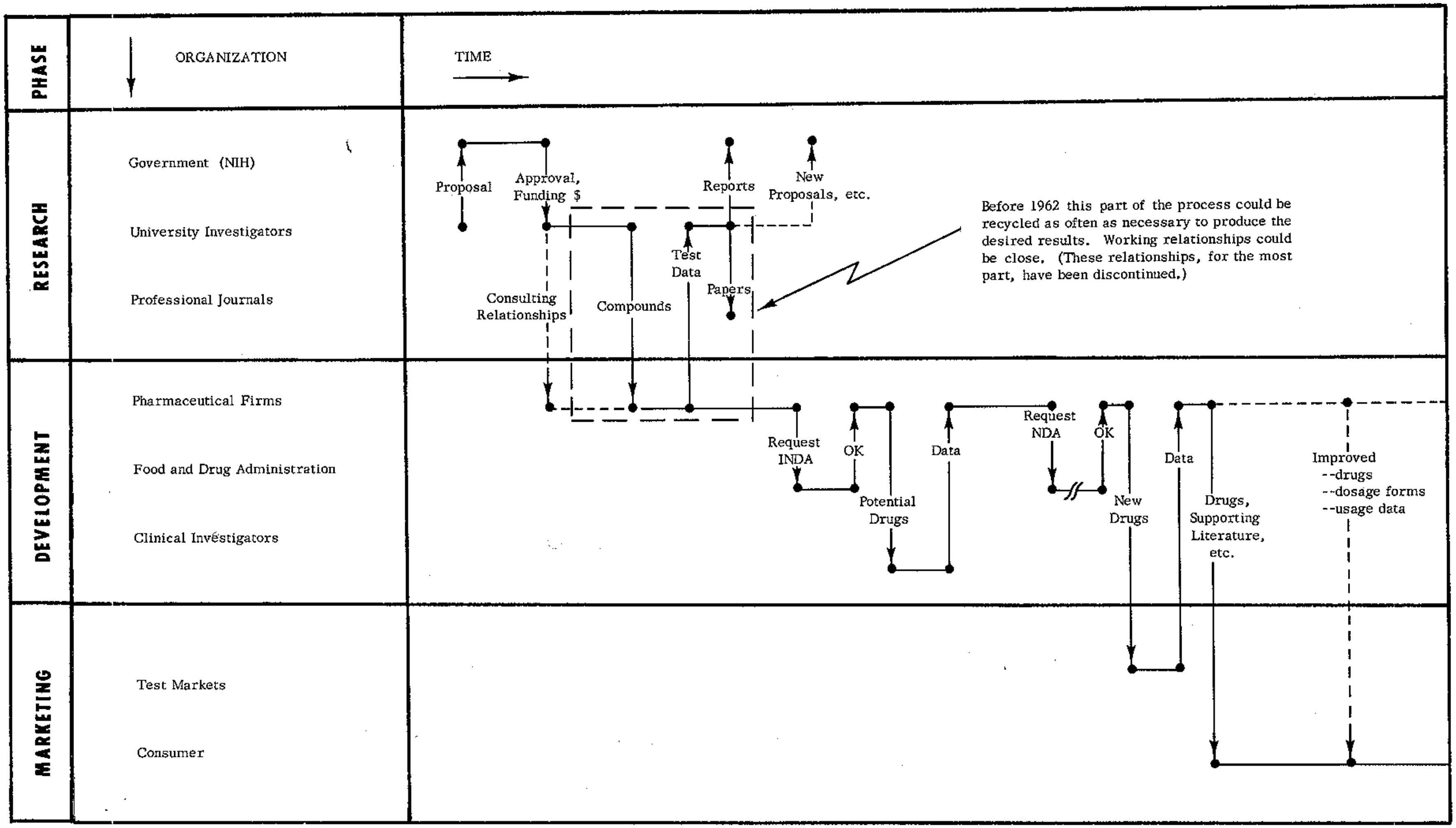
Input of chemical compounds to the Malaria Program comes from about 100 participating firms, many universities, and some interested individuals. Procurement of compounds from industrial suppliers is also undertaken—WRAIR ordered one sample of each of the approximately 10,000 organic chemical items in the catalog of a prominent research chemical supplier. The Malaria Program maintains a "scouting" force of three men who are constantly searching for interesting compounds and assisting chemists in preparing, packaging, and/or shipping compounds to WRAIR. The Malaria Program leaves all rights (except for a license to the government for medical or test purposes) to the submitter of a compound, and will handle the results of testing the compound as directed by the submitter.

To handle the management aspects of the contract activities for the Malaria Program, WRAIR employs a staff of 50 to 60 persons. Like the Cancer Chemotherapy Program, the size of the Malaria Program requires extensive standardization of screening activities, making it relatively unresponsive to specialized test and data requirements of individual investigators. Also like the Cancer Chemotherapy Program, this standardization of approach and the size of the screening efforts enable the per-compound cost of screening to be held down—in WRAIR's case, the per-compound cost of screening is $200. While the special difficulties involved in the specific disease area of malaria make this cost higher than the per-compound screening cost for the Cancer Chemotherapy Program, WRAIR's per-compound screening cost still is considerably lower than that of drug firms (see Figure III-2).

c. *Commercial and Nonprofit Testing Laboratories.* Commercial and nonprofit testing laboratories will generally work on any assignment for the government under contract. Examples of their government (CCNSC) contracts that indicate the range of screening services they provide are:

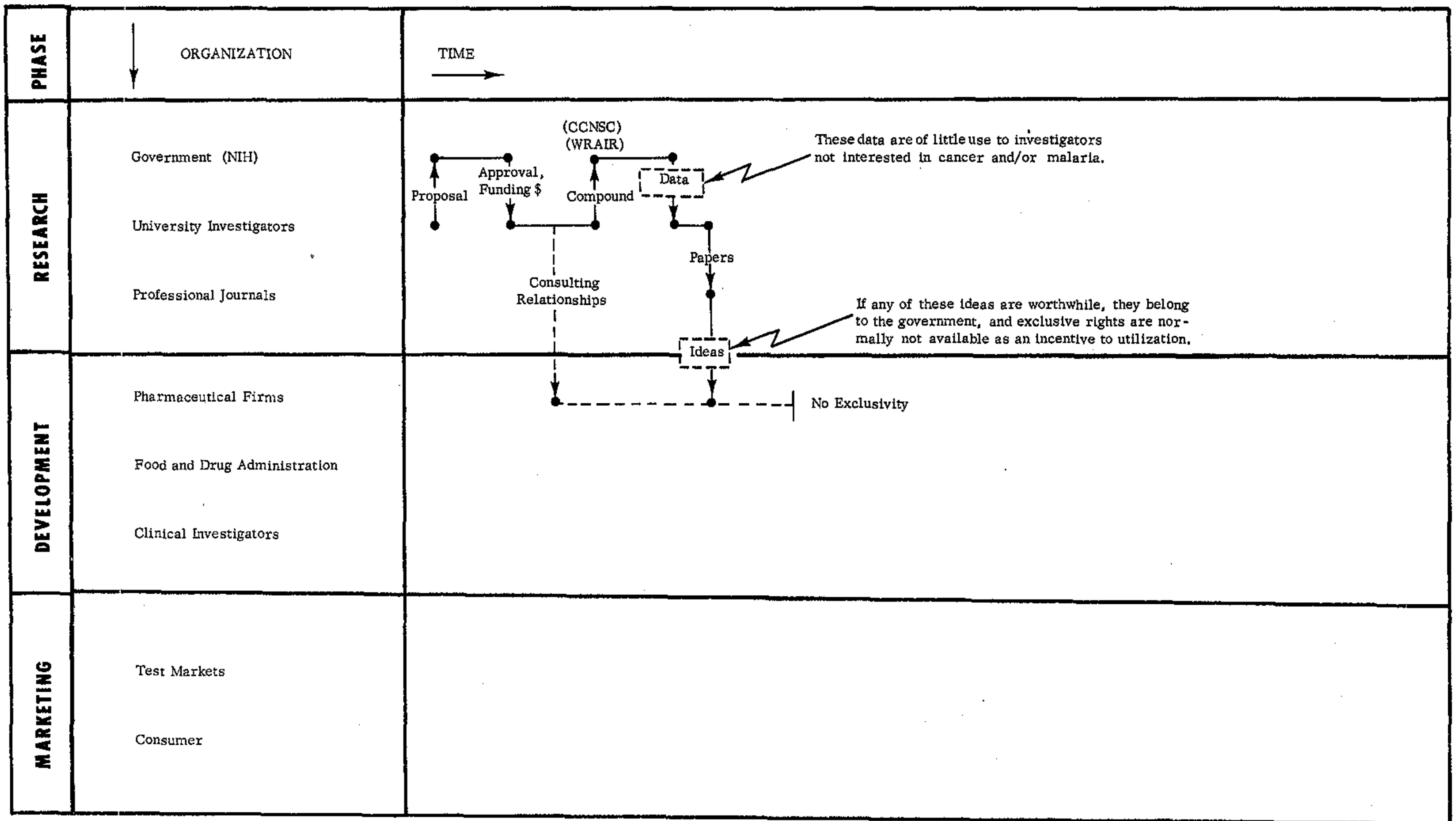
- *Laboratory A*
  - Natural Product Assay
  - In-Vivo Screening
  - In-Vivo Screening R&D
  - Experimental Therapeutics
- *Laboratory B*
  - Natural Product Assay
  - Synthesis
  - In-Vivo Screening
  - In-Vivo Screening R&D
  - In-Vitro Screening
  - In-Vitro Screening R&D
  - Experimental Therapeutics
  - Tumor and Cell Culture Banks
  - Biochemical Mechanisms
- *Laboratory C*
  - Natural Product Collection and Isolation
  - Natural Product Assay

FIGURE III-8
NIH-SPONSORED COMPOUNDS TESTED BY PHARMACEUTICAL INDUSTRY
(PRE-1962)*



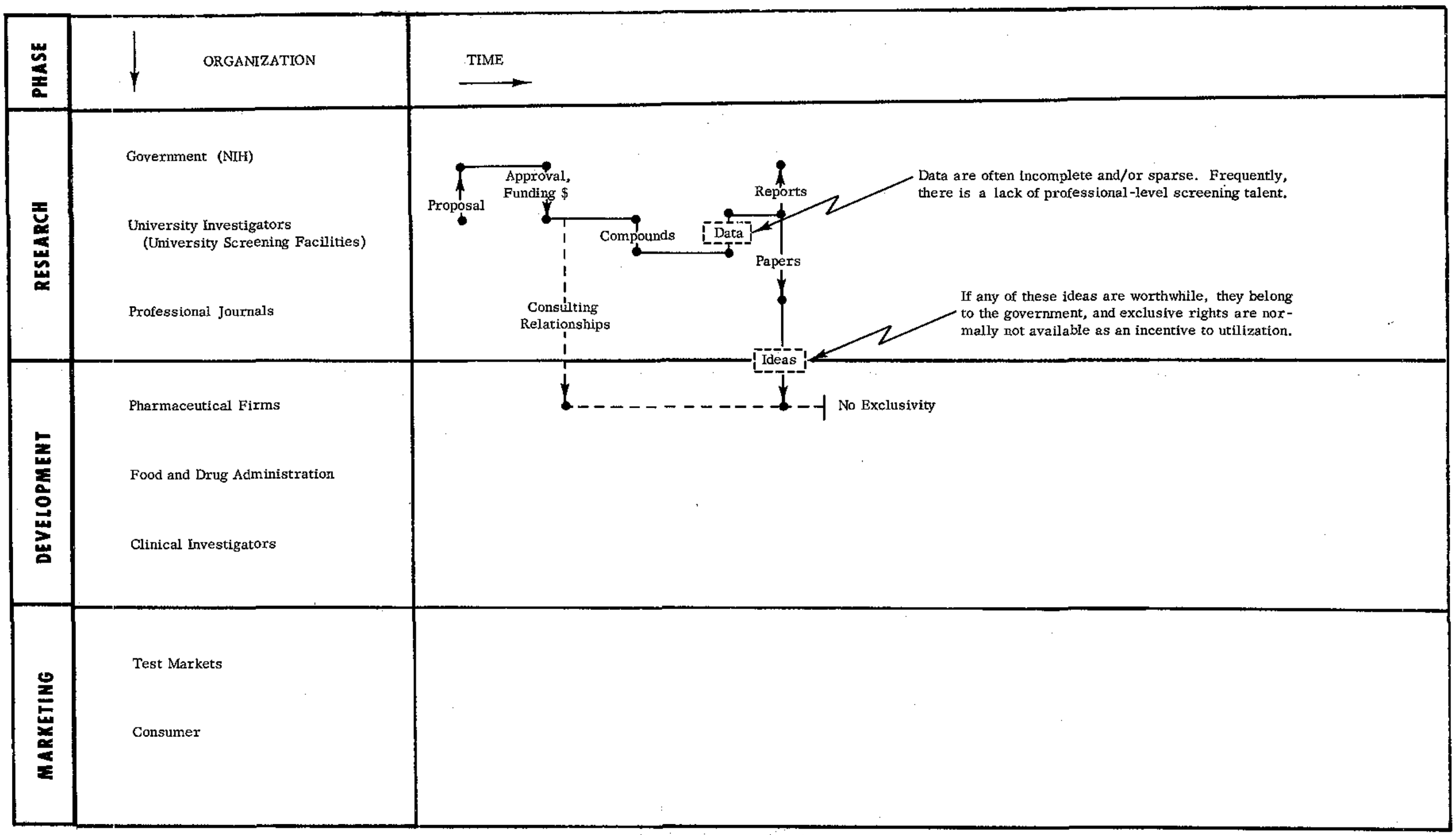
*The effects of the 1962 revisions to HEW patent policy procedures are represented in red.

FIGURE III-9
NIH-SPONSORED COMPOUNDS TESTED BY CCNSC OR WRAIR
(POST-1962)*



*The effects of the 1962 revisions to HEW patent policy procedures are represented in red.

FIGURE III-10
NIH-SPONSORED COMPOUNDS TESTED IN-HOUSE BY UNIVERSITIES
(POST-1962)*



*The effects of the 1962 revisions to HEW patent policy procedures are represented in red.

development, and marketing stages of the drug development process; vertical lines show interaction by way of transfer—of proposal, approval, compound, data, papers, application for FDA approval, ideas, and so forth—between the various organizations involved in the drug development process.)

Before the promulgation in 1962 of the new procedures for HEW patent policy administration, the interplay, as shown in Figure III-8, between the academic community and the drug industry was concrete and specific. A drug firm could actually work, in pursuit of its own interests, with a professor's compound; the professor received, in return, not only the kind of testing appropriate to his specific intentions and test data sufficient for publication, but also, in many cases, practical suggestions about continuation of his research, new avenues of investigation, and, sometimes, the opportunity to pursue further work under specific industrial research grants. The free pharmacological advice and counsel to which the academic medicinal chemist often had access was of the most practical and experienced type available anywhere. At the same time, the relationship between the academic investigator and the drug firm allowed for recycling—based upon test results—of the research. Positive test results from the drug firm could be incorporated readily into the investigator's research design for further work, and he was almost always assured of the availability of additional testing.

When the drug firms stopped testing compounds conceived or developed under NIH sponsorship, the investigators developing these compounds had to turn to other sources of testing—government, university, and independent testing laboratories. The advantages and disadvantages of these respective sources of testing can be summarized as follows:

- *Government Testing Laboratories*
  Although some attempt may be made by the two government laboratories—Cancer Chemotherapy National Service Center (CCNSC) and Walter Reed Army Institute of Research (WRAIR)—to accommodate the specific intentions of the academic investigator who developed the compound being screened, the high volume of tests usually precludes all but the most standardized screening for activity against the two disease systems, cancer and malaria. For example, although potentially analgesic, antihistaminic, or other compounds may be submitted to CCNSC or to WRAIR for testing on the outside chance that they may show activity (and often merely to allow the academic investigators to publish that the compounds have at least been tested for something), the compounds most likely will not be tested for their intended—and potentially most effective—uses.

- *University Testing Laboratories*
  University-run laboratories have only limited capability to carry out pharmacological evaluation beyond the first gross qualitative steps. In most cases, they have limited access to professional pharmacologists, no experience with FDA requirements and procedures, and little interest in active compounds beyond finding out why they are active.

- *Independent Testing Laboratories*
  Both types of independent testing laboratories—commercial and nonprofit—that evaluate academically prepared compounds must charge for their services so that their testing is self-supporting.[6] Although some of the independent testing laboratories can offer a rather complete line of pharmacological testing capabilities, costs tend to be beyond the scope of the academic investigators' grant budgets. Representatives of one independent testing laboratory, an organization capable of performing a fairly complete range of services for academic investigators, said that there have been only a handful of tests performed for principal investigators in the 15 or so years of the organization's experience, and that the total value of all of this work would not exceed $10,000. They attributed the low volume to the costs that they had to charge in order to earn a profit from testing. In some cases, nonprofit organizations may have grants that allow them to run specific screens; however, this is not true in all medically interesting areas.

As Figures III-9, III-10, and III-11 show, it does not seem to matter much which screening source other than drug firms is used to test the NIH-sponsored compounds—the result is the same (except in the case of a compound that proves useful in treating cancer or malaria.)[7] Having to do without the drug firms' screening services—which in their total range include specific

[6] In contrast, testing by a pharmaceutical firm is essentially a by-product of its need for research, testing by government agencies is funded because of important national goals, and testing within universities is squeezed out of operating budgets by interested faculty members.

[7] Because of the large amounts of money available for cancer research and malaria research, the availability of testing facilities in these fields, and the fact that compounds in these fields seem

Footnote continued on next page.

FIGURE III-13
CONCEPTUAL REPRESENTATION OF VARIOUS SCREENING ALTERNATIVES

Organization	Source of Compounds	Test Area	Test Output
Pharmacology Department in Industry (Research Department)	Inventory of Compounds	Pharmacology Department (Broker--responds to market needs)	Evaluation Against Market Needs (usually defined by clinical requirements--that is, the diseased population)
Pharmacology Department in University Medical School	Access to Compounds Both Internal and External	Pharmacology Department (Responds to needs for new knowledge)	State-of-the-Art Studies --Structure/Activity --Chemical Mechanism --Metabolism --Etc.
Commercial Test Organization	Specific Compounds In	Test Organization	Specific Results Out (usually on a custom order basis)

PART IV. The Department of the Interior Programs

A. Scope of Investigation

The case studies in this task were based on data obtained from three major organizational elements of the Department of the Interior: the Office of Saline Water (OSW), the Bureau of Reclamation, and the Bureau of Mines (see Partial Organization Chart, Figure IV-1). The following paragraphs briefly describe the functions and research activities undertaken by these various offices and bureaus.

1. Office of Saline Water

The Office of Saline Water provides research and development of methods for the economical conversion of saline water for agricultural, industrial, municipal, and other beneficial uses. Its program includes both basic and applied research. Basic research activities encompass the investigation of new theories, principles, and phenomena in any field of science potentially useful to saline water conversion. Applied research activities encompass the development of practical applications of saline water conversion to production devices, systems, materials, and processes, including pilot plants, cost estimates, designs, and production engineering.

The OSW research program is conducted through research grants to, and contracts made with, chemists, physicists, engineers, educational institutions, scientific organizations, and industrial and engineering firms.

2. Bureau of Reclamation

The basic mission of the Bureau of Reclamation includes the location, construction, operation, and maintenance of facilities for the storage, diversion, and development of waters required for the reclamation of arid and semiarid lands in western United States. In support of this primary mission, the Bureau conducts a continuing research program to determine economical ways of reducing the evaporation of water from reservoirs, of sealing irrigation canals and concrete pipelines against seepage, of curtailing the growth of water-wasting vegetation, of finding more effective construction materials, and of advancing underground electric power transmission technology. This research is conducted both in-house—by the Bureau's own personnel—and through contracts with private firms and universities.

3. Bureau of Mines

The basic mission of the Bureau of Mines is to conserve and develop mineral resources and to promote safe and healthful working conditions in the mineral industry. Its programs encompass the following areas:

(i) Mineral research—R&D in mining, beneficiation, and metallurgy to ensure adequate supply of mineral commodities.
(ii) Fuels research—R&D activities to minimize waste, increase efficiency, and promote the use of uneconomical fuels.
(iii) Explosive research—R&D studies of the explosion hazard of dusts, fumes, and gases, to promote safety.
(iv) Mineral resources research—R&D studies to evaluate marginal mineral and fuel deposits, mining methods, production techniques, and long-range trade-off requirements for resources.
(v) Helium research—R&D of helium production, conservation, distribution, and transportation.
(vi) Health and safety research—R&D studies to devise acceptable operational standards and to train personnel in safe practices and rescue and recovery methods.

Research activities in these areas are generally conducted at Bureau field establishments, research centers, and research laboratories by full-time government employees—as opposed to being conducted through research contracts with, or grants to, private firms and educational institutions. Some research activities, however, involve cooperative agreements with private industry and universities. Agreements with private industry work in one of two ways. First, a cooperative agreement may involve a firm's funding of a specific study or experiment to be conducted by Bureau personnel using Bureau facilities. Second, the agreement may involve a study or experiment conducted by Bureau personnel at the firm's mine or plant using the firm's facilities, test beds, and personnel. Cooperative agreements with universities generally involve the Bureau's funding a fellowship program, whereby a student designated as a fellow conducts basic research in an area of mutual interest.

Regardless of the method used for obtaining research support, OSW, the Bureau of Reclamation, and the Bureau of Mines are all governed by the patent policy established and administered by the Office of the Solicitor of the Department of the Interior. This policy

1965 which specify that title to inventions—both domestic and foreign—will be vested in the government; background patents will be licensed on a royalty-free basis to the government and, at reasonable terms, to any responsible applicant.

State University immediately took exception to the patent provisions arguing that the definition of "governmental purpose" as it related to the rights of state or municipal governments went beyond the university's interpretation of the term and beyond that of the President's Patent Advisory Panel. According to the university, a literal meaning of the provisions as drafted would require that any field invention made by a staff member at any university campus, whether or not funded by the contract, would belong to the government. The university also argued that it did not know what the background patents might be until foreground inventions existed.

As an alternative to the standard provisions, the university requested using the patent clause set forth in Armed Services Procurement Regulations 9-107.5. Although the issues were never overtly resolved, the university capitulated under protest and signed the contracts nine months after the issue arose. The delays were attributed solely to the dispute regarding background patent provisions.

CASE 4

In March 1966 Ivy University submitted a proposal to the OSW to develop a method of desalination utilizing enzymic membranes. Proposal revisions were completed in June and OSW sent a grant to Ivy for execution. Ten days later Ivy returned an executed copy of the document with an endorsement stating that its acceptance was based on the substitution of its own patent provisions for those of OSW. The school stated that the Office of Naval Research and the Department of Defense had agreed to Ivy's provisions in previous contracts, and it was hopeful that OSW would likewise consent.

OSW replied that the university provisions differed in too many respects from OSW requirements and, hence, were unacceptable. Eventually, Ivy agreed to the OSW background and foreground patent clauses. The major remaining issue was the warranty clause covering employees. Ivy indicated that it did not take title to inventions or patents and consequently did not have any existing agreements with its personnel regarding inventions, as stipulated by paragraph B of the OSW warranty clause.

With the assistance of the Office of the Solicitor, Ivy modified the warranty clause thereby shifting responsibility for compliance with patent provisions to personnel working under the grant. Ivy assigned responsibility to itself to obtain suitable employee agreements in order to enforce compliance from personnel working on the contract. Approximately two and one-half months were lost on the project because of the patent issues raised and the negotiations required to settle them.

CASE 5

In February 1965, the CHM Corporation contacted the Bureau of Mines to ascertain interest in a cooperative project relating to explosives research. Two months later the Bureau and the corporation negotiated a cost sharing contract containing the patent clause then used in such cooperative agreements. At approximately the same time, however, the Office of the Solicitor notified the Bureau that a new patent clause was required in cooperative agreements. The new clause called for assigning title of subject inventions to the government and for the Bureau to determine the disposition of foreign rights after the invention was identified. In addition, it required that a license of necessary company-owned background patents be issued to any responsible applicant. CHM Corporation balked, arguing that the clause went much further than the ASPR clause had required under cost sharing research and development contracts. In addition, the contract was related to an area in which the corporation had "an established nongovernmental commercial position." It therefore requested a patent clause which would provide only a nonexclusive, royalty-free license to the government.

The Office of the Solicitor explained that the Department of the Interior was governed by Kennedy's Statement of Government Patent Policy of 12 October 1963, rather than by ASPR. The corporation restated its objections, pointing out that it had invested a large amount of time, research effort, and money in the technical area involved in the agreement, and had obtained patents on several inventions and it could not "in good conscience, in the husbanding of a valuable corporate property, run the risk of having earlier rights diluted, diminished, or relinquished to the public because of a possible broad interpretation of the 'background patents' sections."

After two more months of negotiations, the corporation capitulated with the comment that it was doing so only because it was certain that nothing patentable could possibly result from the study.

CASE 6

In the late spring of 1965 the ARNT Laboratory approached the Bureau of Reclamation concerning a conventional material. After six months of negotiation, provisions were drafted which were acceptable to both parties.

c. *Patent Clauses in Subject Contract, Grant, or Cooperative Agreement Differed from Clauses in Previous Contracts with Same Office or Bureau.* In 7 of the 24 cases, this issue was raised during negotiations or discussions. In some of the cases, different clauses were required because of changes in the department's basic patent policy. The company in Case 16, below, for example, was caught in a major departmental change from a license to a title patent policy. The companies discussed in Cases 7 and 14, above, were also asked to accept new clauses in new contracts and amendments to existing contracts. In one case, a clause was included and accepted by the company in a draft cooperative agreement. Before the Bureau of Mines had signed the agreement, however, a new patent clause was issued by the department. The attempt to secure consent for the inclusion of this clause touched off the patent issue in that case. A similar incident in Case 15, below, required some skillful negotiations on the part of the department to overcome the patent problems.

In other cases, changes in patent clause from one contract to the next were required because of differences in the circumstances surrounding each effort. This did not prevent the companies from disputing the changes, however. For example, in two previous contracts the company discussed in Case 12, above, had worked under clauses that provided for royalty-free use of inventions by the government, up to and including the demonstration plant phase, after which royalties would be paid by the government. It insisted on seeking the same arrangement in a subsequent contract, which the department contended was not at all similar to the first two.

Case 15, below, demonstrates the problems created by a company's attempt to secure, in a second contract, clauses and concessions appearing in the first. In the first contract, a number of changes in "specific understandings" of the patent provisions had been negotiated over a nine-month period. When the second contract was negotiated, equally extensive negotiations were required to make essentially the same changes. In addition, a number of "specific understandings," agreed to in the first contract, were not approved by the department in the second, a situation that increased the difficulties of the negotiations.

d. *Title to Inventions Would Be Assigned to the Government.* In 4 of the 24 cases, an objection to the title stipulations of the patent policy was made for various reasons. For example, Creative University stoutly maintained that this provision was contrary to the philosophy behind United States patent laws, which were developed to protect the inventor, while at the same time encouraging him to disclose his discoveries. The company in Case 16, below, contended that it should be permitted to retain title to inventions because of an established company-funded patent position. Fresh Water Chemical Company, on the other hand, stated that it desired clear title to patents for subsequent marketing activities. The company noted in Case 14, above, simply maintained that it was company policy to retain title to inventions of its employees.

CASE 15

In the fall of 1964 SWTW Corporation submitted a proposal to the Office of Saline Water (OSW) to conduct a feasibility study of a piezodialytic system. The objective of the study was to increase understanding of methods for protecting desalination equipment against corrosive attack by flowing sea water. For the past ten years, SWTW's principal manufacturing and marketing activities had been based upon the scientific process of electrodialysis—a process closely related to piezodialysis.

OSW's draft of the proposed contract included three alternatives regarding domestic patent rights from which SWTW was to choose one. They were:

(i) Sole title in government;
(ii) Joint title in government and contractor; or
(iii) Sole title in contractor; government has right to issue sublicenses.

SWTW chose alternative (iii) because piezodialysis was so closely related to the commercial item, electrodialysis, that both would necessarily have to draw upon the same reservoir of skills and expertise. SWTW fully expected that the two programs would be mutually beneficial, and that any inventions concerning the piezodialytic process would incorporate a valuable property right of the company.

However, SWTW desired a clear title to any inventions pertaining to piezodialysis for subsequent marketing efforts. The corporation argued that it had used corporation funds to reduce to practice membranes and apparatus suitable for piezodialysis prior to communicating the process to OSW and prior to any understanding that a research contract might be awarded.

The Office of the Solicitor and corporation counsel negotiated patent clauses from February until 21 April 1965, when OSW refused all of the requested changes except to grant the contractor a royalty-free license in government-held foreign patents. SWTW agreed to accept the patent clauses provided that the release of cooperative effort between Mineral Corporation and the center was attempted.

i. *Miscellaneous Objections.* In addition to the eight cited objections, there were a number of miscellaneous issues raised by a single company or university in the cases above. For example, one company objected to the department's patent policy because the cooperator might well introduce some advanced thinking during the work that should normally result in patents to his company. Since the government was bringing no prior experience or knowledge to the proposed cooperative effort, it had no right to title to any inventions arising from the work.

Another company pointed out that in cooperative agreements the company or cooperator was funding the government work on the effort. Accordingly, it should be entitled to inventions made during the study only.

One of the universities maintained that a grant that included detailed patent provisions was, in fact, contract. By imposing the more restrictive provisions of a contract, the university stated, the government was restricting creative research, as well as doubting the integrity of the grantee institution and principal investigator.

The firm referred to in Case 22, below, wanted to interpret the government contract law in the light of accepted patent practice. That is, it argued that an invention which had been "constructively" reduced to practice should be classified as a background invention. The clauses, however, require an "actual reduction to practice" before it can be considered a background invention.

CASE 22

Lexington Chemical Company was a subcontractor to a prime contractor working on the development of a thin film membrane device for desalination of water by reverse osmosis for OSW. In 1964 the subcontractor argued that any issued patent should be regarded as a background patent within the framework of the proposed contract patent article, and title to it should not pass to the government. Lexington's patent counsel advanced three arguments to support the company's position:

(i) That, under the law, the filing of a patent application is a constructive reduction to practice for legal purposes, and, therefore, there should be no distinction made in the contract language between a constructive and an actual reduction to practice.

(ii) That the invention in this case was "entirely clear and readily understood by anyone of ordinary skill" and, although no prototype or model had actually been constructed, such construction would be "simple and straightforward and should not offer any very difficult engineering problems."

(iii) That Lexington Chemical Company had expended substantial sums in developing the invention and in preparing and prosecuting the patent application.

The Office of the Solicitor, after reviewing Lexington Chemical Company's position, requested evidence of reduction to practice in order to permit classification of the invention as a background invention. The subcontractor submitted laminate samples and an extended argument of its expenditures in major membrane work.

The Office of the Solicitor, however, felt that the patent claims extended beyond the actual reduction to practice by the company, and it was not possible within the framework of existing Department of the Interior policy to treat the invention as a background invention at this time under the pending contract. In a letter of January 13, 1965 the Solicitor stated the following:

> The definition of "Subject Invention" includes any invention or discovery first conceived or actually reduced to practice in the course of or under the contract. Hence, if the invention covered by your patent is first actually reduced to practice outside the OSW contract, it would not be a Subject invention and would, in proper circumstances, be a Background Patent when a patent issues.

Lexington evidently accepted this reasoning and the government patent provisions without raising additional issues. The contract was executed in March 1965, after a delay of four months.

CASE 23

In November 1963 the research director of the Bureau of Mines approved the preliminary plan of a program in solution mining, submitted by Mining Research Center. The Bureau had had no previous experience in solution mining and thus lacked personnel with the requisite capabilities to start the program. About a year after the preliminary plan had been approved, therefore, the research center turned to the recognized leading authority in this area, the International Solution Mining Company, and initiated preliminary inquiries about cooperative support.

Solution Mining was enthusiastic about the proposed solution cavity experiment and said that it foresaw no

PART V. Industrial Disenchantment

A. Introduction

Parts II through V of Volume II report instances where patent policy has either discouraged or delayed industry participation in government R&D programs. The drug industry response to NIH work (Part III, above) is the most extreme example of discouragement encountered in our study. Significantly, the response of the drug industry was occasioned more by concern for protecting proprietary rights from its own R&D programs than by a desire to acquire patent right from the government.

Interviews with 21 utilizers (both high and low) of inventions arising from government-sponsored research (see Volume IV of this report) indicate that not all companies or industries are equally sensitive to government patent policy, and that patents play a secondary role in the operation of many firms. For these firms, shifts in government policy—short of acquiring rights in the firms' established patents—would have little or no effect on their participation in government R&D programs. For other companies, a shift in government policy would be critical. Section B, below, reports on the six dominant attitudes toward patents revealed in the interviews, and comments on the probable effect government policy changes would have on firms sharing these viewpoints. Figure V-1 groups the companies interviewed according to the most prominent attitude observed in these companies, which are discussed at greater length in Volume IV.

B. The Six Dominant Attitudes

1. Patents Have No Importance to the Firm's Business Activities.

A lack of interest in patents was characteristic of both research-oriented and manufacturing firms that do a preponderance of their business in the government aerospace and defense markets. No desire to expand into commercial markets and no mechanism for the commercialization of inventions were noted. When these firms obtain patents, their sole purpose is recognition within the company of technical competence. A change in government policy with respect to ownership of patents would have little effect on the business activities of firms in this category because of their underlying lack of interest in patents.

2. Patents Have Little Value to Business Activities, Compared with Accumulated Technical and Management Competence, Production Capability, and Corporate Reputation.

Firms expressing this attitude toward patents were generally manufacturers of complex systems and

FIGURE V-1
DOMINANT INDUSTRIAL ATTITUDES TOWARD PATENTS
AMONG COMPANIES INTERVIEWED

1. *Patents have no importance*

Company F
Company K
Company A

2. *Patents are of little value, compared with technical know-how*

Company E
Company B
Company O
Company P
Company Q
Company U

3. *Patents are valuable for defensive purposes*

Company B
Company G
Company H
Company I
Company O
Company P
Company R

4. *Patents are important in establishing proprietary positions*

Company C
Company J
Company L
Company T

5. *Patents are essential to business activities*

Company L, Company M, Company N — Pattern 1

Company C, Company D — Pattern 2

6. *Patents are judged differently in commercial and government work*

Company C
Company D
Company S

The majority of firms following the second business pattern never have any proprietary expectations for government contracts. Any change in government patent policy respecting license and title rights would have little effect on these firms since they have already divorced their corporate interests from government contract work and do not regard government-sponsored R&D as a source of commercial ideas. Firms following the first pattern, however, would be severely affected since their business activity is based largely on government-sponsored research that may develop commercial applications. Corporate ownership of patents is, therefore, an essential feature of the growth strategy of such firms. If title to inventions arising from government-sponsored research were to become unavailable, such firms would either have to change their mode of business or refuse to contract with the government.

6. Patent Rights in Commercial Activities and in Government Activities Are Judged by Different Standards.

Many diversified companies follow different patent policies in their commercial and government markets. These firms place a strong emphasis on maintaining proprietary positions in commercial markets and express a relative lack of interest in patents arising from government work. The primary purpose of securing patents on government-sponsored research discoveries as in the case of the wholly government-oriented firm, is to provide professional recognition for technical personnel. Changes in government patent policy would not provide any incentive to these firms to utilize the technology and would not, in most cases, affect their willingness to participate in government programs.

APPENDIX A

THE DRUG DEVELOPMENT PROCESS

LIST OF FIGURES

EXHIBIT

Appendix A

The Drug Development Process

A. Introduction

To provide a necessary background to the data obtained during this study, Appendix A provides a brief general description of the drug development process. It covers the process from its beginning—the conception of the idea for a new, potentially useful medicinal compound—to the achievement of its ultimate objective—the marketing of the new product as a drug that is valuable from a medical standpoint and profitable from a financial standpoint.

A potential medicinal product must undergo three basic steps of development (see Figure A. 1 for a graphic summary of the three steps) before it can be marketed as a drug:[1]

(i) *Preparation.* In this step, potentially active compounds are developed, either through extraction from biological and botanical raw materials (plants, animals, microorganisms) or through synthesis from various chemical raw materials. While the end product (usually a novel class or family of chemical compounds) of this step represents the end of the search for a compound, it is only the beginning of the search for a new drug.

(ii) *Screening and Evaluation.* In this step, the compound is analyzed, through initial testing, for its effects on biological systems and its possible utility. Favorable results in initial biological tests (generally known as primary or broad screens) on mice and rats usually call for additional testing (specific pharmacological studies) in order to evaluate more specifically the compound's biological effects on several species of animals, since some species are unaffected by compounds to which others are very sensitive. As long as test results continue to be positive, this part of the screening and evaluation step continues until enough data are obtained to file an Investigational New Drug Application with the Food and Drug Administration (FDA) which is necessary before the next step of the drug development process can begin.

(iii) *Clinical testing.* In this step, clinical tests are conducted on humans to secure enough evidence on the new product's potency, side effects, and toxicity to satisfy the FDA that the product should be marketed.

Successful drug development resulting from a promising lead in initial screening typically takes three to six years. Many drugs have taken longer to develop, however, and many promising screening leads never reach the marketplace or even clinical testing due to technical or economic problems.

B. The Three Steps of the Drug Development Process

1. Preparation

After the idea for a new, potentially useful medicinal compound has been conceived, the investigator begins a search for the substances that will be most likely to realize the desired end product. The nature of the search depends upon the investigator's particular approach. Some investigators specialize in isolating, by appropriate extraction and verification procedures, the potentially active substances of biological and botanical raw materials. Other investigators find their chief interest in designing, validating, and performing the synthesis that will lead to new, potentially active compounds from various chemical raw materials. The work in both cases is generally performed in either industry or academic research laboratorys by skilled (often Ph.D.-level) personnel, and is often quite time-consuming and costly, involving years of library research, trial-and-error experimentation, and considerable expenditure of material before success is achieved.

For example, a specialist in natural products research was working in a laboratory on the east coast of the United States, under an NIH grant, on the extraction of substances from certain West African plants. These plants had to be found, cut, prepared for shipment (by drying and other processing), and shipped under carefully controlled conditions to his laboratory, where the potentially active substances would be extracted. Considerable expenses was incurred in the initial procurement of the materials in bulk quantities (running

[1] As used in this report, "drug" means, in general, the sum total of a particular compound, its dosage form, its packaging and labeling, Federal Drug Administration approval for marketing, and the promotional effort integral to marketing. Federal Drug Administration approval for marketing represents the critical turning point in the evolution of a compound into a product recognized as a drug.

FIGURE A-1
PHASES OF DRUG DEVELOPMENT

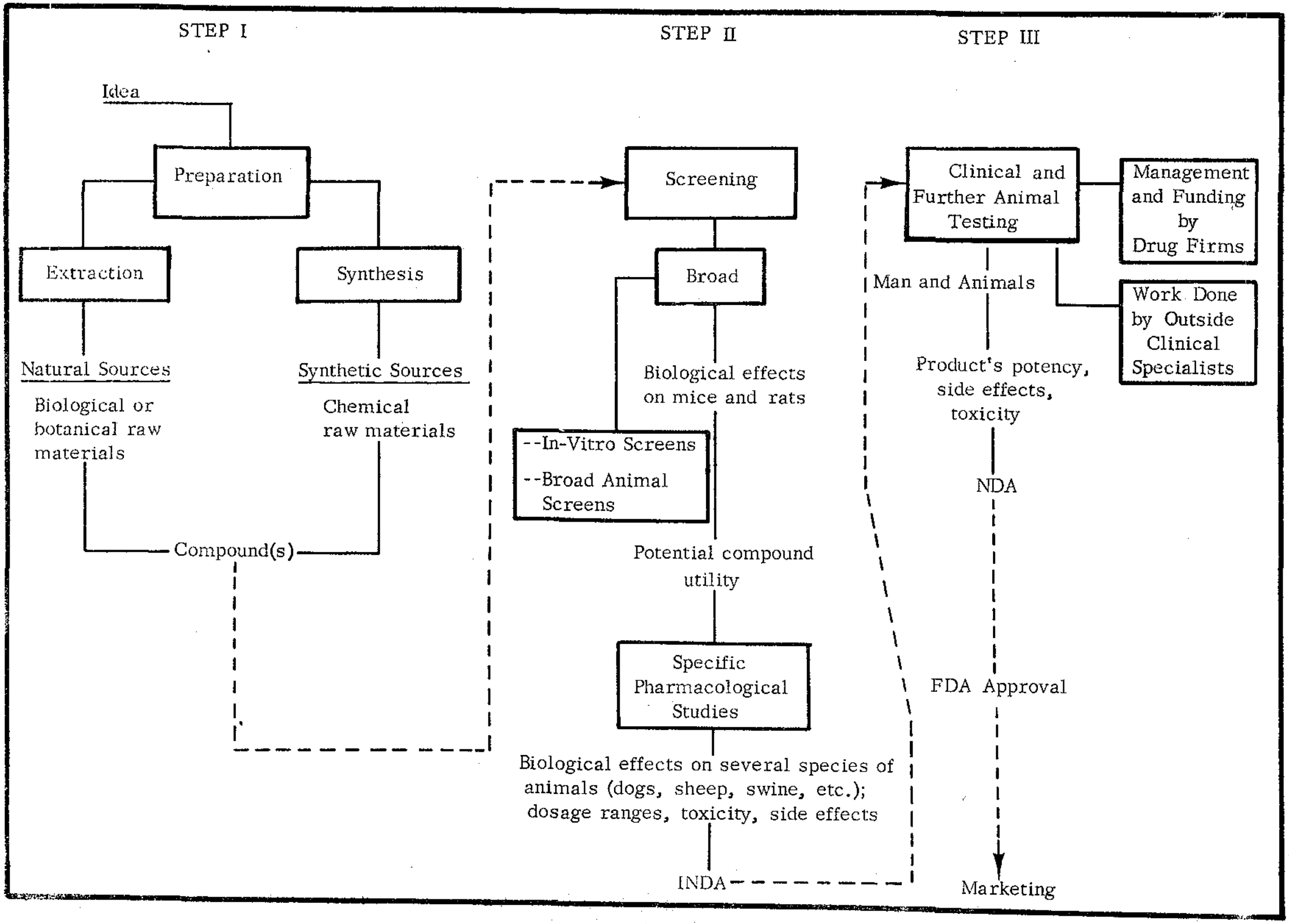


FIGURE A-2
TYPICAL FORM USED IN REPORTING
RESULTS OF INITIAL BROAD ANIMAL SCREEN

Date ________________ Qualitative and Semi-Quantitative Screen and
Toxicity Report of: ________________
Sample Vehicle: ________________ Conc.: ________________ mg./ml.
Sample Dosage: ________ mg./Kg.; Notebook no. ________ pp.

-Response (0 - ++++)

Parameter ↓ ;Time →	C									
CNS										
Motor Activity										
↓ Ataxia										
Loss Righting Reflex										
Analgesia										
Anesthesia										
Resp. ↓ Rate										
Depth										
Loss Corneal Reflex										
Loss Pinnal Reflex										
↓ Back Plasticity										
Paralysis: Fore Legs										
Hind Legs										
Neck										
Screen Grip: F. L. loss										
H. L. loss										
Motor Activity										
↑ Fine Body Tremors										
Coarse Body Tremors										
Fasciculations										
Back Tonus										
Convulsions: Tonic										
Clonic										
Mixed										
↑ Resp. ↑ Rate										
Depth										
EYES										
Enophthalmos										
Exophthalmos										
Palpebral Ptosis										
Pupil Size, mm.										
Pupil Size, mm. (lite)										
Nystagmus										
Lacrimation										
"Bloody" Tears										

OTHER NOTES: Associate observation with specific time post-dosage.

Test Animal: ________________ Fasted? ________ Sex: ________
Mark: ________ Color Mark: ________ Wt., Gms. ________ Cage: ________
ml. injected: ________ Route inj.: ________ Time inj.: ________
Tested by: ________ Evaluated by: ________

-Response (0 - ++++)

Parameter ↓ ;Time →	C									
EARS, ORAL MUCOSA										
Blanching										
Hyperemia										
Cyano-, Metachrosis										
GENERAL										
Salivation										
Tail Erection										
Grasping										
Lashing										
Pilomotor Erect.										
Robichaud Test										
Circling Motions										
Abdom. Griping										
Cheyne-Stokes										
Priapism/Colpect.										
Micturition										
Diarrhea										
Rectal Temp. °C										
Body Wt., Gms.										
SUBJECTIVE										
Head Tap: Aggress.										
Passive										
Fearful										
Body Grasp: Aggress.										
Passive										
Fearful										
Statue Positions										
Excess Curiosity										
Startle Sensitivity										

DEATH AND AUTOPSY NOTES (Note: Resp. or Cardiac Arrest - systole or diastole; color: intest. wall and lungs, other organs. Be specific. Use back of sheet if needed)

Note all sterotypy. Use back of sheet as needed.

c. *Pharmacology Investigation*

If the board screening produces interesting results that indicate further evaluation is desirable, the compound will undergo specific pharmacological testing. This aspect of work involves tests designed to provide quantitative information on the compound's toxicity (lethal dosage), effectiveness, side effects, methods of administration (such as intravenous, oral, or rectal), and so forth. This information will be used to support an Investigational New Drug Application (INDA) filed with the FDA to permit subsequent investigational testing of the product on humans in a clinical setting. And further testing on animals may proceed concurrently with clinical testing on humans described in 3. below.

The tests carried out during this part of development work can be quite expensive. Toxicity and dosage parameters are usually checked out experimentally in at least two, and sometimes several species of animals, since some animals are unaffected by compounds to which others are very sensitive. Dogs and rats are used most often, and sheep, swine, various primates, and other animals are used when necessary. (The purebred beagles and monkeys often used in these tests can cost upwards of $200 each.) To satisfy experimental requirements all animals must be bred, raised, selected, and cared for under carefully controlled conditions. Contamination of experimental results from uncontrolled sources–such as disease or genetic abnormalities of the experimental animal–can waste a lot of valuable data. In additional to meticulous care for experimental animals, some tests require special training, conditioning, or processing of the animals prior to testing. For certain tests of psychopharmacological activity or behavioral reactions, both control and experimental animals must be trained or preconditioned in certain routines in order to measure deviation from these routines. For tests of cardiovascular effects, one firm maintains a colony of dogs–specially bred and prepared for tests–worth about $50,000 each if one amortizes the costs of facilities and operation.

3. Clinical Testing

Some firms have small clinical facilities, but most companies engaged in drug development rely on well-established outside professional contacts (physicians who are clinical specialists) at hospitals, medical schools, medical centers, and prisons to perform the clinical investigation of a potential new drug. These companies use their own research funds to support the professional skills (medical care, pathology, clinical pharmacology), laboratory work, and facilities required for the clinical tests.

The approach to the clinical testing of a particular potential drug depends upon the nature of the disease or disorder involved. For example, the Walter Reed Army Institute of Research (WRAIR) is sponsoring a malaria research program in which paid volunteer prisoners are infected with the resistant strains of the disease and potential cures are tested. In the case of diseases such as cancer, however, it is ethically impossible to infect a human purposely or to use many of the drugs which may be hazardous to health in themselves. The obstacles involved can make clinical testing of such diseases very complicated and time-consuming.

Clinical data serve as the basis for submitting a New Drug Application (NDA) which must be approved by the FDA before the drug can be marketed. Areas that must be covered in the backup data supporting an NDA include specific drug effectiveness, toxicity, specific side effects (abnormal effects on bodily functions, such as respiration and blood pressure, and on mental performance and attitudes), requirements for and limitations on administration of the item[7] (for example, not for pregnant women, not for patients with high blood pressure, contraindicated for hyperexcitable peersons), and symptoms of overdosage and complications from using the drug and appropriate measures for relief.

Because of the tremendous amount of data required and the involvement of human experimental subjects, the clinical phase of testing is very expensive and may take one to four years to complete. One drug company interviewed in this study said that the preliminary testing in man for a successful new medicinal compound took 24 months and cost approximately $350,000, the large-scale testing in man took 24 months and cost approximately $500,000, and the process of filing the NDA and obtaining FDA approval for marketing took another 30 months and cost approximately $800,000.[8]

The length of time required for processing an NDA showed a marked increase in 1963 [see Figure A-3, showing FDA processing time for human NDA's (veterinarian NDA's not included)] after passage of the new drug regulations. The approval procedure was changed from 60 days for review and an automatic right to

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[7] As a result of the thalidomide controversy and the 1959-1962 Kefauver Hearings (in which the profits, pricing, quality control, advertising, and product selection policies of the drug industry were investigated), the FDA since 1963 has required increased testing to establish safety and specific effectiveness parameters of all candidate drugs in a wider range of circumstances (pregnancy, use of drugs in combination, prolonged administration, and so forth).

[8] To put these figures in perspective, this firm estimated that, on a total-compound basis, 60 percent (between $20 and $30 million) of its annual research budget was spent prior to clinical testing and the rest of the budget was spent on clinical or clinically related testing.

FIGURE A-5
NUMBER OF HUMAN NDA'S SUBMITTED TO AND APPROVED BY FDA*

Year	FDA Figures	
	Number Submitted	Number Approved
1958	353	208
1959	375	231
1960	321	165
1961	276	133
1962	282	109
1963	191	69

*This refers to human NDA's as opposed to veterinary NDA's. The NDA's approved are for new chemical entities and duplicate single products. This does not include new dosage forms, which are usually included under the supplementary NDA's.

We found in this study considerable reason to believe that other factors besides the new drug regulations and tighter FDA control are working as inhibitory influences on the rate of introduction of new drugs, but these other factors are probably more important for the future than for the present. For one factor, many people in the drug industry feel that a large number of the most obvious drug compounds have now been exploited, and they believe that it will take increasingly sophisticated research to evolve new means of drug therapy. Also, we found in this study that one important inhibitory effect of current patent policy has been to diminish communications and working relationships between pharmaceutical firms and the government--as a result, it is logical to expect research payoff to decrease, even though expenditures for drug research and development are increasing dramatically.[9] Although the results of the inhibiting of communications necessary to the research process have probably not yet been felt in terms of new products currently coming on the market, this inhibitory influence will probably limit newproduct development activity in the future.

[9] The figures below (from a recent study by the market research group of a major pharmaceutical firm) show the dramatic increase in expenditures for drug research and development:

1959	1960	1964	1965
$197 million	$207 million	$278 million	$320 million (approx.)

conditioned escape response test (anti-psychotic activity).

"Secondary Testing

If the results of the primary screening indicate promising biological activity is present, the compound is then submitted to a planned program of more sophisticated tests. These might include catalepsy, ptosis, confinement of spontaneous motor activity, antiemetric activity, blood pressure in the anesthetized dog, electrocardiogram in the unanesthetized dog, determination of the lethal dose, antihistaminic activity, potentiation of barbiturate activity, analgesia by a variety of procedures, etc. At this time, the compound might also be submitted to one or more of the other testing areas in the R&D Division.

"Work-Up for Clinical Trial

When a compound has survived secondary testing, it must then be submitted to a thorough pharmacological and biochemical study before or in parallel with being submitted to toxicity studies necessary for clinical trial. Such work involves a complete cardiovascular profile of the compound, specific toxicity studies such as on the liver, blood-forming organs, eye effects, etc., metabolism and distribution studies together with studies of the mechanism of action of the drug. Such studies are done on a large number of higher animals in several species over long periods of time. These are often highly sophisticated studies. The exact program of study varies with the structure and basic biological properties of the compound."

* * * * *

Government Patent Policy Study

Final Report

Volume III

Government Promotion of Federally Sponsored Inventions

TABLE OF CONTENTS

INTRODUCTION

A. The Government Patent Policy Study

In September 1966 the Committee on Government Patent Policy of the Federal Council for Science and Technology entered into a study of the effects of government patent policy on federal research and development programs and on the economy. Prior to that time, little data was available to the Committee and the Council to measure how well the policy was achieving the government's objectives. Yet, just such information was needed to recommend to the President and Congress what changes, if any, should be made in the policy.

To bridge the gap in information, the Committee commissioned Harbridge House to gather and analyze data which would explain the effects of government patent policy on three major areas of concern to the government: (i) industry participation in federal research and development programs; and (ii) commercial utilization of federally sponsored inventions; and (iii) business competition.

B. Research Report on Government Promotional Programs

Volume III of the study consists of eight review reports prepared in the fall of 1966 describing the efforts of eight federal agencies to promote utilization of government-sponsored technology at that time. Reflecting the period of the research, the regulations and law mentioned in this volume are those in effect in 1966. The agencies reviewed, which were selected by the Committee on Government Patent Policy, include the National Aeronautics and Space Administration (NASA), the Atomic Energy Commission (AEC), the Department of Agriculture, the Department of the Interior, the Federal Aviation Administration (FAA), the Department of Health, Education, and Welfare (HEW), the Tennessee Valley Authority (TVA), and the Small Business Administration (SBA). Each review report generally encompasses the entire agency but, where necessary, centers on particular programs or organizational elements. Since the purpose of this report is to describe promotional programs that extend beyond that provided by the patent system, the Department of Defense, which produces by far the greatest volume of government inventions, is not included. Although it publicizes its inventions automatically through the system itself (for example, all inventions are abstracted in the Official Gazette of the U.S. Patent Office), and will grant non-exclusive royalty free licenses upon request, it has no specific program to promote their commercial utilization which extends beyond that provided by the patent system except in very special areas like civil defense.

The purpose of Volume III is to identify the activities of various government agencies to promote commercial utilization of the results of their research and development efforts. Most promote their inventions as part of their general mission. It was believed important, therefore, to understand the effect of these promotional activities on commercial utilization of patented government inventions.

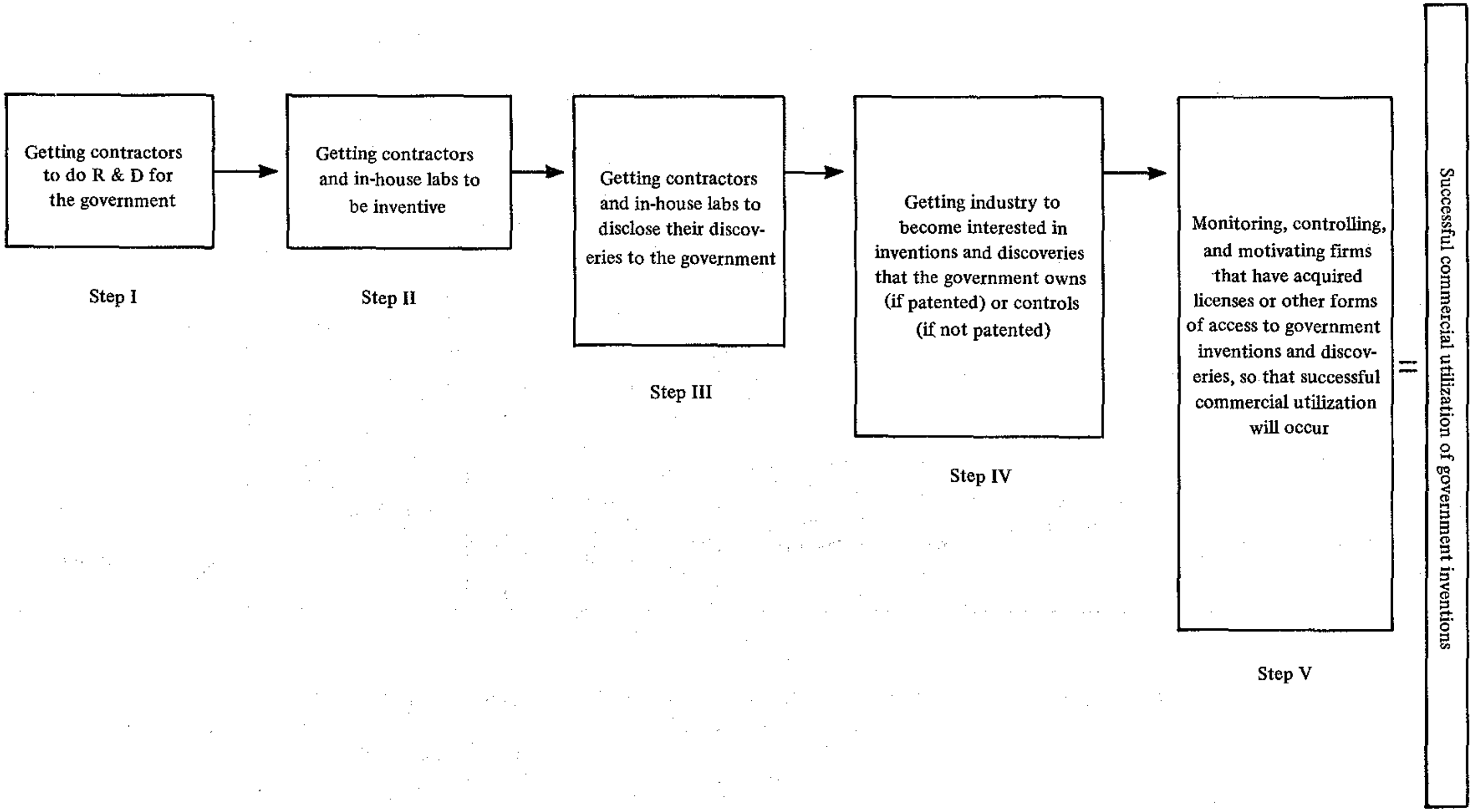
Government agencies determine rights to patentable government-sponsored inventions under the criteria set forth in Executive Order 10096 (except for Atomic Energy Commission) for employee inventions, and under various types of contractual arrangements with regard to inventions made by their contractors. Generally speaking, under Executive Order 10096, the government obtains the entire domestic rights, title and interest to inventions made by government employees (i) during working hours; or (ii) with the contribution of government resources, or (iii) which bear a direct relation to their official duties. Where, however, it is determined that the government has insufficient equity to require the assignment of title to it, title may be left with the employee and the government will acquire an exclusive royalty-free license to use the inventions. The contract clauses which determine the rights to patentable inventions as between the government and its contractors are based upon agency policy or statutory requirements. Under these clauses, the government acquires title to inventions in some cases, and a non-exclusive royalty-free license to use the invention throughout the world, in others.

C. Research Approach

As mentioned above, Volume III consists of individual review reports– each dealing with one of the eight government agencies. Since the similarities and the differences of policy and practice among these agencies with regard to the promotion of utilization must be identified in order to permit evaluation, a basic research plan was developed to serve as a common guide for the study of each agency.

The research encompassed two broad areas: (1) a description of the agency's general mission and its attitudes toward R&D and inventions (to provide understanding of its environment); and (2) a description of the agency's program to promote utilization, including its

FIGURE 1
SEQUENCE OF EVENTS IN THE DEVELOPMENT OF
GOVERNMENT INVENTIONS FOR COMMERCIAL USE



II. PATENT UTILIZATION IN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The mission of the National Aeronautics and Space Administration (NASA), in its broadest terms, is to preserve the role of the United States as a leader in aeronautical and space science and technology and to apply this science and technology to the conduct of peaceful activities within and outside the atmosphere.

B. General Attitudes Toward R&D and Inventions

In carrying out its mission, NASA makes a conscious effort to obtain inventions in the field of aeronautical and space science and technology. NASA spent about $4.0 billion on R&D programs in the fiscal year 1965.

C. Sources of Inventions

The agency's pattern of invention disclosure clearly reflects the fact that most of NASA's R&D programs are carried out under outside contract. By 1966, for example, NASA received a total of 6,542 invention disclosures—4,755 by contractors and 1,787 by employees [see Appendix I (NASA) for additional disclosure data]. The number of contractor disclosures has been increasing rapidly in recent years, while the number of employee disclosures has tended to remain constant at about 400 per year.

D. Policies on Encouragement and Disclosure of Inventions

1. Encouragement

NASA has an active incentive awards program for both NASA and contractor employees. Employee awards are made under the Incentive Awards Act and the enabling act of the agency. Awards to contractor employees are made under the authority of section 306 of the NASA Act. A central NASA Inventions and Contributions Board administers these programs.

2. Disclosure

When an employee makes an invention, he notifies the local[1] Patent Counsel, who may assist him in filling out the standard NASA disclosure form. The reported item is then docketed in the office of the local Patent Counsel and a case number is assigned.

All NASA R&D contracts[2] contain a "new technology" clause requiring contractors to report *any* item of new technology—not only inventions. Contractor disclosures are made either to the local Technology Utilization Officer or to the local Patent Counsel on the contractor's own disclosure form. In either case, the reported item is docketed in the office of the local Patent Counsel and patent case number is assigned, if the item falls within a statutory class of subject matter as covered by the patent laws.

[1] As used here, "local" means a NASA center (field installation), such as Goddard Space Flight Center.

[2] Except those NASA contracts for research with nonprofit institutions for which a shortened property rights and inventions clause is used.

The priority rating on the invention is then reviewed at NASA Headquarters by the Office of the Assistant General Counsel for Patent Matters. If the decision is made to file a patent application, this office initiates a patentability search. If the results of this search are positive, the local NASA Patent Counsel is requested to prepare a patent application, which Headquarters then files at the U.S. Patent Office.

2. Determination of Rights to a Patent Invention

Rights to employee inventions resulting from NASA in-house activities are allocated in accordance with the criteria of Executive Order 10096. The allocation of rights to inventions made by NASA contractors is made in accordance with Section 305(a) of the 1958 Space Act, which provides essentially that any invention conceived or first actually reduced to practice in the performance of work under a NASA contract becomes the exclusive property of the government, unless the Administrator waives commercial rights to such inventions in accordance with Section 305(f). The Administrator has the final right of decision in the case of a waiver.

Section 305(f) of the Space Act authorizes the Administrator to "waive all or any part of the rights of the United States under this section with respect to any invention or class of inventions made or which may be made in the performance of any work required by any contract" if he "determines that the interests of the United States will be served thereby." In the case of a waiver, the government retains an irrevocable, nonexclusive, nontransferable, royalty-free license to the invention. Each request for a waiver is reviewed by the Inventions and Contributions Board which recommends to the Administrator whether waiver should be granted.

3. Selection for Promotion

At times in the past, NASA has used a selection approach in which specific items were selected for promotion because of their apparent commercial potential. However, NASA's current approach to selection for promotion emphasizes the widest possible dissemination to the public of information regarding the agency's new technology, letting industry itself select the items in which it is interested.

Selection for promotion at NASA largely means selection for publication, although, as will be described later, some items are promoted informally at the field level through symposia. Under the direction of the Technology Utilization Division (TUD) within the Office of Technology Utilization, a technology utilization officer (TUO) has been assigned to each of NASA's ten local (field) installations to identify any item of new technology (including inventions) that has potential for general application outside the NASA programs and therefore potential for promotion. It is important to keep in mind that an item does not have to be an *invention* to be selected for promotion, and no item is selected for promotion solely because it is an invention. With the application of NASA's "new technology" clause, any innovation or invention that is considered to have significant industrial application may be selected for promotion.

The TUO scrutinizes all new technology reported under the contract clause concerning NASA new technology, and prepares a "flash sheet" when he finds an item that he feels has commercial potential. Several copies of the flash sheet are forwarded along with supporting documentation to an evaluating institution, which is under contract to NASA.

The evaluating institution evaluates the item in depth, using formal criteria developed by the Technology Utilization Division for this purpose. The most important of these criteria is that the item appear to have significant commercial potential. Theoretically, the TUO applies the same criteria in his initial evaluation of an item. In practice, however, this initial evaluation is largely subjective and the result of admittedly personal opinion.

After completing its evaluation, the evaluating institution sends back to the TUO a report classifying the item into one of several publishability categories. After the TUO has reviewed this report, he sends it to Headquarters for the final decision regarding publication. The Operations Branch Chief of the Technology Utilization Division at Headquarters reviews the recommendations of both the evaluating institution and the TUO. Before authorizing publication, the Operations Branch Chief must be satisfied that the invention or innovation will work and that it will have significant industrial application. If he decides that further evaluation is required, the item may be sent to one of the three contracted institutions with facilities for advanced evaluation.

At no point does the evaluation process approach a market survey, involving such factors as costs, engineering estimates, market potential, and so forth. There is agreement within the Office of Technology Utilization that public funds should not be expended for this purpose.

From the foregoing description, it is clear that an invention or innovation reported to NASA undergoes several evaluations, conducted by different people in difference places. It is important to comprehend here that the decision to file or not to file a patent is a complexity of the item concerned—whether it requires a lot of explanation to be understood and used correctly—determines which publication is best suited to promote the item. Although all TUD publications are designed to effect the transfer of NASA-sponsored technology to the public, some do so in more depth or more quickly than others.

The selection and the implementation of TUD dissemination approaches are well illustrated by two case examples. The first case involved a process for plating copper on aluminum. When TUD received the flash sheet and evaluation report on this item, it was decided to publish it immediately in a *Technology Utilization Report* rather than in a Tech Brief first, since the item, though unpatentable, seemed to be a complex one with considerable commercial potential and warranted the complete technical treatment that a *Technology Utilization Report* would afford.

The second case involved inorganic paint—an item that has received a great deal of publicity, both formally and informally, and on which NASA has filed a patent application. Unlike the first case, however, the technical nature of this item was not regarded as complex enough to warrant its publication as a *Technology Utilization Report.* Thus NASA published it only as a *Tech Brief.* However, it has received considerable publicity in the trade press, aided by press releases from NASA's Office of Public Information.

The other division of the Office of Technology Utilization—the Scientific and Technical Information Division (STID)—also issues several publications, including the Scientific and Technical Aerospace Reports (STAR). Published semimonthly, STAR is STID's best-known publication, a comprehensive journal of abstracts and indexes covering a world-wide reports of literature on the science and technology of space and aeronautics. All NASA-generated reports and publications—some 2,000 a month—are abstracted and indexed in STAR, which contains five indexes to assist in identification of materials. Cumulative indexes are published quarterly—the last one for the year is a guide to the entire year's issues.

Also, STID condenses the many NASA-generated reports and publications and has them reproduced on computer tapes and microfilms. These materials, in turn, are fed into NASA's Regional dissemination Centers (RDC's) which are data banks and constitute a unique media for disseminating to the public information about NASA related technology. There are at present seven RDC's with two new regional sites under consideration. The RDC's use the wide-ranging computer search and retrieval techniques developed by STID. The tapes carry the latest citations of technical reports and publications—at present approximately 5,000 documents are added to the system each month. Approximately 20 percent of the stored documents are NASA-generated, 30 percent come from the Department of Defense, 19 percent from R&D behind the Iron Curtain, and the remainder from other federal agencies and those foreign governments with which the United States has an information exchange agreement.

Target groups are identified by special mailing and distribution lists. NASA currently categorizes all its documents into 34 distribution (subject) categories (such as 01 aerodynamics, 02 aircraft, 03 auxiliary systems, and so forth). The documents are also indexed on computer tapes. In addition, some NASA publications, such as the *Tech Brief,* use a less extensive subject-classification method. Using NASA's elaborate indexing system developed by STID, it is possible to identify any given document by search. The Office of Technology Utilization currently maintains a mailing list of more than 6,000 potential recipients of NASA publications. The Public Information Division in the Office of Public Affairs also maintains a list for the distribution of press releases. Any interested U.S. citizen may have his name added to the mailing list and receive NASA Tech Briefs free of charge; NASA publications may be obtained from the Government Printing Office or the Clearing House for Federal Scientific and Technical Information at a small cost.

In the case of the RDC's a client contracts with one of these centers to provide him with services. Each RDC seeks out potential industrial clients outside the aerospace field within its respective region and the RDC staff gives these potential clients a presentation on the center's services.

In the past, RDC services were made available to the public free of charge, but in 1963 the RDC's began, on a pilot basis, to charge fees for increased services performed. Since 1965 all clients have been put on a fee-paying basis, with the size of the fee varying according to the extent of services provided. One objective of this experimental program is to make the RDC'S financially self-supporting. As of September there were 221 fee-paying subscribers at the six RDC's then fully operational.

The RDC's are regarded as an experimental approach to providing the widest possible dissemination of information about NASA's new technology, while at the same time providing for selectivity based on the client's expressed interests. To provide the client with selected materials stored in an RDC, "interest profiles" are drawn up by professional staff of the RDC. There may be as many profiles for a client as the client has interests. Twice monthly each profile is machine-matched against competition for it. However, to date there has not been competition for an exclusive license.

Exclusive licenses are individually negotiated and have a fixed time limit (usually two to five years). The formal criteria for granting them are laid down by Section 1245.206(c) and (d) of the *NASA Patent Licensing Regulations.* An applicant for an exclusive license must:

(i) Demonstrate a capability to practice the invention.

(ii) State how much money he expects to spend on the invention to develop it.

(iii) Give his status, if any, as a small business firm or as being located in a surplus labor area or both.[1]

(iv) Indicate whether he would be willing to accept an exclusive license for any geographic portion less than the entirety of the United States of American, its territories and possessions.

(v) State any other facts he believes relevant to the granting of an exclusive rather than a nonexclusive license.

When an exclusive license is granted, NASA retains world-wide nontransferable, royalty-free right in the U.S. government to practice the invention.

In general there is only a limited demand for exclusive licenses. NASA has granted only three exclusive licenses during its lifetime—on the line-following servosystem, a nickel-base alloy, and an ablation probe (erosion sensor)—and a fourth application is presently pending. The reason why demand is limited appears to be the long waiting period required before an invention can be made available for exclusive licensing. It presently takes from two or four years to obtain a patent, and the length of time is constantly increasing. (Examples, in case history form, of the cycle from invention to issuance of a patent are shown for a waived invention in Figure 1.) After the patent has been issued, there is, as already mentioned, the waiting period of two years; and an additional three months' waiting period is required from the date on which the invention has been listed as available for exclusive licensing.

The NASA owned inventions that have been the object of the greatest number of licenses are the retrometer, the inorganic paint, and a method for improving the reliability of a rolling element system. Through the calendar year 1965, NASA had licensed 27 out of 268 NASA-owned patents; 31 nonexclusive and 2 exclusive licenses had been granted. Of a total of 512 NASA-owned patent applications, NASA had granted 87 nonexclusive licenses on 30 applications.

[1]In granting an exclusive license, NASA gives preference to adequately qualified applicants in terms of priorities based on two factors: the applicant's status as a business firm and the degree of labor surplus of the area in which the small business is located.

6. Review and Control of Commercial Utilization

There is presently an annual monitoring and review procedure for all NASA licensees and waiver holders, with the exception of the contractors granted nonexclusive, irrevocable licenses. The procedure is administered by the Office of the Assistant General Counsel for Patent Matters.

In the case of nonexclusive licenses and waivers, NASA annually sends the licensee or waiver holder a letter requesting information on the commercial use(s) being made or intended to be made of the invention. Under the terms of the licensing and waiver instruments, the licensee or waiver holder is obligated to report such information when requested. Although the inclusion of a reporting clause in nonexclusive licensing agreements is not mandatory under NASA's licensing regulations, it has been included as a matter of practice in recent years.

In the case of exclusive licenses, a reporting clause is incorporated as a matter of standard procedure. This clause obligates each exclusive licensee to submit to NASA an annual report no later than 15 March each year on "all activity and progress in developing the invention to the point of commercial utility and in making the developed invention available to the public."

The reports received from licensees or waiver holders are reviewed to determine that the licensee or waiver holder has fulfilled all obligations. Failure to practice an invention constitutes possible grounds for revocation of revocable licenses, whether exclusive or nonexclusive. In the case of a waiver, NASA may compel the contractor to license the invention to others if the invention is not worked within three years. To date NASA has never, on its own initiative, had to revoke either an exclusive or a nonexclusive license—although there are many examples of licenses having been revoked, in each case the reason was that the licensee no longer believed it necessary to retain the license.

APPENDIX I (NASA)

STATISTICAL SUMMARY

A. Summary Data--March 1, 1959-December 31, 1965

1.	Inventions Reported	
	a. Employee	1,787
	b. Contractor	4,755
	c. Total	6,542
2.	Patents or Applications	
	a. Patents	340
	b. Applications	715
	c. Total	1,055
3.	Titles Retained by Agency	5,818*
4.	Titles Granted to Contractors	238
5.	Exclusive Licenses Granted	2
6.	Nonexclusive Licenses Granted	
	a. Patents	31
	b. Patent applications	87
	c. Total	118

*Estimate

B. Detailed Data--FY 1963 - FY 1965

		1963	1964	1965
1.	Total Invention Disclosures Reported to Agency	863	1,547	1,933
	a. Government employee disclosures	330	507	407
	b. Contractor disclosures	533	1,040	1,526
2.	Employee Invention Disclosures–Determination of Government Rights in U.S.			
	a. Disclosure of inventions for which government rights in U.S. have been determined	103	115	143
	–Government has title	90	100	120
	–Government has license only	13	15	19
	–Government has no rights	0	0	4
	b. Disclosure of inventions for which government rights in U.S. will not be determined	127	117	221

III. PATENT UTILIZATION IN THE ATOMIC ENERGY COMMISSION

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The Atomic Energy Act directs the Atomic Energy Commission (AEC) to act in the development, control, and use of atomic energy so as to promote the general welfare, encourage maximum scientific and industrial progress, and contribute to the development of the general economy.

B. General Attitudes Toward R&D and Inventions

The purpose of the agency's R&D is to insure a focused, national program for the development of atomic energy, and thus to keep the United States in a position of preeminence in the world for reasons of military and economic security. The total AEC R&D program amounts to approximately $1.2 billion annually. Its range of activity includes both basic research designed to advance man's knowledge and applied research activities aimed at developing an understandings of applications of evolving technology.

Much of the technology involved has applications outside the nuclear field. From electronic computers to a small breed of pigs, new discoveries and novel applications are by-products of the agency's work in atomic energy; rare earth phosphores in television, improved centrifuges, laminar flow, clean rooms, electron beam welding, advances in high-vacuum technology, thin film disposition techniques, and irradiated impregnated wood are only a few examples. However, it is clear that the agency is concerned mostly with applications within the nuclear field. Within this field, the agency's principal interest is not in obtaining inventions, even though it has acquired title to a large number of patents—rather, it is mainly interested in advancing knowledge and insuring that this knowledge is made available to the public.

C. Sources of Inventions

Virtually all AEC research is performed by contractors. By far the largest share—$960 million—is done in government-owned facilities by private contractors, who are contractually supervised by the AEC but allowed a high degree of independence as to program and focus in order to foster creativity. Most of the balance involves AEC contracts to private companies.

D. Policies on Encouragement and Disclosure of Inventions

Government employees may be rewarded for inventions under the AEC's incentive awards program, which provides cash payments to employees for money-saving ideas (which may involve patentable items). Although many of the contractors provide honorariums to their employees for inventions, for which the contractors are reimbursed by the AEC, the AEC gives no separate incentives to its contractors to promote either inventions or disclosures. The AEC requires prompt disclosure of inventions to insure that knowledge is not lost—the agency realizes that scientists, in the course of research, often develop and neglect new and useful knowledge that is peripheral to their principal interests. Disclosure is therefore, a necessary first step toward patenting of inventions and thus insuring public access, and, accordingly, patent personnel in the agency's field offices make specific efforts to insure that contractors are aware of, and comply with, contractual requirements for invention disclosure. In addition, the Commissioner of Patents is required to notify the AEC of all patent applications relating to subject matter in the field of atomic energy. (Section 151D, 1954 edition of the Atomic Energy Act). Data on patents issued on AEC-sponsored work are shown in Appendix 1.

on the criteria set forth in Part 9-9.50 of the AEC Procurement Regulations. The AEC always retains rights to inventions in the field of atomic energy; in other fields the determination of rights rest on the extent of government financing, the demonstrated position of a company in the field of the invention, and various other considerations of public interest.

3. Selection and Promotion

a. *Introduction*

Inventions are selected and promoted in four ways. First, all patents receive routine promotion. Second, patents that are a part of the technology of a particularly useful process may be promoted (indirectly) with the process. Third, some patents receive additional promotion because of industry's apparent interest in them. Finally, while most promotion of government-owned patents throughout the federal government is concerned with information and communications aimed at a potential producing or using public, promotion is done, in some specialized situations, in the form of further developmental work by the government to enhance the invention's potential acceptance and subsequent exploitation by the public.

b. *Routine Selection and Promotion*

The first category is, of course, not selective at all. The Division of Public Information periodically issues publicity releases announcing the availability of AEC patents; these releases are accompanied by abstracts prepared by AEC patent representatives containing the numbers and descriptions of the patents. The releases and accompaning abstracts are distributed broadside to industry, to news and technical information media, and to the AEC field offices for further local distribution. As a second part of the routine promotion process, the agency in the past has supplied lists of all new patents to the Small Business Administration for publication in its Product List Circulars, which have recently been discontinued. Also, all patents issued to the AEC are listed in the *Official Gazette* of the U.S. Patent Office.

c. *Promotion of Patents as Part of a General Promotion of Technology as a Process*

Twice monthly the AEC publishes the Nuclear Science Abstract, which contains a large amount of information concerning technological advances, including abstracts of new government patents and lists of patent obtained by others. It is distributed to a system of depository libraries in all parts of the country and is available for sale at the Government Printing Office.

In an interagency endeavor, the AEC collaborates with NASA in the preparation of Industrial Applications Flash Sheets relating to the field of atomic energy. The flash sheets serve as a basis for disseminating developments in the Space Nuclear Propulsion program. Information is compiled from the flash sheets into a brochure that receives wide distribution.

After the technical reports of AEC contractors have been cleared for security and received patent review, they are released by AEC's Division of Technical Information or the local laboratories sponsored by the AEC. Several private journals, such as *Chemical Abstracts, Mining and Metallurgy,* and *Physical Review,* publish abstracts of AEC-generated patents appropriate to their disciplines. These abstracts are based on information received through the media described above.

d. *Promotion Because of Apparent Industrial Applications and Interest*

The Division of Technical Information, in cooperation with SBA, NASA, the Department of Commerce, and industry trade associations, arranges meetings slanted toward the interests of particular groups of businessmen. For example, the Office of Industrial Cooperation at Argonne[1] arranged a meeting with tool and die industry representatives to describe some of the new metal-working techniques pioneered at the Argonne laboratory. As a result of this meeting, one of the firms involved has had two of its engineers working at Argonne with Argonne personnel for several months. These engineers are learning the details of a particular process preparatory to designing machines for its commercial exploitation.

The Division of Technical Information also works with SBA and state agencies organized under the "State Technical Service Act" to identify firms by specific segments of an area's industrial community. The division tries to reach these firms, once identified, through meetings and written material describing available technology and the channels through which information can be obtained. These efforts are followed by other efforts by the division to interest particular companies in

[1] The Division of Technical Information finances two Offices of Industrial Cooperation, one at Oak Ridge and one at Argonne. These are contractor-staffed. Their primary function is to interest industrial firms in the results of AEC research and development; in the last few years they have put a good deal of effort into the promotion of nonnuclear developments to small and medium-sized firms.

4. Arrangements for Commercial Access to an Invention

The Office of the Assistant General Counsel for Patents deals with all requests for licenses. When inquiries concerning publicized patents come in, this office tries to provide the firm or individual with all necessary data. This process can be said to be a form of promotion in itself. It may simply require providing reference to the source of the particular patent(s), or it may require letters to field locations requesting further data or drawings for the prospective licensee, or perhaps arrangements for visits or even coordination of plans for cooperative work with AEC personnel.

A product mentioned earlier in this report provides a good illustration of AEC initiative in soliciting industrial participation—which is part and parcel of its overall promotional efforts. With regard to irradiated impregnated wood, the Division of Isotope Development approached 20 selected firms with the idea of cooperative pilot-plant work. Eventually, three firms became interested in the project. However, all three firms accepted the license on the patent, but declined any help in developing the process further. Each firm is now pursuing its pilot-plant work independently.

In pursuit of its program to encourage industry to take over nuclear processing, the AEC has been very active in selecting and attempting to interest particular firms. For example, private companies are operating the chemical separation plants at Hanford, using government patents and processes. The government patents for processing nuclear fuels were involved in the establishment of a company for fuel processing. The government guarantees to take 50 percent to 60 percent of the plant output. Establishment of the company enabled the agency to withdraw partially from nuclear fuel processing.

Up to the present, the AEC has followed a policy of granting only nonexclusive royalty-free licenses on government-owned U.S. patents; these licenses have been available to anyone requesting them. However, there is enough flexibility in its regulations for the agency to depart from this policy if it wishes. There are many shades of opinion within the AEC on the effect on nonexclusive licenses on industrial interest in government patents. At present, the agency is awaiting the results of government wide consideration of this granting of exclusive licenses.

In the meantime, incentives to license are encouraged in certain instances by partial market guarantees such as those for Nuclear Fuel Services. One case now developing concerns the sterilization of meat by irradiation. A cooperative effort with the Department of Commerce and the U.S. Army, the program to develop this process is near the point of industry participation. The AEC will look for a firm that will build and operate a processing plant and guarantee a certain dollar level of commercialization effort[2] over several years. In return, the U.S. Army will guarantee to take 30 percent of the plant's production. There is some speculation, however, that even this guarantee will not be adequate to generate sustained interest and that some form of exclusive license may have to be negotiated.

5. Review and Control of Commercial Utilization

The Office of the Assistant General Counsel for Patents has reviewed, on a selective basis, the commercial utilization of many of its patents. This office characteristically will check five to ten of the principal licensees on a major patent. Selection of these particular licensees is based on the personal judgment of the office's personnel as to the licensees' serious intent to commercialize the invention. For example, an individual who had requested several licenses probably would not be included in the review, whereas a well-known company would be included.

Follow-up normally takes the form of a letter. In the case of water purification, fourteen licensees were surveyed; nine replies came in from municipalities and engineering firms. In other instances, a company, presumed to be active, will be contacted. One chemical company recently replied to such a query by indicating that it is using patents issued during the period from 1953 to 1965 in its rare-earth processing. For the ultra-clean room, the office developed a questionnaire that it sent to 39 licensees of the patent, which has been exploited widely. About one-half of these licensees responded.

Since AEC licenses are freely available and nonexclusive, the office of the Assistant General Counsel for Patents exercises no real control over their use or lack of use. There are no actions to terminate licenses, and follow-up is for purposes of information rather than control.

[2] By "commercialization effort" is meant effort that is specifically aimed at developing a product to a point where it is available and useful to the consuming public.

IV. PATENT UTILIZATION IN THE DEPARTMENT OF AGRICULTURE

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The Department of Agriculture is responsible for agricultural research and education, conservation, marketing and regulatory work, rural development, and disposal of agricultural surplus. It has traditionally placed great emphasis on the development of new methods and products as a principal means of carrying out its responsibility for promoting the well-being of the farmer and the many industries that both support and depend upon the farmer.

The department's research efforts are directed at such diverse areas as agricultural and industrial chemistry, industrial uses of farm products, entomology, soils, agricultural engineering and economics, marketing, crop and livestock production, production and manufacture of dairy products, human nutrition, home economics, and forestry and conservation.

B. General Attitudes Toward R&D and Inventions

The principal research arm of the department, and the source of virtually all patentable inventions, is the Agricultural Research Service (ARS). ARS was established in 1953 to consolidate most of the department's physical biological, chemical, and engineering research within a single organization. Its activities fall into five broad categories: nutrition, consumer- and industrial-use research; marketing research; farm research; foreign research; and regulatory and control research.

Any discussion of patent utilization in the department must necessarily focus largely on the efforts of the first of these five categories–nutrition, consumer- and industrial-use research–which offers the greatest opportunity for, and has in fact been, the principal source of all patentable inventions. For example, of the 81 patents issued to the department in the fiscal year 1965, 72 resulted from work in this area. Its program objectives are as follows:

(i) Nutrition and consumer-use research is directed towards developing new knowledge about human nutrition; nutritive food values; effective consumer-use of food, clothing, and textiles; and efficient management of money, time, and other family resources.

(ii) Industrial-use research is directed towards finding new and expanded uses for agricultural products.

The Office of Nutrition, Consumer- and Industrial-Use Research consists of four regional Utilization Research and Development (UR&D) divisions: Eastern, Northern, Southern, and Western. Each of the UR&D divisions has its own in-house laboratories in which approximately 80 to 90 percent of the funds available for domestic UR&D projects are currently expended. The remaining funds go to research under contracts and grants. In terms of project numbers, however, the division between in-house and contracted research is even greater. Thus, of the 462 domestic projects active at the end of the fiscal year 1965, [see Figure 1 (Agriculture)] 20 were directly supported by industry through fellowships or direct financial support, 196 were under Department of Agriculture contracts or grants,[1] five were supported by funds transferred from other federal agencies, and 241 were being performed in government laboratories.

UR&D programs include both basic and applied research in six areas: cereal grains and forages; cotton and wool; fruits and vegetables; oilseeds; new and special plants; and poultry, diary, and animal products. Over the years research efforts in these areas have given rise to a long list of well-known products. Frozen orange juice, potato flakes, stretch pants, wash and wear fabrics, and aerosol sprays are but a few of the many products that have been based on UR&D inventions.

The scope of the UR&D effort is suggested by the fact that 630 projects (462 domestic and 168 foreign) were active at the end of the fiscal year 1965. Expenditures (obligations) for domestic UR&D projects included $29,884,762 [see Figure 1 (Agriculture) for detailed summaries], whereas those for foreign projects only amounted to about $2.75 million.[2] In addition,

[1] The great majority of R&D contracts and grants of the Department of Agriculture are with educational institutions. This fact is underscored by the following breakdown of department R&D funds obligation for domestic contractor use in the fiscal years 1963, 1964, and 1965.

($ in millions)

Contractor	1963	1964	1965
Profit organizations	0.9	1.1	2.2
Educational institutes	40.6	48.6	57.2
Other nonprofit organizations	1.0	1.6	2.3
Total	42.5	51.3	61.7

[2] Most of the foreign projects were to be conducted over a five-year period under agreements with foreign institutions.

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

In line with its mission to promote the well-being of the agricultural community, it *is* department policy to encourage the exploitation of any invention that appears to offer a potential benefit from an agricultural standpoint. The department's primary aim is maximum exploitation of a natural resource (the government-owned invention) by the agricultural community. Remuneration, impact on competition, and exploitation by the public outside the agricultural community are not significant aims.

As stated earlier in this report, responsibility for both disclosing inventions and for determining the desirability of patent action lies initially with the inventor, his immediate supervisor, and the patent advisor in the case of in-house research, and with the inventor, the cognizant government project director, and the patent advisor in the case of research under contract or grant.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Items to Be Patented

a. *Patenting Objectives.* It is Department of Agriculture policy to patent and retain title to all inventions that offer a potential benefit to the agricultural community. This policy, which applies to both in-house inventions and those made under contract, is based on the premise that the department's research programs are intended solely for the benefit of the farmer and that, accordingly, inventions developed as a result of such research should not be patented by private interests. Thus, in a sense, the department's reasons for patenting are essentially defensive–to protect the farmer by preventing nonagricultural concerns from gaining control of inventions resulting from department research. Several sections of *The Patent Manual for Employees of the Department of Agriculture* serve to amplify these patenting objectives, as follows:

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If the Department does not obtain a patent on an invention resulting from such research, the field may be left open for someone else to obtain the patent. This would be true even if the Department disclosed the invention in a publication, because a publication is not a bar to the granting of a patent to another if his application is filed in the Patent Office within a year of the publication date and he can show that he made the invention before the date of the publication. Such a circumstance is not infrequent. Independent workers often make the same invention at about the same time, especially in a rapidly advancing art. The fact that the one who disclosed his invention in a publication may actually have made his invention before the applicant for the patent would not prevent issuance of the patent, because there is no provision in Patent Office procedure to establish priority under such circumstances.

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The Department patent also serves other purposes. The assigned patent affords prospective users the opportunity to obtain licenses under liberal terms. Organizations having a nonprofit patent policy, such as the Department of Agriculture, do not gain monetary advantages from the licensing of their patents. Significant advantages are gained, however, from developing and perfecting cooperative relationships with private interests throug the medium of licenses. A patent license relationship demands amicable cooperation between the parties if maximum benefits are to be derived. Both the licensor and the licensee have the common purpose of maximum utilization of the invention, and they cooperate to obtain this end. The patent license relationship frequently stimulates further independent invention and discovery on the part of the licensee. At the very least, it stimulates concerted efforts by all parties to exchange technical information in a spirit of mutual cooperation.

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The properly drawn patent specification is a disclosure of technical information for the specific purpose of guiding others to obtain the advantages of the invention. In this sense it is a very useful parcel of knowledge and may be used in the same way that other technical publications are used. The Department patent thus furnishes an effective expedient through which the Department can obtain wider dissemination of information concerning its research findings. For example, the United States Patent Office Official Gazette contains brief information relating to each weekly issue of patents by that Office, and copies of patents are widely distributed by the Patent Office. Technical journals, license. At present, the department seldom follows the dedication route, although at one time this was the rule rather than the exception. (The potential usefulness of holding title as a means of enforcing product quality has not been borne out in practice.)

The process of determining what patent rights should be taken by the government begins with the inventor's disclosure of his invention. Department regulations, 1 AR Chapter 15, stipulate that the inventor—as part of his disclosure report—should indicate whether he believes he has a claim to the title of any patent that might arise from the invention. When such a claim is asserted under either Section 880 (2) or Section 880 (4) of the Administrative Order, the inventor submits a detailed description of the basis for his claim through his superior and the administrator to the Patent Counsel in the Office of the General Counsel for a determination. If the Patent Counsel favors the claim, the detrmination is submitted to the Commissioner of Patents for approval. Similarly, if the Patent Counsel rejects it, the inventor may appeal to the Commissioner. As noted earlier in this report, the chairman also reviews all decisions not to file a patent application when the domestic patent rights are assignable to the government.

b. *Domestic Rights to Inventions Made Under Contract or Grant.* Most department research contracts (as distinguished from joint or cooperative undertakings) are issued under the authority of the Research and Marketing Act of 1946, as amended. Section 10(a) of that act specifies that "any contract made pursuant to this authority shall contain requirements making the results of research and investigations available to the public through dedication, assignment to the Government, or such other means as the Secretary shall determine." To meet this statutory requirement, the department includes a Patent Provisions and Publications Clause in all research contracts. The same procedure is followed in determining and acting upon government patent rights to inventions resulting from department contracts as is used for inventions resulting from in-house R&D.

c. *Foreign Rights.* The Department of Agriculture obtains a six-month option to file foreign patent applications on inventions resulting from research conducted or financed by the department. However, these options have seldom been exercised in recent years because of the lack of sufficient funds to file foreign applications.

In a few instances, generally involving a contractor, the inventor has filed one or more patent applications in foregn jurisdictions following expiration of the government option. For example, this occurred in a case involving dehydrated potato flakes, which subsequently proved problematic when a U.S. licensee under the department's domestic patent was prevented from shipping his product into Canada. To meet problems of this nature, the department now requires that it have the right to license U.S. firms in the case of foreign patents arising from in-house research.

3. Selection for Promotion

The department has provided little formal guidance to its personnel as to the methods or criteria to be followed in deciding which inventions to promote. However, several standard practices that can be identified are described in this section.

a. *Dissemination of Information.* A resume of all department inventions is published by the Government Information Center of the Bureau of Standards—this approach to promotion involves no selection decision, since all items are automatically selected. Promotion of items beyond this automatic effort is largely decided by UR&D research staff members and the assistant director for industrial development of the UR&D laboratories. Although members of the research staff may decide when to prepare technical papers on in-house inventions, this decision is left largely to the inventor in each case. However, as an inducement, the department underwrites the necessary preparation time and pays travel costs (associated with presentations) and so-called "page costs" required for publication in many technical journals.[2]

In the UR&D laboratories, the assistant director for industrial development is responsible for ensuring that UR&D inventions are brought to the attention of potential users. As part of this function, the assistant director personally screens all new inventions against known and potential industrial requirements and makes certain that appropriate information on each invention is disseminated to those who may have an interest. In making these decisions to promote an invention, he relies upon his personal judgment as to the needs of the producers who serve the agricultural industry. This judgment is based primarily upon the criterion of fulfilling agricultural needs rather than providing economic opportunities to producers.

b. *Additional Development.* Most UR&D inventions require additional development before they can be effectively exploited by anyone. Often, this additional development work is carried out in one of the UR&D engineering development laboratories, although on

[2] The page costs alone, for approximately 3,200 papers published annually, have averaged more than $100,000.

Several other approaches are used to disseminate information on new inventions. For example, periodic meetings are held with interested groups and individuals within industry. These meetings range from informal visits to UR&D laboratories by representatives of various firms, associations, or other interest groups to formal symposia on specific problems and techniques—such as the periodic conferences sponsored by various UR&D laboratories to consider the problems and technology of specific commodity areas. Control of these meetings rests jointly and informally with UR&D technical staff members and the industrial development officer. Decisions on the inclusion of particular inventions as topic items and on the nature of the presentations are made principally by technical personnel, while the groups to be addressed are selected by both technical staff members and the industrial development officer. These decisions, for the most part, are coordinated informally between the persons involved.

b. *Additional Development.* In the case of promotion in the form of additional development, once basic production feasibility has been shown, further "scaling up" may be undertaken to isolate and resolve any problems in quantity production. For example, one UR&D laboratory is currently producing an improved cheese in 400-pound lots to test large-scale production procedures under simulated production conditions. The output of cheese is being used for both stability and storage tests and for limited market testing conducted by the department's Economic Research Service (ERS) and a cooperating distributor.

The UR&D divisions occasionally use industrial facilities for limited production testing, which may be performed under contract or on a cooperative basis. To illustrate testing under contract, a company has been given a contract to establish a plant capable of removing strontium 90 from 100,000 pounds of milk per day—using a process developed by the department. Typical of a cooperative arrangement is the case of three firms making trial production runs of a new egg white pasteurization process developed by ARS engineers. Under the terms of the agreement, ARS provides the salt materials required in the pasteurization process—together with necessary technical assistance—while the firms provide the eggs and facilities and assume any risk of loss.

Technical assistance is not limited, of course, to the testing of new developments. Indeed, the preponderance of this effort involves assistance in connection with established products or processes. In terms of total projects, the technical assistance program probably represents the largest UR&D promotional effort. In the fiscal year 1965, for example, UR&D assisted in the feasibility evaluation or planning of 79 proposed agricultural processing plants.

5. Arrangements for Commercial Access to an Invention

The Department of Agriculture will grant a royalty-free, nonexclusive license for any of its patents to any responsible firms. The only requirement is that the patent and licensee be properly identified. No information is required or maintained on how the license is used.

While it is generally up to the firm to request a license for a particular patent, the department attempts to encourage applications for license through its public information program—by acquainting industry with, and stimulating interest in, department-owned inventions. In some cases, UR&D laboratory personnel—often the assistant director for industrial development—will undertake to "sell" appropriate firms on the desirability of a particular application. The targeting of firms for such sales efforts may be done in various ways, but most frequently the identification is based on the knowledge and/or opinion of laboratory personnel as to who in the industry is likely to be interested.

No exclusive licenses have been granted by the department because of the lack of specific statutory authority to do so. The legality and feasibility of granting a limited form of exclusive license is currently under interagency study. Since there have been several marginal cases when an exclusive license appeared desirable or necessary in order to encourage the exploitation of a particular invention, the department has sought legislation to clarify the authority to grant such licenses.

Licenses are granted through ARS. However, there is no analysis or decision-making required to grant a license because of the nonexclusive, totally available nature of the licensing program.

6. Review and Control of Commercial Utilization

The department has no formal procedure for evaluating the nature or degree of commercial utilization of its inventions. (For example, as noted earlier in this report, the license agreement carries no formal reporting requirement.) Nor is there any attempt to use the license as an enforcement tool. Department personnel have pointed out that the regulatory authority over various agricultural commodities granted the department provides a far more effective tool for enforcing quality than the licensing process ever could.

On the other hand, department personnel in general, and UR&D personnel in particular, make every effort to

V. PATENT UTILIZATION IN THE DEPARTMENT OF THE INTERIOR

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The Department of the Interior is concerned with the management, conservation, and development of the nation's water, wildlife, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and territorial affairs.

The department has a diversified research effort conducted independently by 12 of its bureaus and offices under separate legislative acts. This research effort, directed primarily at the preservation or utilization of natural resources, results in a relatively small number of patentable inventions. Its major output is a large number of technical publications.

The estimated total of federal funds obligated to the department's R&D for the fiscal year 1966 was $137 million [see Figure 1 (Interior)]. Approximately $91 million of this was obligated for in-house work. The remaining $46 million was almost equally distributed among private firms and research centers, educational institutions, and nonprofit organizations.

Given the patent activity of the department as a whole, six bureaus and offices stand out as major sources of inventions disclosed [see Figure 2 (Interior)]. Of the 164 invention reports submitted to the department during the fiscal year 1966, 155 were from these six agencies. In addition, all of the 44 patent applications filed by the department in the fiscal year 1966 were from these agencies. The six agencies and their missions are as follows:

(i) *Bureau of Mines.* The basic mission of this bureau is to conserve and develop mineral resources and to promote safe and healthful working conditions in the mineral industry. Research activities are generally conducted at bureau field establishments, research centers, and research laboratories by full-time government employees–as opposed to being conducted through research contracts with, or grants to, private firms and educational institutions. Some research activities, however, involve cooperative agreements with private industry and universities.

(ii) *Office of Saline Water (OSW).* This office provides R&D relating to methods for the economical conversion of saline water for agricultural, industrial, municipal, and other beneficial uses. Its program, which includes both basic and applied research, is conducted through grants to, and contracts with, chemists, physicists, engineers, educational institutions, scientific organizations, and industrial and engineering firms [see Figure 1 (Interior)].

(iii) *Office of Coal Research.* This office provides research to develop new and more efficient methods of mining, preparing, and utilizing coal. It also undertakes pilot plant or other experimental plant construction and operation to determine the possibility of commercial utilization of the results of previous research.

The Office of Coal Research carries out its functions by contracting for, sponsoring, cosponsoring and promoting the coordination of research with recognized interest groups, such as coal trade associations, coal research foundations, educational institutions, agencies of states or of their political subdivisions, and other agencies of the federal government [see Figure 1 (Interior)]. This office, which only undertakes conctracted work in coal research, collaborates with the Bureau of Mines, which only undertakes in-house work in this area.

(iv) *U.S. Geological Survey.* This agency performs surveys, investigations, and research covering topography, geology, and mineral and water resources of the United States. It classifies land as to mineral character and water and power resource, supervises engineering activities, enforces regulations regarding the department's mining leases, and publishes and disseminates data relating to these activities. Its research effort is conducted almost exclusively in-house [see Figure 1 (Interior)].

(v) *Bureau of Reclamation.* The basic mission of this bureau is to locate, construct, operate, and maintain facilities for the storage, diversion, and development of water resources required for the reclamation of arid and semiarid lands in the western United States. In support of this primary mission, the Bureau of Reclamation conducts a continuing research program to determine economical ways of carrying out its objectives. This research is conducted both in-house–by the bureau's own personnel–and through contracts with private firms and universities [see Figure 1 (Interior)].

FIGURE 2 (INTERIOR)

PATENT ACTIVITY OF THE DEPARTMENT OF THE INTERIOR

FY 1966*

Agency	Invention Report Submitted		Patent Applications Filed	Patents Received**	Licenses Granted
	In-House	Contractor			
Bureau of Mines	55	–	16	16	
U.S. Geological Survey	17	–	8	1	
Bureau of Commercial Fisheries / Bureau of Sport Fisheries and Wildlife	6	3	5	4	1
Office of Saline Water	4	35	9	7 (1 in-house 6 contractors)	1
Office of Water Resources Research	–	1	–	–	1
Bureau of Reclamation	10	–	2	2	
Office of Coal Research	2	23	4	1 (contractor)	1
National Park Service	1	–	–	–	1
Bureau of Land Management	2	–	–	1	
Bonneville Power Administration	4	–	–	2	1
Bureau of Outdoor Recreation	–	–	–	–	
Bureau of Indian Affairs	1	–	–	–	
TOTAL	102	62	44	34	6

*Source: Office of the Solicitor, Department of the Interior.

**Processing through the Patent Office normally takes two to three years.

(vi) *U.S. Fish and Wildlife Service.* This agency consists of the Office of the Commissioner, the Bureau of Commercial Fisheries, and the Bureau of Sport Fisheries and Wildlife. The Bureau of Commercial Fisheries' efforts include biological research, exploration of fishing grounds, research on measures for developing inland fisheries; market research and publication, research on more effective fishing gear and vessels, and product quality research. The Bureau of Sport Fisheries and Wildlife has as its objectives the conservation of the nation's wild birds, mammals, and sport fish for both recreational and economic purposes, while still encouraging their maximum possible use. Its activities include basic and applied research. Both bureaus conduct most of their work in-house or through other government agencies, such as the various state wildlife agencies.

B. General Attitudes Toward R&D and Inventions

Because of the varying nature of the missions of the agencies within the Department of the Interior, the types of inventions in which they are interested vary greatly. For example, in the fiscal year 1966:

–The Bureau of Mines received 16 patents on various methods of refining, handling, and processing minerals.

–OSW received seven patents for inventions, all relating to water demineralization.

–The U.S. Fish and Wildlife Service received four patents, of which two involved chemical processes for controlling sea lampreys (a major fish pest in the Great Lakes).

–The U.S. Geological Survey received a patent on an optical plumbing device.

Background Patent at reasonable terms on the written request of any responsible applicant therefor."

The patent clauses also give the government the right to "the entire foreign right, title, and interest in any Subject Invention," but this may be waived to the contractor. As stated previously, the department apparently has not exercised this last right prior to 1967 because of the expense of filing, and the limited commercial potential of many inventions.

2. Disclosure of Inventions

Both contractors and in-house employees are required to report inventions. In the case of contractors, this obligation is stated in Article III of each contract:

> The final report submitted under the contract shall list all Subject Inventions made in the course of the work performed under this contract. If to the best of the Contractor's knowledge and belief no Subject Inventions have resulted from performance under this contract, the Contractor shall so certify to the Contracting Officer.

Two standard forms are provided contractors for reporting inventions—Form DI-1217: Invention Disclosure Contractor, and Form DI-1216: Summary Report of Inventions and Subcontracts. These reports are submitted through the contracting officer to the Patent Counsel, Office of the Solicitor.

No special attempt is made to guarantee full contractor disclosure. The department has felt that progress reviews (performed at least annually) of contractors' work—as well as informal checks—combined with the strong legal obligation to report are adequate controls. However, it has been acknowledged that if a contractor both failed to report an invention and did not attempt to patent it himself, the invention might be difficult to detect.

Department employees are also required to report inventions to the Office of the Solicitor. Again, two forms are provided for this purpose—Form DI-1215: Report of Inventions, and Form DI-1218: Invention Rights Questionnaire.

The department's interest in patenting is mainly to prevent outside groups from filing a patent application first, and thus being in a position to require the government to pay royalties on an invention it has already paid to obtain. To prevent premature disclosure to the public, which might result in loss of the government's patent rights, all contractors—as well as in-house personnel—are required to obtain approval from the Office of the Solicitor before publishing information about their work.

describing the invention in question. The Patent Counsel, with the aid of technical staff, determines whether a patentable invention has been made, and if so, whether its potential applications warrant patent action. These decisions are made on a case-by-case basis, relying on the personal judgment of the individuals concerned.

The department, prior to 1967, did not seek title to foreign patents, because the limited commercial potential of many inventions does not justify the expense of filing, and because of staff limitations. (Inventors are generally allowed to file for foreign rights themselves but apparently rarely ever do so.) As indicated in Figure 2 (Interior), in the fiscal year 1966 there were 164 invention reports submitted to the department and 44 patent applications filed; in addition, 34 patents previously applied for were issued.

2. Determination of Rights to a Patented Invention

The Department of the Interior's title rights to patents fall into three categories:

- (i) Patents in which title is assigned to the government.
- (ii) Patents in which title is assigned jointly to the government and to the contractor or grantee.
- (iii) Patents in which title is assigned to the contractor or grantee.

In the vast majority of cases, the department takes domestic title to all patents, whether the inventions are developed by contractors or its own employees. A typical patent clause in a contract states in part:

> The Contractor agrees that it will promptly disclose to the Contracting Officer each Subject Invention and that it will grant and does hereby grant to the Government, as represented for this purpose by the Secretary of the Interior, the full and entire domestic right, title and interest therein, subject to the reservation in the Contractor of a royalty-free, nonexclusive, and irrevocable license.

> With regard to employee inventions the Departmental Manual implements Executive Order 10096 and provides that the Solicitor will provide for the Government all domestic rights in inventions made by employees during working hours; or with substantial contribution by the Government of facilities, equipment, materials, funds, information, or the paid services of other Government employees; or bearing direct relation to the employee's official function.

Both the normal contract patent clause and the Department Manual claim foreign patent rights for the government, unless they are waived or not exercised.

The second class of patent rights—joint title in both government and the contractor or grantee—is rarely used. It has been suggested as a solution to a contract negotiation impasse with any contractor who insists on retaining title to inventions as a matter of prestige, since it is felt that joint title would in no way dilute the government's rights.

The third case—title assigned to inventor—is also only rarely seen. In the case of in-house employees, it applies only to inventions made outside an employee's normal line of duty. The Departmental Manual states:

> Where there is some contribution by the Government to the making of an invention or some relationship between the invention and the employee's official function, but the Solicitor determines that ownership of rights to the invention by the Government is not warranted, or where the Government has insufficient interest in the invention to obtain the entire right in it although it was made under conditions described in 453 DM 1.4A, rights will be left with the employee subject to a nonexclusive, irrevocable, royalty-free license to the Government. Such a determination shall be subject to review and approval by the Commissioner of Patents.

The department is willing to vest title in the contractor in only two situations:

- (i) When a cooperative project has been undertaken to assist a contractor in reducing an invention to practice on which he has already invested considerable private resources. In this case, the department will insist on receiving a license to use the invention—either royalty-free or with the royalty to be considered paid-up in advance in the amount of the government assistance.
- (ii) When it is determined that any inventions resulting from the contract will have no possible commercial utilization and will not contribute to public health and safety. No examples of inventions in this category were found in the research done by Harbridge House staff members.

Examples of patents in which the department did not take title include:

- —One patent in 1966 for a trapping device from the U.S. Fish and Wildlife Service.
- —Four patents in 1965: a barrel-type soil auger and an automatic gate control from the Bureau of Reclamation, a method of agglomerating iron ore mines from the Bureau of Mines, and an electrode tube from the U.S. Fish and Wildlife Service.

The process of determining what rights should be taken by the government begins with disclosure of the invention by the inventor. As part of his disclosure report, an in-house employee is required to indicate whether he believes he has a claim to the title of any patent that might arise out of the invention. As working relationship with the minerals industry and participates in and sponsors conferences and technical meetings. It promotes cooperative participation by industry and universities in advanced development, performing market and economic studies to select projects and carrying on pilot plant development to secure cost, production, and enginerring data. It also publishes economic studies to point out the potential of products.

(ii) *Office of Coal Research.* This office distributes the final technical reports on its contracts to depositary libraries, members of Congress, and interested agencies. The reports are available for sale. The Office of Coal Research also issues occasional press releases on its developments and includes descriptions of its activities in its annual reports. Its efforts have thus far resulted in one license on a flyash brick process.

(iii) *Office of Saline Water (OSW).* This agency publishes the results of its work in R&D progress reports, which are distributed free of charge to libraries on request and which are for sale from the Government Printing Office. It also issues press releases announcing the publication of these progress reports.

(iv) *Bureau of Reclamation.* This bureau makes no special effort to promote the use of its patents. It issues occasional publicity releases describing new inventions but regards this as a public information function, rather than as an effort to promote utilization.

(v) *Bureau of Commercial Fisheries.* This agency issues fishery bulletins and special scientific reports. The fishery bulletins, which contain information on new developments, are issued intermittently, depending on the flow of manuscripts from the laboratories.

(vi) *Federal Water Pollution Control Administration.* This agency, (recently transferred from HEW), emphasizes publication rather than patenting. The principal promotional effort of this agency is made through means of demonstration grants to induce communities to employ new processes. The findings of water pollution control research are reported in the appropriate scientific and technical journals and at many conferences attended by scientific personnel.

5. Arrangements for Commercial Access to an Invention

The Department of the Interior will grant to any responsible organization or individual a royalty-free, nonexclusive license to any department patent. No effort has been made to discover any unlicensed use of its patents. Although licensees are required to report annually their actual utilization of licensed patents, no action has ever been taken for failure to report such utilization, and no information is maintained on utilization reports.

The department grants no exclusive licenses. This policy is based on its interpretation of the requirements of the legislative authorizations of its various bureaus and offices and on President Kennedy's Statement of Government Patent Policy of October 12, 1963.

As the department itself generally does not take title to foreign patents, it can in general only issue foreign licenses, limited to government purposes, to those few foreign patents awarded to contractors or in-house employees. No examples of such a license were discovered during this study.

The department's policies with respect to licenses have a strong effect on competition. The department's desire for free and unfettered use of its inventions is very strong. For example, a university controls a background patent in the desalination of water that it offered to license at a high royalty. OSW is engaged in research aimed at developing an alternative technology.

According to department personnel, its policies on utilization of patents are apparently widely understood, but there is evidence of some disagreement with them. Two cases in point relate to the department's refusal to grant exclusive licenses:

(i) The U.S. Fish and Wildlife Service has applied for a patent on a machine to mechanize the process of picking the meat from Maryland blue crabs. This machine was developed in-house under a special appropriation. It needs further development work but offers good potential to reduce costs significantly in the small industry of crab processing. No licenses have been granted to produce the machine, however, apparently because of reluctance on the part of manufacturers to expend the needed production engineering funds without the protection of an exclusive license.

(ii) Similar difficulty is being experienced by the Bureau of Mines in obtaining a licensee for a new mine-safety device—an explosive rock bolt—patented in 1964.

6. Review and Control of Commercial Utilization

The department apparently has no procedure for reviewing and evaluating the nature or degree of commercial utilization of its inventions. The requirement that licensees report on the utilization of department patents is not strictly enforced.

EXHIBIT 2

NUMBER OF PATENT APPLICATIONS FILED, BY AGENCY

FY 1962 - FY 1966

(Figures in parentheses refer to contractor inventions included in totals)

Agency	1962	1963	1964	1965	1966	Total
Bonneville Power Administration	1	1	1	–	–	3
Bureau of Indian Affairs	–	1	–	–	–	1
Bureau of Land Management	–	–	1	–	–	1
Bureau of Mines	16	16	19	26	16	93
Bureau of Reclamation	–	3	2	1	2	8
U.S. Fish and Wildlife Service	2	2(2)	5	7	5 (3)	21 (5)
U.S. Geological Survey	6	2	1	4	8	21
Office of Coal Research	–	–	–	2 (2)	4 (4)	6 (6)
Office of Saline Water	2 (2)	2 (2)	3 (1)	12 (12)	9 (9)	28 (26)
Total	27 (2)	27 (4)	32 (1)	52 (14)	44 (16)	182 (37)

EXHIBIT 3

LICENSES GRANTED BY THE DEPARTMENT OF THE INTERIOR

FY 1962-FY 1966

(Figures in parentheses refer to contractor inventions included in totals)

Fiscal Year	Licenses Granted	Patents Involved
1962	5	3
1963	4	4
1964	5	5
1965	3	3
1966	6	6
Total	23	21

VI. PATENT UTILIZATION IN THE FEDERAL AVIATION ADMINISTRATION

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The primary mission of the Federal Aviation Administration is to promote the development and safety of civil aeronautics, while concurrently assuring the fulfillment of those defense requirements that are dependent upon civil aeronautic activities. Towards these ends the agency exercises control, both civil and military, over the use of the domestic navigable air space, and supervises the research and development, installation, and operation of air-navigation facilities, including a common civil/military system for air-traffic control and navigation.

B. General Attitudes Toward R&D and Inventions

Section 312(c) of the Federal Aviation Act states that "the Administrator shall develop, modify, test and evaluate system procedures, facilities, and devices, as well as define the performance characteristics thereof, to meet the needs for safe and efficient navigation and traffic control . . . , and will select such systems, procedures, facilities, and devices as will best serve such needs . . . ." Discharging this responsibility, which amounts to a responsibility for fostering the advancement and the public utilization of technology in the air navigation and safety area and thus is wholly in keeping with the fundamental mission of the agency, involves annual FAA expenditures of from $60 million to $80 million for research, development, testing, and evaluation programs. The objectives of these efforts are to bring about the development of items needed but not yet in existence (for example, collision avoidance devices) and to refine and to encourage the widespread adoption of items that have already been developed (for example, an air-crash recorder). About two-thirds of these efforts center on the testing and evaluation of already developed items–the testing and evaluation is performed both in-house (at the National Aviation Facilities Experimental Center, Atlantic City, New Jersey) and by contractors. The remaining expenditures involve developmental work in refining existing items (for example, a cost- and weight-reduction effort on a transponder) and in developing new products (for example, all-weather landing systems)–these developmental efforts are performed almost entirely by contractors.

C. Sources of Inventions

The majority of the disclosures received by the FAA come from outside contracts–for example, during the period from 1963 to 1965, 125 disclosures came from contractors and 21 from in-house employees [see Exhibit 1, Appendix I (FAA)]. The disclosures involved both inventions closely related to FAA program activities (such as a beacon reply counter) and inventions related to the job activity of the inventor (such as the "E-Z" bucking bar for riveting) rather than to any particular program.

D. Policies on Encouragement and Disclosure of Inventions

1. Encouragement

The agency has a policy of making cash awards to in-house inventors for all disclosures of inventions on which the agency files for a patent. One counteracting influence, however, is the limited capacity of the agency's patent staff.[1]

2. Disclosure

FAA policy requires reporting of all inventions produced by employees during the performance of their regular duties. This policy also prescribes the procedures for in-house disclosure, which are controlled and implemented by the Office of the General Counsel. Responsibility for insuring FAA employee disclosure rests with "those segments of the agency having responsibility for engineering, design, research, or development. . . ." The responsibility is actually carried out as part of the regular supervisory responsibilities of technical management and is chiefly implemented by managers' personally staying on top of projects and encouraging invention and disclosure by employees.

FAA contracts require contractors to report all inventions conceived or first reduced to practice during the performance of the contract. Insuring contractor compliance with these reporting requirements is a responsibility of the FAA contracting officer and the FAA project manager. The contracting officer is the

[1] The staff, in September 1966, consisted of one patent attorney.

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

1. Objectives

In furthering its mission, the agency is vitally concerned with getting the aviation industry interested in applicable technology—whatever its source. Its aims in this regard are twofold. The stated and principal aim is to exploit a national resource—the technology—by effecting widespread adoption and use of products that will improve the efficiency and the safety of air traffic. (The FAA has very little interest in promoting utilization of applications of its technology that fall outside the field of aviation.) It should be kept in mind that the focus in the discussion of FAA is on technology, *not* necessarily patented and *not* necessarily government technology. The agency works very hard to promote items or processes that it controls or is aware of, if it deems them to be of significance to aviation. However, more often than not, the item or process promoted will not involve a patent—the agency owns very few. Therefore, the FAA's broader utilization activities are described because they also shed light on ways in which patented government inventions can be selected and promoted. Thus the scope of this report is somewhat broader than the scope of most of the reports on the other agencies studied in this task.

The agency's secondary aim in promoting industrial utilization of its technology is harder to classify than its primary objective. The secondary aim, indicated by the FAA's current contracting processes,[1] is recovery of investment. It is current FAA practice to include cost-recovery clauses in development contracts or licenses. These clauses essentially provide for payments to the agency by contractors for sales of equipment developed with FAA funds, whether or not a patent is involved. In this way the agency may recoup some or all of its investment in the development of the item involved. A case in point involved the refinement of a transponder with the objective of cost reduction—the contracts specifically provided for repayments to the FAA if the item proved to be commercially marketable.

[1] The Agency feels strongly that its policy of recovering the government's costs of developing a product through royalties is equitable and proper. In effect, it provides a mechanism to shift the burden of paying for the development from the general taxpayer to those who benefit from the work, the purchasers of the product.

2. Responsibilities

The Office of the General Counsel has the designated responsibility for making decisions regarding the filing of patents, making recommendations to the FAA Administrator on patent rights, and issuing licenses. The principal concern of the contracting officer in utilization, broadly defined, is to insure contractor compliance with invention reporting requirements. The agency's technical staff personnel (most often in the Systems Research and Development Service) perform technical evaluations of disclosed inventions and advise the General Counsel as to the advance made in the art by the invention.

Beyond these, there are no designated responsibilities that can be specifically identified as solely utilization-oriented. However, as will be discussed later in this report, the Office of Information Services, the various program services (Air Traffic Service, Flight Standards Service, Airports Service, and Systems Maintenance Service) under the direction of the Associated Administrator for Programs and referred to hereafter in this report as the Program Services, and the various development services (Aircraft Development Service, Installation and Materiel Service, Systems Research and Development Service, and National Airspace System Program Office) under the direction of the Associate Administrator for Development and referred to hereafter in this report as the Development Services have an impact on and relationship to utilization in the course of their regular duties. In fact, it seems clear that the heart of the agency's utilization-oriented activities relates to these three components of the agency. These three components are involved primarily in the identification and selection of technology for promotion and, subsequently, the promotion itself—patenting, licensing, and commercial monitoring are of only secondary concern.

3. Interagency Relationships

Sources of technology available for FAA promotion may depend, to a certain extent, on FAA relationships with other government agencies. Section 302(d) of the Federal Aviation Act requires the exchange of technical information among the Department of Defense (DOD), the National Aeronautics and Space Administration those cases where contracts do not specify in advance the allocation of rights to inventions, they do provide the FAA Administrator with unilateral authority to make disposition of rights if inventions arise.

In those cases where the contractor has rights but waives them, the decision on filing (and therefore the government's assuming title) is processed in the same manner as in any disclosure. In those cases where the government has rights but decides not to file and the contractor subsequently indicates his intention to file, the evaluation and decision process is repeated—with a second technical evaluation and a second application evaluation—to give the Office of the General Counsel another opportunity to consider the question of filing. If the agency still decides not to file, it may allow the contractor to do so.

Agency contracts generally contain a background rights clause that covers those contractor-owned inventions (those inventions produced by the contractor before the starting date of the contract) that are necessary to the useful application of a product or process developed by the contractor under contract with the FAA. This clause empowers the Administrator to decide if the contractor is reasonable in making the background patents available (by license or other means) to the public and to direct the contractor to do so if his actions in this regard are adjudged to be unreasonable.

3. Section and Promotion

a. *Introduction*

FAA utilization efforts are not easily divisible into separate steps, as, for instance, those of NASA are. Thus it is more useful to consider both FAA's selection for promotion and implementation of promotion together as an integrated process, which in turn is part of a larger process—FAA's operations in managing its basic mission. As part of FAA's regular business, there is a continuous evaluation of products and systems that the agency has developed or become aware of for their utility in meeting the needs of the aviation industry. Technology arising from contractor studies or in-house efforts is constantly being selected, at various decision points in the normal FAA operational cycle, for promotion of some sort. There are several components of the agency that are principally responsible for making the particular decisions that result in the selection of products for promotion—the promotional approach used generally depends upon which of these components is effecting the selection.

For illustrative purposes, selection and promotion will be discussed here in terms of categories of selection; however, it must be kept in mind that selection and promotion are not segmented activities in actuality, but, rather, occur in the normal operations of the FAA. Before considering selection and promotion in detail, it is well to note that agency-owned patents as a category is clearly *not* consciously considered for promotion and therefore utilization.

b. *Selection of Products for Additional Development*

The Development Services, with the endorsement of the agency's Executive Committee,[5] select products for promotion by additional in-house or contractor development. Although the process for this type of selection was not explored in depth by Harbridge House, it appears that the decisions of the Development Services are based on a variety of inputs as to what kinds of further development promise the highest yield in terms of ultimate use by the aviation industry. For example, a staff member of the Development Services stated that a market analysis was made of the probable demand for a transponder that was a candidate for cost reduction. The market analysis indicated a large market and was then used as one of the justifications for launching the cost-reduction project (which had the ultimate aim of effecting widespread adoption of the device). At least in some cases, the decisions involved in selection of products for promotion by further development are subject to review by the Executive Committee.

c. *Selection of Equipment for the National Airspace System*

The head of the agency, aided by the Development Services and the Program Services, selects equipment for incorporation into the National Airspace System. The National Airspace System establishes the air navigation and control requirements for airports, aircraft enroute, and traffic control facilities. In implementing the National Airspace System design, the FAA thus defines what types of equipment will be required and creates markets for products and innovations as the National Airspace System continually evolves.

The selection process is initiated by the Development Services through recommendation of equipment as meeting the requirements of the National Airspace System. The criteria for establishing satisfaction of these requirements include:

(i) Impact on existing elements in the National Airspace System.

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[5] The Executive Committee consists of the Deputy Administrator, the four Associate Administrators, and the General Counsel. Committee decisions that are not unanimous are approved by the Administrator.

Although the subjects selected for promotion by the Office of Information Services may or may not involve new technology and the primary objective is not utilization *per se,* this type of selection and promotion may result in industry interest and potential utilization. An interesting case in point involved the May 1966 issue of the *FAA News.* In an article of general reader interest on general aviation activities, mention was made of a desert still[9] which produced an inquiry from a manufacturer about the possibility of producing such an item.

In searching for suitable subjects, both the News Division and the Publications Division may respond to requests or suggestions from personnel throughout the agency, or they may request reports on R&D studies and examine them for newsworthy items. Close coordination is maintained with Development Services when material from technical reports is to be publicized.

f. *Selection for Routine Promotion*

The agency has two types of routine or automatic promotion. As is the case with all government agencies, all patents issued to the FAA are published in the official *Gazette* of the U.S. Patent Office. However, perhaps because of the very small number of patents held by the FAA, this method of promotion has not resulted to date in inquiries to the agency.

The second routine promotional approach involves technical projects or studies. Agency study reports (contractor and in-house) are processed through the Department of Commerce clearing house when the agency determines that they should be published. Concurrently press releases are made announcing their availability.

[9] This item was developed by the Department of Agriculture.

g. *Evaluation of Promotion*

The agency attempts to assess promotional effectiveness on occasion. When Development Services or Program Services management desires some indication of promotional effectiveness, a specific check may be made. For example, a study of flight plans was performed by the Flight Standards Service to identify the degree to which private aircraft were being equipped with the transponder that had emerged from specific cost-reduction efforts. Evaluations of promotional effectiveness may also be based on direct contacts with industry groups (air transport associations) or with manufacturers. One technical staff member of the FAA, for example, cited the large number of ads in *Business and Commercial Aviation* magazine for a particular item in which he was interested as ample evidence of its widespread adoption.[10]

4. Arrangements for Commercial Access and Review and Control of Commercial Utilization

Lacking any outstanding licenses, the agency has no formal program for reviewing and controlling their use. With regard to the area of review and control of utilization, the agency's primary interest is in evaluating the effectiveness of its promotional efforts by measuring the extent to which devices and systems it has promoted are used in the industry.

[10] The fact that FAA developmental contracts contain cost-recovery clauses—believed to be unique in the federal government—suggests that such a practice could develop.

VII. PATENT UTILIZATION IN THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The mission of the Department of Health, Education, and Welfare (HEW) is to promote general welfare in the fields of health, education, and social security. The several constituent agencies undertake this mission through the direct operation of programs, making grants to states for federal/state programs, testing products or devices developed outside the department, and making research grants and contracts in widely diverse areas.

B. General Attitudes Toward R&D and Inventions

The primary R&D activity within HEW which results in patentable inventions is conducted by the Public Health Service (PHS) which has an extensive program of in-house research in the health problems of man ($180 million in the fiscal year 1965) and a program of grants and contracts in areas such as medicinal chemistry, medical instrumentation and cancer chemotherapy. The National Institutes of Health (NIH), within PHS, support about 40 percent of all medical research conducted in the United States. The grant and contract program, which accounts for about 40 percent of all federal funds used to support research in universities, amounts to an additional $875 million. To promote use of its research results, HEW provides free access to information concerning its research, inventions and patents. (Volume II of the Patent Policy study discusses the effect of HEW's patent practices on industry participation in its medicinal chemistry program.)

C. Sources of Inventions

The majority of HEW's inventions have been made by contractors and grantees. In the fiscal year 1963, 96 percent of all inventions were contractor/grantee inventions and only 4 percent were in-house, and in the fiscal years 1964 and 1965, 90 percent were contractor inventions and only 10 percent were in-house.

D. Policies on Encouragement and Disclosure of Invention

1. Encouragement

The department has a system of incentive awards, basically a cost reduction program, for valuable suggestions from employees. While a patentable employee invention may be eligible for consideration of an award, such inventions are not the primary focus of the incentive awards program. There is no incentive program as such for contractors and grantees. However, various clauses governing the disclosure of and the rights in inventions are employed in its research agreements which require their identification and disclosure.

2. Disclosure

Both HEW employees and contractors/grantees are required to disclose inventions made in the course of government work. However, the number of contractor/grantee disclosures is far greater for at least two reasons: many of the latter (for example, NIH contractors and grantees) undertake research tasks having greater potential for inventions, and there is a great deal more research performed under grants and contracts than is performed in-house. For these reasons, in the fiscal year 1963 out of 238 total invention disclosures, 228 were contractor disclosures and only 10 were in-house; in the fiscal year 1964 out of 324 disclosures, 292 were contractor and only 32 were in-house; and in the fiscal year 1965 out of 246 disclosures, 221 were contractor and only 25 were in-house (see Appendix I, Statistical Summary).

The department requires disclosure of inventions through the grant provisions and contract clauses mentioned above. Each PHS grantee or contractor must file an annual inventions statement regardless of whether or not an invention has been made. Since many of the NIH grantees are more interested in publishing research than in reporting inventions, this requirement has been quite fruitful in promoting invention disclosures. The principal means for ensuring in-house disclosure in accordance with Executive Order 10096 is the wide dissemination of the disclosure requirement (in the form of a memorandum) among those most likely to produce inventions—that is, members of the professional research staffs in the department.

Secretary (Health and Scientific Affairs) who decides whether or not the government should take title and if a patent application should be filed on behalf of the government.

3. Selection for Promotion

The responsibility for administration of patent matters rested with the heads of the constituent agencies until it was transferred to the Assistant Secretary for Health and Scientific Affairs in late 1966. Because of the recency of this organizational change when data was gathered for this report, no formal plans or policies for the promotion of invention had yet been developed at the departmental level.

4. Determination of Promotional Approaches

a. *General.* Promotional approaches used in the Department do not depend upon the technology or process involved. Generally, the approach consistent with the constituent agency's normal mode of operation is most frequently employed. For example, NIH encourages publication in professional journals and publishes on its own account to assist staff members in disseminating the results of their research. The Children's Bureau promoted the use of the PKU test through state children's agencies and the VRA promoted the use of the aids to blind carpentry by making working drawings of the devices available to state vocational rehabilitation agencies.

b. *Target Groups.* HEW is principally concerned with reaching the user/consumers. Thus, technology after "selection" is simply fed into regular operations and reaches appropriate "target groups" as part of standard procedure. Accordingly, an item or process, believed by HEW to be sound and desirable, is normally brought to the view and attention of the user, rather than directly to the potential producers.

5. Arrangements for Commercial Access to an Invention

As noted in the previous paragraph, technology relevant to HEW missions is identified, tested, evaluated, and communicated to the community as a regular part of the business of HEW agencies. However, in some cases access problems may arise because a patent is involved. HEW does not have specific statutory authority to grant exclusive licenses to patents it owns. It is department policy that licenses to commercial firms be royalty-free and nonexclusive. Under its contract and grant programs, however, it may allow contractors or grantees to retain title to inventions they develop, if the situation meets the criteria specified in Part 6 of the HEW Manual of General Administration. In the past, this latitude has been exercised, in most instances, in favor of educational institutions. Due the small number of HEW-sponsored inventions that have arisen in the past, review and control of their commercial utilization has been done on a case by case basis. In appropriate instances, the Inventions Office requests scientists within HEW or consultants to the department to complete an evaluation questionnaire on HEW inventions which includes estimates of their potential uses. The evaluations are then factored into the department's decision concerning the best disposition of the inventions. Beyond this step, review and control of commercial utilization is exercised as individual circumstances require.

VIII. PATENT UTILIZATION IN THE TENNESSEE VALLEY AUTHORITY

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PART I. Attitudes Toward and Policies on Obtaining Inventions

A. General Mission

The mission of the Tennessee Valley Authority (TVA) is to further the proper conservation, development, and use of the resources of the Tennessee Valley region. In accomplishing this mission, the TVA is concerned with:

(i) the development of the Tennessee River and its tributaries with regard to improved navigation, flood control, and the generation and disposition of hydroelectric power; and

(ii) the development of new types of fertilizer in the interests of improved agriculture as well as of national defense.

B. General Attitudes Toward R&D and Inventions

To date, TVA has conducted its research almost entirely on an in-house basis. Its in-house research is extensive and principally involved with chemical fertilizers. Initially, the fertilizer research effort was undertaken as part of TVA's mandate "to provide for reforestation and the proper use of marginal lands in the Tennessee Valley [and] . . . for the agricultural and industrial development of" this region and to promote "the prevention of soil erosion by the use of fertilizers and otherwise." Under the broad directive as to soil erosion, TVA gives attention to the fertilizer needs of agricultural areas throughout the United States.

TVA's Office of Agricultural and Chemical Development (OACD) carries out programs for R&D in fertilizers and fertilizer manufacturing processes and for testing and demonstrating the value and use of fertilizer as an aid in soil and water conservation and in improved use of agricultural and related resources. The major R&D and production facilities of the OACD are located at TVA's National Fertilizer Development Center, Muscle Shoals, Alabama. The complex at Muscle Shoals is the center of the TVA fertilizer research effort. TVA annually spends some $2 million for R&D and $19 million for production for new or improved types of fertilizers.

C. Sources of Inventions

Since the great bulk of TVA's research efforts are in-house and devoted to the field of chemical fertilizers, it is not surprising that most TVA inventions are in-house and involve fertilizers. TVA currently holds 204 patents, of which 159 are for chemical developments related to the manufacture of fertilizers [see Appendix I (TVA)].

There are only a few exceptions to TVA's in-house research emphasis. One exception involves a series of small dollar value contracts awarded to various land-grant colleges to evaluate and demonstrate the effectiveness of various TVA-developed fertilizers. There has apparently been only one TVA contract in the past five years that the agency has considered sufficiently likely to produce a patentable discovery to warrant the inclusion of a patent title clause in the contract.

D. Policies on Encouragement and Disclosure of Inventions

1. Encouragement

TVA has no direct incentive program to encourage either government employees or contractors to invent. Because the agency considers inventing to be part of an employee's normal function, it provides no remuneration for inventions. However, inventions act as incentives for TVA employees in that an employee's invention record is a consideration for professional advancement, and every effort is made to assist an employee in publishing his inventions.

2. Disclosure

TVA personnel are required to record all potentially patentable inventions in permanent official laboratory notebooks. When an entry is made, a copy is forwarded to the branch chief of the inventor. TVA contract clauses typically do not require contractors to disclose inventions. An exception is a contract recently negotiated with a university—the requirement for disclosure resulted from a precontract determination by the TVA research staff that the project offered significant possibilities for innovation.

that defensive factors (patenting a discovery to prevent others from doing so even though the discovery appears to offer no immediate payoff) are also considered, but they could cite no specific examples.

If the Patent Committee determines that additional data on the likely costs and/or benefits of the invention are required, the branch chief undertakes appropriate additional investigation or feasibility studies.

If the Patent Committee decides that the invention should be patented, the branch chief undertakes such further development and other forms of promotions as the committee deems necessary. This is the context in which it can be said that the decision to patent and the decision to promote become merged and treated as one. The members of the Patent Committee are the key people with regard to the decision to promote as well as the decision to patent. For example, one member, the Director of Research, has a great deal to say about what additional development work–such as the construction of a pilot plant or of a demonstration plant–is necessary and what the source of the required funds can be. The approval of the decision to promote depends upon the level of funds needed–whether the money can come from regular R&D funding or whether special funding requiring the approval of TVA's Board of Directors is involved.

When the Patent Committee determines, and the TVA Board of Directors agrees, that a particular invention is not of sufficient value to warrant prosecution of a patent application, or that TVA's contribution to the invention is insufficient equitably to justify ownership by TVA,[3] the inventor may be given permission to prepare and prosecute a patent application in the government's behalf. In such cases, the inventor agrees to assign title to the patent to the government and in return he receives an exclusive license for the term of the patent.

2. Determination of Rights to a Patented Invention

Section 5 (i) of the Tennessee Valley Authority Act of 1933 stipulates:

> That any invention or discovery made by virtue of and incidental to such service by an employee of the Government of the United States serving under this section, or by any employee of the Corporation, together with any patents which may be granted thereon, shall be the sole and exclusive property of the Corporation, which is hereby authorized to grant such licenses thereunder as shall be authorized by the board: *Provided further,* that the board may pay to such inventor such sum from the income from sale of license as it may deem proper.

While the basic Act speaks only to discoveries by government personnel, the TVA Board of Directors has extended this policy to cover discoveries by TVA contractors as well. The Board of Directors' policy statement of December 12, 1963, stipulates in this regard:

> In accordance with the Tennessee Valley Authority Act, TVA acquires title to inventions of employees made by virtue of and incidental to the performance of services for TVA. It also generally acquires, under terms of the contract, title to inventions made by virtue of and incidental to the performance of services by consultants, cooperating institutions, other contractors, and their employees engaged in work with or for TVA.

Despite this basic policy statement, no patent title clause has been included in the series of small dollar value contracts that constitute an exception on TVA's in-house research emphasis. Awarded to various land-grant colleges to evaluate and demonstrate the effectiveness of various TVA-developed fertilizers, these contracts involve, according to TVA's Division of Law, little likelihood of producing a patentable discovery.

Indeed, apparently the only contract within the past five years to carry a patent title clause is one recently negotiated with a University. Before contract placement the TVA research staff had determined that the project offered a significant potential for innovation and therefore had recommended that provision be made for the government to take title to any inventions arising from the research effort. The university, however, apparently had also recognized the patent potential and therefore had balked at assigning its patent rights to TVA. When TVA offered and the university accepted an additional $1,000 (approximately 12 percent of the contract value) for the patent rights, the deadlock was broken.

To date, TVA has not sought or obtained any foreign patents, although the policy statement of December 12, 1963, by the TVA Board of Directors provides for them. Various reasons have been advanced for the inaction in this area–for example, some believe that there would be little exploitation of foreign patents, since those countries with the greatest need to exploit such patented

[3] In theory, the Tennessee Valley Authority Act of 1933 may be interpreted to require that the government be given title to any patent whatsoever stemming from an invention by an employee. However, TVA has taken the position that it would be inequitable to take exclusive ownership in certain situations–for example, where an employee has developed, on his own time, an invention that is largely unrelated to his work. This situation is very infrequent–over the past five years, there has been only one instance where an exclusive license was granted under these circumstances.

Following pilot plant demonstration and field testing, TVA may build a larger plant—a demonstration-scale production plant—at Muscle Shaols to work out processing techniques and determine production costs, although this is generally done only when it appears that this production experience is necessary to demonstrate the practicality of the new process to industry. As in the case of the pilot plants, the demonstration plants serve not only to prove out the manufacturing processes but also as a source of the quantities of the new product required for subsequent field testing and promotion.

Overall, TVA's demonstration-plant program represents a major effort. In the fiscal year 1965, more than 25 different fertilizer products weighing over 300,000 tons were produced and shipped to the field at a cost in excess of $25 million.

(ii) *The Distributor Demonstration Program.* The distributor demonstration program, like the demonstration-plant program, is designed to encourage the fertilizer industry to produce and introduce promising new fertilizers. Under this program TVA supplies cooperating firms with limited quantities of new products from demonstration plants at prices designed to encourage their use. In 1965 some 209 private and cooperative firms in 44 states used one or more TVA products or materials under this program. Included in the distributor demonstration program last year were two newly developed materials: the first, anhydrous ammonia-sulphur, was tested by selected distributors in Idaho, Washington, Nebraska, Kansas, Texas, Florida, and Alabama under the supervision of TVA field engineers, while the other new material, urea-ammonium nitrate suspension, was initially tested by a Kentucky cooperator.

In addition to assisting distributors in their sales programs by supplying them with new TVA products or materials to sell, TVA also works, through its field engineers, with distributors in helping them to use these materials to upgrade their own products. In the past the distributors simply resold most TVA fertilizers as received, but they now use some three-fourths of their allocation in manufacturing experiments designed to improve their own products. For example, TVA engineers recently assisted a major Georgia distributor in formulating and testing higher analysis grades of fertilizer based on TVA's diammonium-phosphate.

Distributors have been encouraged to test and demonstrate how new TVA products can be distributed more effectively to the farmer. Among the techniques developed have been bulk blending and spreading of high-analysis straight materials, the application of these materials in multiple-hopper spreaders or trucks, and the use of suspension-type fertilizers.

The distributor demonstration program also seeks to encourage and assist the distributor in educating his dealers in new marketing techniques. For example, as part of its agreement to supply a new TVA product to the distributor, TVA may require the distributor to conduct certain educational and/or demonstration activities for his dealers. A recent case in point was the ammonium-nitrate incentive program that provided funds for a variety of educational projects, including several for dealer education—incentive funds helped finance an intensive training program for dealers in the Dakotas, Montana, and Minnesota.

TVA also provides distributors and dealers with a variety of visual and teaching aids. Perhaps typical is a recently completed package of educational materials on the bulk blending of granular fertilizers; this package is designed for use in discussion-type teaching situations where it can be supplemented and strengthened with local information.

(iii) *The Test Demonstration Program.* Just as TVA utilizes a variety of demonstration programs for manufacturers, distributors, and dealers to promote an adequate source of supply for new products, so too it has sought to promote an appropriate demand for these products through similar demonstration programs for farmers. Probably the best known of these programs for the farmer is the so-called Test Demonstration Program, first undertaken in 1935. Administered in the states by the extension services and aided by county organizations of farmers, this program centers on the selection of individual farmers who are willing to use new types of fertilizer under the direction of county agents, thereby demonstrating to their neighbors what modern fertilizers and farming methods will do.

APPENDIX I (TVA)
STATISTICAL SUMMARY

A. Summary Data–FY 1962-FY 1966

TVA currently holds 204 patents, 159 of which are for chemical developments related to the manufacture of fertilizers. The number of patents issued to TVA over the past five years is as follows:

FY 1962	12
FY 1963	4
FY 1964	4
FY 1965	7
FY 1966	4
Total	31*

At present 276 companies hold 454 licenses to use TVA patents in 426 plants scattered over 39 states. All of these licenses involve chemical developments. Of the total, 190 licenses have been granted to the last five years as follows:

FY 1962	43
FY 1963	45
FY 1964	30
FY 1965	32
FY 1966	40
Total	190

*Less than five of these are nonfertilizer patents.

B. Detailed Data–FY 1963- FY 1965

	1963	1964	1965
1. Total Invention Disclosures Reported to Agency	41	28	32
a. Government employee disclosures	41	28	32
b. Contractor disclosures	0	0	0
2. Employee Invention Disclosures–Determination of Government Rights in U.S.			
a. Disclosure of inventions for which government rights in U.S. have been determined	41	28	32
–Government has title	41	28	32
–Government has license only	0	0	0
–Government has no rights	0	0	0
b. Disclosure of inventions for which government rights in U.S. will not be determined	0	0	0

PART I. Agency Mission in Relation to Research and Development

The mission of the Small Business Administration (SBA) is to aid, counsel, assist, and protect the interests of small business concerns. The SBA itself does not participate in research and development programs, either in-house or by contract. Thus it has no direct concern, unlike the other agencies studied in this task, in the development or promotion of inventions or patents, either for government or commercial benefit.

The SBA does, however, have an interest in helping its clientele—the small businesses of the nation—to realize the benefits of technology. To this end, it helps small businessmen to gain access to technological developments that they may be able to use, it assists them in marketing inventions and patents that they have developed or acquired, and it provides them with financial assistance in exploiting such inventions and patents. In all instances, it is concerned with the utilization of technology and patents controlled by others; it has no patents of its own.

PART II. Organization and Responsibility

In other sections of this report, organizational responsibilities are discussed in relation to activities involved in the promotion of patent utilization—determination of rights, selection for promotion, and so on. Since the SBA has no direct interest in patents as such, its promotion of patent utilization occurs as an incidental part of its activities to carry out its primary mission. Accordingly, the organizational elements of SBA that paly a role in the promotion of patent utilization are described here separately, and the agency's activities in relation to promotion of utilization are discussed in Part III.

The SBA operates through a Headquarters organization in Washington and a number of area, regional, and branch offices throughout the country. In the SBA Headquarters organization, three Deputy Administrators (now called Associate Administrators) direct the three major program areas of the agency: financial affairs, procurement and management assistance, and investment and development company assistance and supervision.

Most of the activity related to patent utilization occurs in the field offices. For example, as a loan application is being processed, SBA personnel may direct the attention of the applicant to a patented item bearing on the product to be financed by the loan; or government patent policy may be discussed in a seminar for small businessmen sponsored by the SBA; or information on government-controlled patents in a particular field of technology may be presented to small businessmen through SBA arrangement.

Research and development specialists with industrial engineering or other technical backgrounds provide technical advice and assistance to SBA staff and to the clientele of the agency. There are three such specialists at SBA Headquarters in the office of the Associate Administrator for Procurement and Management Assistance and 12 in the field offices.

The agency's contracting officers have no specific role in relation to utilization of inventions, since the SBA does not enter into contracts for research and development. The Office of the General Counsel provides general advice to the agency's clientele but does not provide any service that might be construed as a client-lawyer relationship—for instance, assistance in arranging a licensing agreement for a specific product. The Public Information Office assists in the preparation of literature about SBA programs, but it does not have a specific interest or responsibility in promoting the utilization of inventions.

can work effectively with the regional dissemination centers. The SBA plans to extend the program to the NASA regional dissemination centers at the Universities of Indiana and Pittsburgh, and to other centers as they come into being.

Finally, for the past two years, SBA participated as a sponsor of the Annual International Inventors and New Products Exposition in New York City. This exposition is run by a nonprofit organization, Patent Exhibits, Inc. SBA made its business facilities inventory available to Patent Exhibits, Inc., for advance mailings, and maintained a booth to provide information and guidance to small-business concerns about SBA assistance available in exploitation of items that interested them. SBA is presently considering participation in next year's exposition.

Government Patent Policy Study

Final Report

Volume IV

Effect of Government Policy on Commercial Utilization and Business Competition

VOLUME IV
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PART I. Introduction and Analysis of Utilization Questionnaires

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PART 1. Introduction and Analysis of Utilization Questionnaires

A. Introduction

In September 1966 the Committee on Government Patent Policy of the Federal Council for Science and Technology entered into a study of the effects of government patent policy. The Committee subsequently commissioned Harbridge House to gather and analyze data which would explain the effects of patent policy on (i) industry participation in federal research and development programs; (ii) commercial utilization of government-sponsored inventions; and (iii) business competition. The study findings are presented in a summary report (Volume I) and three research reports (Volumes II through IV).

Volume IV reports on two major aspects of the study—commercial utilization of government-sponsored inventions and the effect of patent policy on business competition. Organizations are disguised and confidential data are omitted where necessary to protect information provided in confidence to the study contractor.

1. Selection of the Study Sample

The utilization and competition tasks reported in Volume IV involve investigation of government-sponsored inventions patented in the two sample years of 1957 and 1962. In addition, a group of supplementary patents issued from 1956 through 1966 were added for certain agencies such as the Department of Agriculture and the Department of the Interior which have few patents in the main sample. Patents representing two full years were selected as the data base to ensure that the sample was both representative and significant in size. The sample includes two main groups of inventions: Those belonging to the first, and larger, group—referred to as "contractor" inventions—were developed under government contract, and the contractor retained either title or license to the invention. Most of these originated with the Department of Defense. Patents in the second, and smaller, group, referred to as "licensee" inventions, are owned by the government and licensed to organizations which did *not* develop them. Included within this group are inventions developed by government employees, for which license requests were received as well as inventions developed under contract. Most inventions in this group originated with Tennessee Valley Authority (TVA), Agriculture, Interior, and the Atomic Energy Commission (AEC).

Even though the main sample predates the 1963 Kennedy Memorandum on patent policy, it was selected so that enough time would have elapsed from date of development to allow the inventions to work their way into commercial use. Having determined the effect of title or license on the sample, it was felt that the results could be evaluated against the criteria set forth in the Memorandum.

2. Research on the Sample Inventions

The study sample was investigated in several related research tasks, each looking into a major aspect of the study. Initially, separate but similar invention utilization questionnaires were sent to contractors and licensees to obtain basic data on the entire sample. The questionnaires inquired into various aspects of utilization and licensing by organizations holding rights to the inventions. (Copies of the questionnaires are included in Appendix A.)

Upon receipt and analysis of the questionnaire responses (reported later in this part), four additional tasks were performed to complete the information on the sample:

(i) A group of high and low invention utilizers were interviewed to determine what business factors have the greatest effect on utilization. The results of this task are reported in Part II of Volume IV.

(ii) The inventions of three public-service oriented agencies—Agriculture, Interior, and TVA—were researched to determine what effect agency mission has on utilization. The results of this task are reported in Part III of Volume IV.

(iii) A representative group of educational and nonprofit institutions were interviewed to determine what role they play in utilization. The results of this task are reported in Part IV of Volume IV.

(iv) All firms reporting refusals to license sample inventions were interviewed and all inventions involved in infringement suits were investigated to determine the effect of patent policy on business competition. The results of this task are reported in Part V of Volume IV.

3. Findings on Utilization and Business Competition

The most significant finding of Volume IV is that commercial utilization of government-sponsored

B. Analysis of the Utilization Questionnaires

1. Analytical Approach

The questionnaire data were grouped into three categories for analytical purposes:

(i) Contractor inventions developed by profit-making organizations;
(ii) Contractor inventions developed by educational and nonprofit institutions; and
(iii) Licensee inventions developed either by government employees or by contractors and licensed to third parties.

The major portion of the statistical analysis involves "contractor" inventions developed by profit-making organizations and includes the great majority of inventions. Part II provides additional analysis of this category of inventions through case studies of selected profit-making firms having records of higher or low utilization.

Some statistical analyses are provided for the second and third categories, but the number of inventions in these categories is small, limiting the conclusions that can be drawn from purely statistical techniques. Accordingly, the case studies in Parts III and IV of this volume are relied upon for most of the findings concerning licensees and educational and nonprofit institutions.

The statistical analysis had three purposes: (i) To describe and measure significant patterns of patenting, utilization, and licensing activity within the sample; (ii) To isolate and evaluate the factors that explain invention utilization; and (iii) To indicate areas in which additional research was needed to explain the effects of government patent policy. To implement the first objective, patent activity was measured in four dimensions: size of firm, percent government business, field of technology, and form of invention. To implement the second, an N-tuple[1] and a regression analysis[2] were performed to test for statistical correlations between utilization and factors such as exclusive and nonexclusive patent rights, prior experience, age of patent, size of firm, percent government business, field of technology, and form of invention[3]. To implement the third, interviews and case studies were conducted on high and low utilizers, public service agencies, educational and nonprofit institutions, and inventions involved in refusals to license or in infringement suits, and are reported in Parts II through V of this volume.

Because DOD represents such a high percent of the response, the analysis of contractor inventions in Part I is based on the experience of all agencies grouped together for the main sample years (1957 and 1962). Where this is not the case, specific mention is made of the data which are used.

2. The Sample Profile

The invention sample included 3,689 patents and 700 contractors and licensees. The distribution of inventions by year and by patent rights is set forth in Table 1.

TABLE 1
DISTRIBUTION OF SAMPLE PATENTS

Contractor/ Licensee Patent Rights	Sample Year 1957	Sample Year 1962	(Supplementary) 1956 - 1966	Total
Title	1,003	1,621	72	2,696 (73%)
License	419	411	17	847 (22%)
All rights in govt. (AEC)	51	95		146 (4%)
Total	1,473	2,127	89	3,689 (100%)

Organizations owned 73 percent (2,696 patents) and held licenses in 28 percent of the sample (847 licenses). The government (AEC) retained all rights in 146 inventions, or 4 percent of the sample.

Table 2 classifies the sample according to the government agencies which sponsored the inventions. DOD (Army, Navy, and Air Force) is the largest sponsor,

[1] An N-tuple analysis is a statistical technique for determining the incremental effect of a series of factors–such as title, license, and prior experience–on a given characteristic under study–such as commercial utilization.

[2] A regression analysis is a statistical technique in which a characteristic under study–such as utilization–is selected as a dependent variable and is related to a series of independent variables–such as title, license, and prior experience through application of a mathematical model. The result is a regression equation which identifies and states the strength of the statistical relationship between the dependent and independent variables.

[3] The N-tuple and regression analysis techniques complement each other and provide a cross-check on the statistical findings. Harbridge House, Inc., thanks Assistant Professor William Gruber of the M.I.T. Sloan School of Management for his assistance in conducting the statistical analysis of the questionnaire data. We also wish to thank Professor F. M. Scherer, Associate Professor of Economics at the University of Michigan and advisor to the Committee on Government Patent Policy, for his advice on the statistical analysis and his performance of the regression analysis, both of which provide important findings reported in this part.

accounting for 2,862 inventions, about 78 percent of the total. AEC accounted for 686 patents (18 percent), and all other agencies, 185 (5.0 percent).[4] To avoid duplication of a recent report[5] NASA's 15 patents in the sample years were not included in the questionnaire survey. Nor were questionnaires distributed on 415 AEC inventions which presented no opportunity for commercial utilization by the contractor or which were subject to special intergovernment or interagency agreements.[6]

3. Patterns of Utilization

a. *Questionnaire Returns.* Tables 3, 4, and 5 set forth patent and utilization activity by contractors[7] for patents issued in 1957 and 1962. Represented in this subgroup of the sample were 463 contractors and 3,398 patents. One hundred ninety two contractors returned 2,024 questionnaires for a response of 60 percent of the patents and 41 percent of the firms. Ninety-five percent of the response involved DOD inventions.

Telephone interviews with those firms not responding indicate that the group includes several firms with large holdings and a majority with one or two patents each.[8] The five largest of the firms not responding account for almost 40 percent of the inventions for which no questionnaires were received. Because the data for inventions patented in 1957 are older, there are proportionately more nonresponders for that year than for 1962.

[4] Included within the "all other" category are NASA, HEW, Agriculture, Interior, GSA, Internal Revenue Service, Commerce, TVA, NSF, FAA, and Post Office. The utilization histories of Agriculture, TVA, and Interior inventions are reported in Part III of this volume. Two additional TVA inventions are reported here even through not patented in 1957 or 1962 because they are used in conjunction with patents that were.

[5] Watson, Donald S. and Mary A Holman, "An Evaluation on NASA's Patent Policy," George Washington University, 1967.

[6] Forty-three were inventions in which the AEC was required to retain all rights by statute, 103 were inventions in which contractors surrendered all rights, 241 were inventions developed by universities in which the institution retained only a non-exclusive license, and 28 were inventions covered by intergovernment, interagency, or other special agreements.

[7] Neither third-party licenses nor supplementary patents held by contractors are included in Tables 3, 4, and 5. Data on licensees are presented in Section 9, below, and in the case studies in Part III. Data on supplementary inventions for Agriculture and Interior are presented in Part III.

[8] Telephone conversations with nonresponders revealed that lack of personnel to complete the questionnaires and lack of information on the inventions were the *major reasons* for not responding.

b. *Concentration of Patent Holdings and Commercial Utilization*

(1) *Contractor Patent Holdings and Utilization in the Main Sample (1957 and 1962).* Tables 3, 4, and 5 show that concentration and utilization patterns do not differ significantly between the two sample years. Both patent holdings and utilization are heavily concentrated in a few firms. In each year the top 25 firms hold about 70 percent of the sample and account for roughly the same proportion of the response and of commercial utilization. Significantly, only about one of every 10 patents in the response (210 in all) achieved any commercial use—compared with estimates of 50 percent or better utilization for privately sponsored patents.

In all but 7 of the utilized inventions, the contractor owned the patent. And, if utilization is measured by the 49 inventions which played a critical role in their commercial use (see Table 11B) the rate of utilization declines dramatically to 2.1 percent.[9]

(2) *Contractor Holdings and Utilization by Size of Firm and Percent Government Business.* Table 6 shows the percent distribution and utilization of sample patents by size of firm and percent government business.[10,11] Table 7 provides a breakout of contractor inventions in the Response; Table 8 shows the number of responders in each category; Table 9 shows holdings of exclusive rights; Table 10 shows holdings of nonexclusive rights; Table 11A shows holdings of patents in commercial use; and Table 11B shows holdings of patents which played a critical role in their commercial use.

These tables show that rights and utilization of inventions, like patented inventions generally, are concentrated in large companies. Firms with annual sales over $200 million, account for about 37 percent of the

[9] Industrial contractors reported that 49 sample inventions played a critical role in their commercial use. Educational and nonprofit institutions reported another six which are not included in this step of the analysis.

[10] This series of data includes all contractor inventions in both sample years except those held by educational and nonprofit institutions. (The latter, because they don't use sales as a measure of activity, were unable to reply as to size of firm and percent government business.)

[11] Since the statistics persented in this report are based upon a tabulation of questionnaire results, there may be small differences among the numbers given in various tables because some questionnaires were not fully completed. These differences do not, however, affect materially the findings reported in Part I.

TABLE 4

CONCENTRATION OF CONTRACTOR PATENT HOLDINGS IN THE SAMPLE AND RESPONSE AND RATE OF COMMERCIAL UTILIZATION: ALL AGENCIES FOR 1957

	Number of Patents in			Percent of Total Patents in			
	Sample	Response	C. U.	Sample	Response	C. U.	Average Utilization Percent
Total Sample - 1957[1]							
Top Five Firms	301	283	23	36.3	35.8	26.4	8.1
10	461	432	34	55.6	54.5	39.2	7.9
25	648	614	59	78.3	77.5	68.0	9.6
50	732	697	71	88.4	89.0	81.6	10.2
Total	829	792	87	100.0	100.0	100.0	10.5
In Sample, No Response	509						

Number of Firms:

(1) Responding	123
(2) Not Responding	136
(3) Total	259
(4) With At Least One C.U.	38

[1] A firm's rank in 1957 or in 1962 may be different from its rank in the total sample. Thus, the percentages shown in Table 3 are not the average of percentages set forth in Table 4 and 5.

TABLE 5

CONCENTRATION OF CONTRACTOR PATENT HOLDINGS IN THE SAMPLE, RESPONSE RATE AND RATE OF COMMERCIAL UTILIZATION: ALL AGENCIES FOR 1962

Number of Firms	Number of Patents in			Percent of Total Patents in			
	Sample	Response	C. U.	Sample	Response	C. U.	Average Utilization Percent
Top Five	461	425	41	31.1	34.4	33.4	9.7
10	742	670	52	50.0	54.4	42.3	7.8
25	1,028	922	86	69.1	74.8	70.0	9.3
50	1,300	1,079	100	87.5	87.5	81.4	9.3
Total	1,487	1,232	123	100.0	100.0	100.0	10.0
In Sample, No Response	573						

Number of Firms:

(1) Responding	147
(2) Not Responding	186
(3) Total	333
(4) With At Least One C.U.	46

TABLE 7
CONTRACTOR INVENTIONS[1] IN RESPONSE
(UTILIZATION QUESTIONNAIRES)

Frequency
(Percent)

		Size of Firm ($ in millions)			
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	1,912 (100.0)	62 (3.2)	155 (8.1)	160 (8.4)	1,535 (80.3)
0 - 20	783 (41.0)	12 (.6)	33 (1.7)	52 (2.7)	686 (35.9)
20 - 50	450 (23.5)	3 (.2)	36 (1.9)	19 (1.0)	392 (20.5)
50 - 80	210 (11.0)	5 (.3)	27 (1.4)	31 (1.6)	147 (7.7)
80 - 100	469 (24.5)	42 (2.2)	59 (3.1)	58 (3.0)	310 (16.2)

[1] Note that patents held by nonprofit outside contractors are excluded because these contractors could not complete the sales and percent government business questions.

50 percent category constitute a much small percentage of the responders (5 percent) but proportionately own (19.8 percent) and use (27.5 percent) many more inventions than any other class of firms in the sample. Large firms doing 80 to 100 percent of their business with the government comprised only 8 percent of the responders, but they owned (17.6 percent) and used (13.5 percent) a larger share of inventions than their share of responses.

Grouping firms by percent government business rather than by size, Table 6 shows that firms with 20 percent or less in government work have the most patent activity and utilizations. Comprising 43.5 percent of the responders, this group owns 38.9 percent of the inventions and accounts for 29 percent of the utilization. Firms in the 80 to 100 percent category are second in level of activity, comprising 31.5 percent of the responders, 26.3 percent of the titles, and 21 percent of the utilization. Firms in the 20 to 50 category, however, show a better record of utilization. Constituting 23.6 percent of the inventions, they account for 32 percent of the utilization. The high utilization is due primarily to the large firms (over $200 million) in the group. Firms in the 50 to 80 percent category show fairly low levels of activity: Comprising 11 percent of the responders, they own 12 percent of the patents and account for 18 percent of the utilization.

(3) *Distribution of Inventions by Field of Technology and Form of Invention.* Inventions of respondents were also classified as to field of technology and form of invention to identify the nature of inventions arising from government R&D and to determine the effect of these two factors on utilization.[12] DOD accounted for 1,948–or 93 percent–of the 2,101 inventions included in these data.

Table 12 shows the distribution of inventions in the response by field of technology and form of invention. The electronic and mechanical fields of technology (54.2 percent) and the components and end product from of invention (79.2 percent) predominate. Table 13 shows the distribution of inventions in commercial use. Mechanical inventions achieved a far higher percentage of utilization (32.1 percent) than their share of the response (20.2 percent). Utilization was about evenly divided between components (14.4 percent) and end

[12] Inventions were classified on the basis of their description in the utilization questionnaires. The supplementary patents for 1956 to 1966 were included in this series to increase the number of observations.

TABLE 9
INVENTIONS WITH EXCLUSIVE RIGHTS
(CONTRACTORS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	1,618 (100.0)	59 (3.6)	131 (8.1)	137 (8.5)	1,291 (79.8)
0 - 20	630 (38.9)	12 (.7)	24 (1.5)	45 (2.8)	549 (33.9)
20 - 50	367 (22.7)	2 (.1)	29 (1.8)	15 (.9)	321 (19.8)
50 - 80	195 (12.1)	5 (.3)	25 (1.5)	29 (1.8)	136 (8.4)
80 - 100	426 (26.3)	40 (2.5)	53 (3.3)	48 (3.0)	285 (17.6)

TABLE 10
INVENTIONS WITH NONEXCLUSIVE RIGHTS
(CONTRACTORS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	294 (100.0)	3 (1.0)	24 (8.2)	23 (7.8)	244 (83.0)
0 - 20	153 (52.0)	0 (0.0)	9 (3.1)	7 (2.4)	137 (46.6)
20 - 50	83 (28.2)	1 (.3)	7 (2.4)	4 (1.4)	71 (24.1)
50 - 80	15 (5.1)	0 (0.0)	2 (.7)	2 (.7)	11 (3.7)
80 - 100	43 (14.6)	2 (.7)	6 (2.0)	10 (3.4)	25 (8.5)

TABLE 12

CONTRACTOR INVENTIONS IN RESPONSE: 1957, 1962, AND SUPPLEMENTARY INVENTIONS (UTILIZATION QUESTIONNAIRES)

Frequency

(Percent)

Field of Technology	Type of Invention					
	Total	Process	Material	Component	End Product	Other
Total	2,101 (100.0)	239 (13.8)	139 (6.6)	999 (47.5)	667 (31.7)	7 (.3)
Electronic	714 (34.0)	31 (1.5)	0 (0.0)	479 (22.8)	204 (9.7)	0 (0.0)
Electric	51 (2.4)	3 (.1)	1 (0.0)	19 (.9)	28 (1.3)	0 (0.0)
Chemical	309 (14.7)	156 (7.4)	125 (5.9)	5 (.2)	23 (1.1)	0 (0.0)
Mechanical	424 (20.2)	32 (1.5)	1 (0.0)	278 (13.2)	113 (5.4)	0 (0.0)
Hydraulic	42 (2.0)	0 (0.0)	0 (0.0)	25 (1.2)	17 (.8)	0 (0.0)
Nuclear	13 (.6)	0 (0.0)	0 (0.0)	7 (.3)	6 (.3)	0 (0.0)
Optics	34 (1.6)	5 (.2)	2 (.1)	8 (.4)	19 (.9)	0 (0.0)
Life Science	15 (.7)	7 (.3)	0 (0.0)	3 (.1)	5 (.2)	0 (0.0)
Other	499 (23.6)	55 (2.6)	10 (.5)	175 (8.3)	252 (12.0)	7 (.3)

products (12.6 percent). The use of mechanical end products is more than double (12.6 percent) that of mechanical processes (5.1 percent) and more than double their share in the response, whereas the share for components remains constant. Where mechanical inventions play a critical role in commercial use, Table 14 shows that their share decreases to 20 percent, matching their percent of the response. Utilization of mechanical components, however, decreases over 50 percent from the total share in the response and over 60 percent from the share in all utilization, whereas end products continue to make a strong showing (10.9 percent of critical-role inventions). In effect, mechanical patents achieve greater utilization than their share in the response due largely to end product and component inventions.

Electronic devices, with 714 patents, comprise the single largest group of inventions—34 percent of the response (Table 12). Over 90 percent of the inventions are components and end products, with components outnumbering end products more than two to one.[13] But that pattern is reversed in utilization where end products outnumber components over two to one. In this connection, the electronics group includes 25 percent of the inventions which play a critical role in commercial use (Table 14).

Chemical inventions, with 14.7 percent of the responses, constitute the third major group (Table 12). This group is heavy in process and material inventions

[13] Definition as to whether an invention was a component or end product was made by the responder of the questionnaire.

TABLE 14

COMMERCIALLY UTILIZED PATENTS WHERE PATENT PLAYED A CRITICAL ROLE
1957, 1962, AND SUPPLEMENTARY INVENTIONS

(UTILIZATION QUESTIONNAIRES)
Frequency
(Percent)

Field of Technology	Type of Invention					
	Total	Process	Material	Component	End Product	Other
Total	55 (100.0)	13 (23.6)	1 (1.8)	10 (18.2)	31 (56.4)	0 (0.0)
Electronic	14 (25.5)	2 (3.6)	0 (0.0)	4 (7.3)	8 (14.5)	0 (0.0)
Electric	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chemical	8 (14.5)	7 (12.7)	1 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)
Mechanical	11 (20.0)	2 (3.6)	0 (0.0)	3 (5.5)	6 (10.9)	0 (0.0)
Hydraulic	2 (3.6)	0 (0.0)	0 (0.0)	1 (1.8)	1 (1.8)	0 (0.0)
Nuclear	1 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	0 (0.0)
Optics	5 (9.1)	1 (1.8)	0 (0.0)	1 (1.8)	3 (5.5)	0 (0.0)
Life Science	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	14 (25.5)	1 (1.8)	0 (0.0)	1 (1.8)	12 (21.8)	0 (0.0)

A similar pattern is shown in Table 17 for inventions which play a critical role in the products in which they were commercially used. Utilization decreases from 4.7 to 1.8 percent when exclusive rights are not present and from 3.6 to 0.6 percent when commercial experience is lacking.

Significantly, prior experience has an even greater effect on utilization than does ownership of the patent. The case studies in Part II confirm this. Interviews of 10 high and 11 low utilizers showed that, in most large firms, the decision to patent government contract inventions is usually separate from specific plans to use them. Most frequently the decision to patent these inventions based on a desire to ensure freedom of design, to protect against infringement suits, to cross license, to recognize employee inventiveness, or to enhance the firm's image. In most instances, utilization counts only as a speculation that the invention *may* have some commercial use. Tables 18 and 19 provide some measures of the weight given the commercial value of government inventions by these firms: With the exception of three companies who do most of their business with the government, all file one-third or less of their patent applications on government-sponsored inventions.

The decision to use government inventions commercially, on the other hand, is more often based on keeping up with the market than on the availability of patents to provide a proprietary position. It is based on company knowledge and experience, often without reference to

TABLE 18
INTERNAL PATENT MANAGEMENT
TEN HIGH UTILIZERS

Company	Size of Firm ($ in millions)	% Government Business	Number of Applications Filed Per Year (Approx.)	% Government-Sponsored Applications*	% Company-Sponsored Applications*
Q	over 1,000	65-80	Not Available	20	80
S	over 1,000	40	960	12	88
A	200 -1,000	40	75	33 1/3	66 2/3
G	200 -1,000	30-40	150	15	85
R	200 -1,000	10	500	10	90
E	50 - 200	85	125	14	86
H	50 - 200	75	75	25-30	70-75
N	50 - 200	70	140	25	75
M	5 - 50	10-40	25-30	25	75
J	under 5	20-50	Not Available	Not Available	Not Available

*Percentages are approximate.

TABLE 19
INTERNAL PATENT MANAGEMENT
ELEVEN LOW UTILIZERS

Company	Size of Firm ($ in millions)	% Government Business	Number of Applications Filed Per Year (Approx.)	% Government-Sponsored Applications*	% Company-Sponsored Applications*
B	over 1,000	80	1,000-2,000	2-5	95-98
C	over 1,000	2	510	1 (-)	99+
I	over 1,000	75	300- 350	33 1/3	66 2/3
O	over 1,000	50-90	70	25	75
P	over 1,000	95	175- 200	50	50
T	over 1,000	30	600	10-15	85-90
D	200- 1,000	10	1,000	0 (since 1962)	100 (since 1962)
U	200- 1,000	55-70	250	20	80
F	5- 50	85	Not Available	Not Available	Not Available
K	5- 50	90	5-6	100	0
L	under 5	Not Available	30	65	35

*Percentages are approximate.

TABLE 20
EFFECT OF FIELD OF TECHNOLOGY ON UTILIZATION

	Commercial Use with Title and Prior Experience		Commercial Use with Title but No Prior Experience	
	Percent	Observations	Percent	Observations
Mechanical Inventions	33.3	40/120	11.0	25/227
Inventions in Other Fields of Technology	20.6	89/431	5.2	38/725

commercial utility. Not many of the inventions involved in the study have reached that point.

Nevertheless, since patents are an incentive to contractors for a variety of reasons, it appears desirable to allow contractors to retain exclusive rights in most cases to create the most favorable environment for utilization. The only instances where this might not be so are when the government has developed inventions fully in their commercial form and there is a big enough market to at tract utilizers without need for exclusive rights to protect their investment.

5. Sales and Private Development Costs for Utilized Inventions

Table 21 shows the sales and private development costs associated with utilized inventions. (Sales data represent the respondents' estimates of cumulative sales through 1966.) Measured in dollars, domestic and foreign sales of utilized sample inventions are a modest $406 million to the date of the survey.[15] All but $271,000 are attributable to DOD inventions, emphasizing again the dominant role played by that agency in this portion of the sample. (In comparison, sales of licensee inventions are $210.3 million and almost none are attributable to DOD. See section B.9.e. below.)

Sales of critically important contractor inventions are a little over half the total—$193.6 million from domestic sales and $47.3 million from sales abroad; $241 million in all.[16] *Five inventions,* accounting for approximately*88 percent* of the sales in this group, involve the following technologies: *transistors, vacuum tubes, numerical control devices, computers,* and *gas turbine engines.* The remaining 44 critically important contractor inventions totaled only $29 million in sales. This amounts to annual[17] sales of $20 million for the five inventions with high sales and about $659,090 for the other inventions in that class.

The extreme variability of sales within the sample indicates that it is difficult to predict the commercial potential of a given group of government-sponsored inventions. This has major policy implication: It suggests that a flexible policy applied under appropriate criteria is more likely to promote commercial utilization than one that disposes of all patent rights uniformly. This conclusion is confirmed by the $210 million in sales generated by ten sample inventions to which the government holds title. These ten inventions generate almost as much income as the 49 critically important inventions owned by industry.

The criteria for disposing of rights are a separate consideration. On that question, the case studies in Parts II, III, and IV and the report on the government's efforts to promote utilization (Volume III) help to define the circumstances under which patent protection appears necessary or desirable to achieve commercial utilization.

In relating sales to the concentration of patent holdings, it was found that not one of the top ten patent owners has a sample invention with cumulative sales of more than $2 million, even though the group holds 52 percent of all the patents. Only one firm, ranked in the 11 to 25 group, had a patent with significant utilization—$70 million to the date of the survey. Although contractors licensed 31 firms to use various critically important inventions, no royalty figures were available.

When private development costs were compared with utilizations, it was found that firms in the survey spent $26 million in bringing inventions into commercial use. It is difficult to generalize on these data because many firms provided no information; however, the data we do have indicate that about 56 percent of private funds were spent in technical development, and the balance was divided about equally between production facilities and marketing.

It seems fair to say, judging from the evidence presented above, that few contractors are achieving significant commercial sales of government-sponsored inventions.

6. Time Lags to Utilization

Table 22 presents the time lag between the time a patent application was filed and first commercial utilization of contractor inventions. About a third of the patented inventions were used commercially by the time a patent application was filed. This finding was confirmed in the case study interviews.

One would expect that firms with prior commercial experience in a given technology would have a shorter time lag to utilization than firms without such experience. This expectation is confirmed in Table 22. If rapid utilization is defined as occurring in three years or less from the date of application, then inventions developed by firms with prior commercial experience achieved a

[15] Interviews were conducted with all respondents who reported inventions with sales of more than $1 million in order to verify their estimates. When an invention did not contribute significantly to the sales of a product, they were excluded from the analysis.

[16] In grouping the data, sales involving critically important inventions (those which were clearly responsible for commercial sales) were separated from those involving supporting inventions which played an incidental role in sales of commercial products.

[17] Computed from the date of patent application to the date of the survey. Three years were allowed for filing an application prior to insurance of patent. On this basis, the availability of 1957 inventions is 13 years; and of 1962 inventions, eight years. The average availability is 10.5 years for inventions in both sample years.

TABLE 22
TIME LAG FROM PATENT APPLICATION TO FIRST COMMERCIAL UTILIZATION
CONTRACTOR ACTIVITY FOR SAMPLE YEARS 1957 AND 1962

Independent Variables	≤0 Years	1-3 Years	4-8 Years	≥9 Years	9* Years	Total
Sales of Firm						
Less than $5 million	3	4	2	0	3	9
$5 - $50 million	8	6	7	0	1	21
$50 - $200 million	5	11	3	3	6	22
Over $200 million	37	33	22	0	14	92
TOTAL	53	54	34	3	24	144
Prior Activity						
Yes	41	36	13	2	8	92
No	12	19	21	1	16	53
						145
Percent Government Business						
0-20	16	14	20	2	2	52
20-50	16	10	3	0	2	29
50-80	10	11	1	0	7	22
80-100	11	20	10	1	13	42
						145
Field of Technology						
Mechanical	14	22	12	1	6	49
Other	39	33	22	2	18	96
						145
Form of Invention						
Material	12	10	6	0	2	28
Process	2	4	0	0	3	6
Component	22	17	7	1	10	47
End Product	17	24	21	2	9	64
						145
Kind of Agency						
DOD	50	53	31	3	24	137
AEC	2	1	3	0	0	6
Other	1	1	0	0	0	2
						145

*Years between filing and first expected commercial utilization. This column is not included in the row totals.

Several utilization trends are apparent from the licensing data: The utilization rate for licenses is 5 percent of the inventions available for license[18]—about half the rate experienced through *direct* use of the inventions.[19] Measured against the number of license agreements, utilization is about 56 percent of the total,[20] reflecting the positive interest of licensees in inventions they wish to license.

Although large firms (over $200 million) account for the major share of inventions available for license (79.9 percent),[21] they account for a much smaller share of license requests (56 percent),[22] license agreements (52.2 percent),[23] and licenses in use (46.8 percent).[24] This is due to the tendency of large firms to patent inventions more broadly for reasons such as to recognize employee inventions, to protect against infringement suits, to obtain patents with which to negotiate cross licenses in addition to patenting them for direct commercial utilization (see Part II). Thus, larger firms have a larger share of inventions with speculative utility than do smaller firms.

[18] 1,539/77 (Tables 23 and 26).
[19] Table 3.
[20] Tables 25 and 26.

[21] Table 23.
[22] Table 24.
[23] Table 25.
[24] Table 26.

TABLE 25
LICENSING AGREEMENTS
(CONTRACTOR INVENTIONS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	138 (100.0)	12 (8.7)	49 (35.5)	5 (3.6)	72 (52.2)
0 - 20	9 (6.5)	4 (2.9)	0 (0.0)	0 (0.0)	5 (3.6)
20 - 50	38 (27.5)	0 (0.0)	15 (10.9)	1 (.7)	22 (15.9)
50 - 80	37 (26.8)	1 (.7)	32 (23.2)	1 (.7)	3 (2.2)
80 - 100	54 (39.1)	7 (5.1)	2 (1.4)	3 (2.2)	42 (30.4)

TABLE 26
LICENSES IN USE BY LICENSEE
(CONTRACTOR INVENTIONS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	77 (100.0)	5 (6.5)	28 (36.4)	8 (10.4)	36 (46.8)
0 - 20	14 (18.2)	1 (1.3)	0 (0.0)	8 (10.4)	5 (6.5)
20 - 50	18 (23.4)	0 (0.0)	1 (1.3)	0 (0.0)	17 (22.1)
50 - 80	29 (37.7)	0 (0.0)	26 (33.8)	0 (0.0)	3 (3.9)
80 - 100	16 (20.8)	4 (5.2)	1 (1.3)	0 (0.0)	11 (14.3)

TABLE 27
NUMBER OF LICENSED INVENTIONS
(CONTRACTOR INVENTIONS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	26 (100.0)	2 (7.7)	9 (34.6)	0 (0.0)	15 (57.7)
0 -20	2 (7.7)	1 (3.8)	0 (0.0)	0 (0.0)	1 (3.8)
20 - 50	5 (19.2)	0 (0.0)	3 (11.5)	0 (0.0)	2 (7.7)
50 - 80	8 (30.8)	1 (3.8)	5 (19.2)	0 (0.0)	2 (7.7)
80 - 100	11 (42.3)	0 (0.0)	1 (3.8)	0 (0.0)	10 (38.5)

TABLE 28
COMMERCIAL UTILIZATION OF PATENTS THROUGH THE USE OF LICENSES:
PROFIT AND NONPROFIT CONTRACTORS, SAMPLE YEARS 1957 AND 1962

Rank in Number of Licenses in Commercial Use	Average Rank* in Number of Patents in:		Licenses in Commercial Use (3)		License Requests Received (4)	
	the Response (1)	Commercial Use (2)				
Top Five Firms	25	14	58	(70.7%)**	65	(49.6%)
10	41	20	68	(82.9%)	75	(57.3%)
Total						
23 Firms	49	27	82	(100%)	131	(100%)

*Average ranks for the 23 licensors in terms of their patent holdings in the response and in commercial use are calculated by adding their ranks in each of those categories and dividing by the number of firms in the licensor groups being measured. Nonprofit organizations were not included in the concentration calculated in Table 2, and have, therefore, been excluded in the calculation of average rank in Table 28. The five inventions they did license are included in the total number of licenses in use.

**Percent of total in column.

TABLE 30
FACTORS AFFECTING REASONS FOR NONUTILIZATION OF INVENTIONS

Utilization Factor	Technical Reasons for Nonutilization (percent)	Marketing Reasons for Nonutilization (percent)	Number of Observations
Contractor has prior experience.	39.7	60.2	405
Contractor has no prior experience.	31.6	68.3	958
Contractor has title.	35.9	64.0	1,187
Contractor has no title.	21.0	78.0	176
Contractor does more than 50% of his business with the government.	29.7	70.2	841
Contractor does less than 50% of his business with the government.	40.9	59.0	522
Contractor has annual sales over $50 million.	33.8	66.1	1,177
Contractor has annual sales under $50 million.	34.0	65.9	186

The tables show that marketing reasons[48] predominate, the majority (Table 29)[49] relating to the lack of commercial utility of the invention–indicating once again the importance of that factor.

As far as other factors are concerned, Table 30 shows that patent rights have the greatest effect on whether nonutilization was attributed to technical or marketing reasons. Technical reasons rate 15 percent higher with title than without it. Similarly, they are about 8 percent higher with prior experience than without it and about 11 percent higher with contractors doing 50 percent or less business with the government than with firms doing more than 50 percent government business. Size of firms, on the other hand, does not appear to materially affect the results.

Interviews conducted in connection with Part II indicate that exclusive patent rights cause the greatest shift from marketing to technical reasons because firms normally do not take title when the inventions clearly appear to have no utility. Thus, a marketing reason is inherent in the decision not to take title. Even when the contractor owns the patent, however, marketing reasons predominate since firms will often take title when there is only a slim possibility of utilization and for reasons unrelated to direct commercial use of an invention.

Table 30 indicates that the effect of prior experience and percent government business are related. In both situations, proximity to commercial markets appears to increase the percentage of acquired inventions with commercial potential, resulting in a smaller number of inventions eliminated for marketing reasons.

9. Utilization of Government-Owned Inventions

a. *Introduction.* The utilization survey included a subsample of inventions owned by the government and licensed to firms (referred to here as licensees) with had not developed them. This study was undertaken to gain a better understanding of the circumstances underlying utilization without patent protection.

As noted above, review of contractor inventions showed that only 7 inventions were utilized when the contractor (and inventor) did not own the patent. Since most of these inventions originated under defense contracts in which the contractors had the option to retain title, nonutilization when licenses were retained was not necessarily caused by lack of exclusive rights–but probably because contractors anticipated no use for them and, therefore, elected not to apply for a patent.

[48] Marketing reasons include: (i) inventon became obsolete; (ii) expected market failed to materialize; (iii) technology too sophisticated; (iv) too much competition; (v) channels of distribution lacking; (vi) invention falls outside of company product line; and (vii) no commercial potential seen.

[49] Seventy-one percent of the responses ranked the following reasons as most important: no commercial potential seen (420) technology too sophisticated (171); expected market failed to materialize (208); and invetion became obsolete (236).

TABLE 31

LICENSED GOVERNMENT -OWNED INVENTIONS

(1957 AND 1962)

Agency	1957		1962		Total	
	No. Inventions	No. Licenses	No. Inventions	No. Licenses	Inventions	Licenses
DOD	13	18	11	12	24	30
AEC	26	31	22	36	48	67
Agriculture	16	73	18	49	34	122
Interior	1	1	1	1	2	2
HEW	1	1	0	0	1	1
Commerce	7	7	7	7	14	14
TVA	0	0	3	106	3	106
TOTAL	64	131	62	211	126	342

TABLE 32

NUMBER OF USES PER GOVERNMENT-OWNED INVENTION

	Total	DOD	AEC	TVA	Agriculture	Other
Inventions in Use	10	2	1	2	4	1
Number of Users	50	2	2	36	9	1
Number of Inventions Used						
Most Frequent Use	1 @ 32			1 @ 32		
Second Most Frequent Use	1 @ 3				1 @ 3	
Third Most Frequent Use	1 @ 2		1 @ 2			
Once	7 @ 1	2 @ 1		1 @ 1	3 @ 1	1 @ 1
Number Not Specified By Invention	6			3	3	

TABLE 35

LICENSES IN USE WHERE THE INVENTION PLAYED A CRITICAL ROLE

(LICENSEES OF GOVERNMENT - OWNED PATENTS)

Frequency
(Percent)

	Size of Firm ($ in millions)				
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	22 (100.0)	11 (50.0)	5 (22.0)	1 (4.0)	5 (22.0)
0 - 20	22 (100.0)	11 (50.0)	5 (22.0)	1 (4.0)	5 (22.0)
20 - 50	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
50 - 80	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
80 - 100	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TABLE 36

LICENSEES OF GOVERNMENT -OWNED PATENTS

(1957 AND 1962)

Frequency
(Percent)

	Type of Invention					
Field of Technology	Total	Process	Material	Component	End Product	Other
Total	149 (100.0)	58 (38.9)	34 (22.8)	19 (12.8)	36 (24.2)	2 (1.3)
Electronic	7 (4.7)	0 (0.0)	0 (0.0)	2 (1.3)	5 (3.4)	0 (0.0)
Electric	3 (2.0)	0 (0.0)	0 (0.0)	3 (2.0)	0 (0.0)	0 (0.0)
Chemical	79 (53.0)	38 (25.5)	33 (22.1)	3 (2.0)	5 (3.4)	0 (0.0)
Mechanical	16 (10.7)	2 (1.3)	0 (0.0)	1 (.7)	13 (8.7)	0 (0.0)
Hydraulic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nuclear	3 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (2.0)	0 (0.0)
Optics	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Life Science	14 (9.4)	12 (8.1)	1 (.7)	0 (0.0)	1 (.7)	0 (0.0)
Other	27 (18.1)	6 (4.0)	0 (0.0)	10 (6.7)	9 (5.0)	2 (1.3)

TABLE 38
LICENSES IN USE WHERE THE INVENTION PLAYED A CRITICAL ROLE
(LICENSEES OF GOVERNMENT -OWNED PATENTS)
(1957 AND 1962)

Frequency
(Percent)

Field of Technology	Type of Invention					
	Total	Process	Material	Component	End Product	Other
Total	30[1] (100.0)	14 (46.7)	12 (40.0)	1 (3.3)	3 (10.0)	0 (0.0)
Electronic	2 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	2 (6.7)	0 (0.0)
Electric	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chemical	22 (73.3)	10 (33.3)	12 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mechanical	3 (10.0)	2 (6.7)	0 (0.0)	1 (3.3)	0 (0.0)	0 (0.0)
Hydraulic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nuclear	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Optics	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Life Science	2 (6.7)	2 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	1 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)	0 (0.0)

[1] Table 38 shows eight more licenses in use than reported in Table 35 due to uses by nonprofit cooperatives who could not be classified by size of firm and percent government business.

TABLE 41
REASONS FOR NONUTILIZATION OF INVENTIONS
(NONINVENTOR LICENSEES OF GOVERNMENT-OWNED PATENTS, 1957 AND 1962)

Frequency
Percent

Rank of Reason / Reason for No Commercial Utilization	No Reason Given	Development Costs Too High	Development Revealed Serious Flaws	Development Personnel Not Available	Invention Became Obsolete	Expected Market Failed to Materialize	Technology Too Sophisticated	Too Much Competition	Channels of Distribution Lacking	Invention Falls Outside of Company Product Line	No Commercial Potential Seen	All Other	Total Reasons Given
1	23	9 (13.1)*	16 (23.2)	0 (0)	8 (11.6)	5 (7.3)	3 (4.3)	0 (0)	0 (0)	19 (27.6)	2 (2.9)	7 (10.1)	69
2	53	6 (15.4)	2 (5.1)	2 (5.1)	2 (5.1)	4 (10.3)	1 (2.6)	0 (0)	1 (2.6)	5 (12.8)	3 (7.7)	13 (33.3)	39
3	74	1 (5.5)	2 (11.1)	0 (0)	2 (11.1)	2 (11.1)	6 (33.3)	0 (0)	1 (5.5)	1 (5.5)	0 (0)	3 (16.7)	18
4	80	0 (0)	1 (8.3)	0 (0)	1 (8.3)	7 (58.3)	1 (8.3)	0 (0)	1 (8.3)	1 (8.3)	0 (0)	0 (0)	12
5	82	1 (10.0)	0 (0)	1 (10.0)	6 (60.0)	1 (10.0)	0 (0)	0 (0)	0 (0)	1 (10.0)	0 (0)	0 (0)	10

*Percentage is the total responses for a reason, divided by the total responses given for that row.

TABLE 43
TOTAL RESPONSE
(INSTITUTIONAL INVENTIONS)

Frequency
(Percent)

Field of Technology	Total	Process	Material	Component	End Product	Other
Total	125 (100.0)	25 (20.0)	19 (15.2)	34 (27.2)	47 (37.3)	0 (0.0)
Electronic	21 (16.8)	3 (2.4)	0 (0.0)	9 (7.2)	9 (7.2)	0 (0.0)
Electric	4 (3.2)	0 (0.0)	0 (0.0)	0 (0.0)	4 (3.2)	0 (0.0)
Chemical	31 (24.8)	13 (10.4)	16 (12.8)	1 (.8)	1 (.8)	0 (0.0)
Mechanical	15 (12.0)	1 (.8)	0 (0.0)	13 (10.4)	1 (.8)	0 (0.0)
Hydraulic	1 (.8)	0 (0.0)	0 (0.0)	1 (.8)	0 (0.0)	0 (0.0)
Nuclear	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Optics	3 (2.4)	1 (.8)	0 (0.0)	0 (0.0)	2 (1.6)	0 (0.0)
Life Science	10 (8.0)	4 (3.2)	0 (0.0)	3 (2.4)	3 (2.4)	0 (0.0)
Other	40 (32.0)	3 (2.4)	3 (2.4)	7 (5.6)	27 (21.6)	0 (0.0)

PART II. Commercial Utilization of Government-Sponsored Inventions by Industry

LIST OF FIGURES

valuable. The true measure of that is how well they serve their intended use.

Utilization was concentrated in a small number of responding firms, the top 25 contractors[3] in patent holdings accounting for 67 percent of the inventions utilized, and only 65 of 192 responders reporting any utilization at all.[4] Side by side with high utilizers were other firms holding as many patents, but reporting little or no utilization of sample inventions. Both types of firms were largely defense-oriented in their government work and had the right, in most cases, to acquire title to inventions developed under their contracts.

To determine the reasons for high or low utilization and how inventions developed under government contract work are successfully transferred to commercial product situations, 21 companies were interviewed. To assure a relatively even distribution of high and low utilizers in the sample, a numerical rate of utilization was established from the computer runs that ranked all participating firms on the basis of total number of patents received during the sample years and the total which were commercially utilized. Since there was a clear-cut break between utilization rates of less than 7 percent and greater than 12 percent, all firms in the first group were considered low utilizers and those in the second group were considered high utilizers. Ten high and eleven low utilizers were selected from these groups. Size of firm and industry classification were used in addition to utilization as selection criteria. Figures 1 and 2 show the distribution by size and industry of the selected firms.

Wherever possible, interviews were conducted with managers of various functions in each company to get a balanced view of the role of government patents and inventions in the business affairs of the organization. Data were gathered on the sample inventions and more general information were obtained on company attitudes toward patents. Information was also gathered as to the scope of the company's private research and how it relates to its use of patents and inventions in commercial work. Through this data we tried to determine what effect, if any, a change in government policy would have on these firms. The results of the interviews are analyzed below.

[3] The term "contractor" is used in Part II, as in Part I, to describe the firms which developed the inventions under contract in contrast with companies that licensed them from the government.

[4] Measured in dollars, 25 inventions achieved cumulative sales of $1 million or more, individually, and five of these accounted for over half of all sales by contractors in which the inventions played a critical role.

FIGURE 1

SIZE DISTRIBUTION OF SAMPLE COMPANIES

Annual Sales (1957-1962)	High Utilizers	Low Utilizers
Less Than $5 Million	Company J	Company L
$5 to $50 Million	Company M	Company F
$50 to $200 Million	Company H Company N	Company K
$200 to $1 Billion	Company A Company G Company R Company E	Company U
More Than $1 Billion	Company Q Company S	Company B Company C Company I Company O Company P Company T Company D

FIGURE 2

INDUSTRY DISTRIBUTION OF SAMPLE COMPANIES

Industry	High Utilizers	Low Utilizers
1. Military & Space Systems & Airframe Manufacturers	–	Company O Company P
2. Aircraft Engines & Components Manufacturers	Company Q Company R	–
3. Diversified Products & Servicing Firms (military & commercial)	Company A Company S	Company T Company U
4. Instruments, Components, & Subsystems Manufacturers	Company E Company N	Company F
5. Electronic & Communications Equipment Manufacturers	Company G Company H	Company B Company I
6. R & D Firms	Company J	Company K Company L
7. Commercial Product Firms	Company M	Company C Company D

FIGURE 3
INVENTION UTILIZATION
TEN HIGH UTILIZERS
(CONTRACTOR INVENTIONS)

Company	Rank in Patent Houldings[1]	Patent Holdings				Number Utilized	Number Utilized With Commercial Sales Over $1 Million	Total Commercial Sales Million-Dollar Inventions
		Title	License	Number	% of Sample			
Company S	1	153	21	174	7.8	43	3	3.0
Company R	6	110	0	110	5.4	13	2	7.2
Company Q	10	52	4	56	2.7	13	1	1.0
Company E	14	36	0	36	1.7	5	1	1.0
Company H	20	22	0	22	1.0	7	0	0.0
Company A	22	20	0	20	.9	7	1	2.0
Company G	24	15	4	19	.9	4	2	70.0
Company J	25	18	1	19	.9	3	0	0.0
Company N	31	13	0	13	.6	5	3	22.2
Company M	45	8	0	8	.3	3	1	1.25
TOTAL				477	22.2	103	14	107.65

[1] Rank based on holdings of both title and license to inventions in the survey sample.

FIGURE 5
INTERNAL PATENT MANAGEMENT
TEN HIGH UTILIZERS

Company	Size of Firm ($ in millions)	% Government Business	Number of Applications Filed Per Year (Approx.)	% Government-Sponsored Applications*	% Company-Sponsored Applications*
Q	Over 1,000	65-80	Not Available	20	80
S	Over 1,000	40	960	12	88
A	200 - 1,000	40	75	33 1/3	66 2/3
G	200 - 1,000	30-40	150	15	85
R	200 - 1,000	10	500	10	90
E	50 - 200	85	125	14	86
H	50 - 200	75	75	25-30	70-75
N	50 - 200	70	140	25	75
M	5 - 50	10-40	25-30	25	75
J	under 5	20-50	Not Available	Not Available	Not Available

*Percentages are approximate.

FIGURE 6
INTERNAL PATENT MANAGEMENT
ELEVEN LOW UTILIZERS

Company	Size of Firm ($ in millions)	% Government Business	Number of Applications Filed Per Year (Approx.)	% Government-Sponsored Applications*	% Company-Sponsored Applications*
B	over 1,000	80	1,000 - 2,000	2-5	95-98
C	over 1,000	2	510	1 (-)	99+
I	over 1,000	75	300 - 350	33 1/3	66 2/3
O	over 1,000	50-90	70	25	75
P	over 1,000	95	175 - 200	50	50
T	over 1,000	30	600	10-15	85-90
D	200 -1,000	10	1,000	0 (since 1962)	100 (since 1962)
U	200 -1,000	55-70	250	20	80
F	5 - 50	85	Not Available	Not Available	Not Available
K	5 - 50	90	5-6	100	0
L	under 5	Not Available	30	65	35

*Percentages are approximate.

attempt involved three distinct product areas resulting from research at a government division. Marketable commercial products were developed in terms of performance and price, and production lines and distribution channels established. But they were abandoned after several years of loss because of high operating and overhead costs and lack of top management support.

A second endeavor was dropped after two years when management realized that competition in the commercial market was significantly different from the military markets with which the company was familiar. The military operating environment, based on tight government specifications with heavy emphasis on reliability, field maintenance, and broad environmental considerations, could not sustain the more cost-conscious commercial operation. With the failure of these two attempts, Company A has abandoned efforts to generate commercial spin-off from inventions developed under government contract. In the commercial sector, however, where Company A has a number of well-established product lines and is attempting to diversify into yet other markets as a result of the largely unprofitable utilization of government-sponsored inventions, patents are viewed as essential to maintaining a market position.

For all three companies, a shift in government patent policy would have little effect on either their participation in government programs or their commercial utilization of resulting inventions.

b. *Patents Have Little Value to Business Activities, Compared with Accumulated Technical and Management Competence, Production Capability, and Corporate Reputation*

Firms expressing this attitude toward patents were generally manufacturers of complex systems and technical products, such as aircraft, jet engines, computers, or communications equipment. Although as much as 75 percent of their sales may be direct to the government, these firms frequently sell similar products to commercial markets. Inventions developed during the course of R&D activities tend to be auxiliary components and subsystems or incremental improvements to the basic product. These inventions are not as important to these companies in sustaining sales or selling new products as is the basic engineering management and production capability of the firm. New ideas and inventions are incorporated in product modifications or in new models with little consideration given to the protection offered by patent rights. Using a new idea to enhance product performance is regarded as more important than assuring that the company owns the exclusive right to use it. A change in government patent policy from license rights to title rights would probably have little effect on the business activities of these firms and on their interest in continuing to undertake government contract work.

Although *Company P* has a proliferated (corresponding to division) view of patents, the predominant opinion is that patents are of little value as compared with technical know-how. The aircraft-aerospace divisions consider patents important for defense purposes, such as cross-licensing and design flexibility, and the electronics division considers patents essential to its operations. Company P's patent philosophy, however, has evolved with its business orientation: during the sample years, when it acquired 75 patents and seven licenses to government-sponsored inventions, it was not interested in commercially utilizing its government-derived patents because its business base was primarily government; now, however, it is attempting to penetrate more commercial markets. Nonetheless, Company P is a systems-oriented firm which relies more on its ability to engineer and manage large systems than on its capacity to develop a large patent portfolio. The company is a low utilizer, with five commercially utilized patent out of a total of 82.

Like Company P, *Company O's* basic capability is as a systems developer for large projects. It acquired title to 30 government-sponsored patents during the sample years. While patent rights are considered valuable for defensive purposes and for future design flexibility, patents are not as critical to Company O as technical know-how, ability to manage large system projects, and manufacturing capability. The patents most critical to the firm are those related to major design innovations, rather than to small hardware components. The firm establishes patent rights on commercial designs to protect itself against infringement claims or royalty payments to others. Patents on military inventions are taken primarily to recognize technical contributions of company personnel. In addition to defensive and honorific motives for filing, Company O recognizes the opportunity for royalty income from licensing its patents to both domestic and foreign companies.

The firm's attitude toward its government customers is one of complete cooperation and, therefore, separation of in-house R&D from government work is not of primary importance. In situations where the patent department has warned of possible conflicts to claims of priority on inventions on which parallel government- and company-sponsored research has been conducted, management has decided to apply the technology to government work because of its importance for obtaining future government contracts. This consideration outweighed any advantages in securing proprietary positions.

the areas in which they are willing to undertake government research. Faced with the possibility of being unable to obtain title to patents they develop, these firms may refuse to contract in research areas that would impair their operational flexibility.

For Company G, a high utilizer and major subsidiary of a consumer-oriented company having less than half its business devoted to government contracts, patents are valuable for defense purposes. It acquired title to fifteen and license to four survey inventions and reported commercial use of four patents. The character of the market for Company G's products supplants the need for proprietary positions that patents establish: competition is intense; the industry's growth rate is high; patents are widely cross-licensed; and the government is a major customer of the industry. These factors combine to make early entry into the market more crucial to the life of a new product than patent coverage.

While patents are regarded by this company as important to maintain or establish proprietary positions in related commercial areas, holding patents is ordinarily not critical in decisions to utilize new ideas. Although as much coverage as possible is always desirable, patent protection is frequently ignored in a scramble for a market foothold. More important also, in the decision to utilize, is the further investment required, and the potential return.

The company will file for patents if the invention represents a significant advance in the state of the art, or if disclosures are broad. On balance, however, a shift in government policy toward greater ownership of patents would probably have little effect on Company G's participation in government programs. Depending on the nature of the invention and the size of investment required, it would have some effect on the company's commercial use of the resulting inventions.

With most of its sales arising from government contract work, *Company H,* a high utilizer, uses patent rights primarily (i) to defend against infringement suits, (ii) to discourage competitors from copying Company H's special features, (iii) as trading material to avoid paying excessive royalties for the use of inventions owned by others, and (iv) to maximize freedom of design. Search and disclosure of inventions arising out of government work, however, tends to be done: (i) to satisfy contractual requirements, (ii) to prevent possible harassment in the form of infringement suits, (iii) to afford recognition to the inventors, and (iv) to enhance the company's qualifications for future government work.

Government patent policy has little effect on the degree of commercial utilization of patents by this company. The design of a product is dictated by market requirements and competitive factors, rather than proprietary positions. Whether Company H or the government holds title to a particular component rarely has a significant bearing on how or whether it is used.

The government is an essential customer for *Company I,* owing to the nature of the communications industry, in which the company markets. The company acquired title to 84 and license to 47 survey inventions of which it used four in commercial work. Its patent activity in its government work is essentially defensive and largely unrelated to new product considerations. Most of Company I's sample patents describe components, circuit details, and manufacturing process for military applications of electronic equipment which the company feels have limited or negligible commercial potential.

d. *Patents Are Important in Establishing Proprietary Market Positions*

Firms having this attitude actively seek ownership of patents, to establish and maintain proprietary positions in new technologies, as well as in established product areas. Invariably, however, estimates of market potential and corporate investment requirements determine which product areas are developed. The makeup of the patent portfolio may indicate the direction for product development in order to strengthen proprietary positions, but development is rarely, if ever, undertaken solely because patent protection is available. A change in government policy from license rights to title rights would limit the government-sponsored R&D activity of firms in this categroy because of possible conflict with company-sponsored research activities. Contract opportunities would be examined on an individual basis and, in many cases, the government might be refused.

A low utilizer, *Company T,* which sells one-third of its annual volume to the government, used three of its 117 survey inventions (with title to 67 and license to 50). It considers patents valuable in establishing a proprietary position when developing new technology, although, in general, they are not critical in the decision to utilize ideas arising from government work. The corporate organization of Company T may contribute to low utilization. The Company's divisions are oriented specifically toward government or commercial markets, and in those divisions serving the government, it is difficult to establish commercial servicing and marketing channels or to modify products for commercial applications.

Patent considerations are more important in the initial decision of whether to accept a government R&D

e. *Ownership of Patent Rights and Maintenance of Proprietary Positions Are Fundamental Precepts of Business Operations*

Firms in this category regard patent rights as essential to their business activities, and are careful to avoid government claims or conflicts over ownership of inventions. Their policies generally lead them into one of two business patterns. In the first pattern, firms will assure corporate ownership of patents before initiating work on a government contract. They may assure ownership either by negotiating contracts that permit them to acquire title to patents on inventions they may develop, or by developing and patenting basic inventions with limited private funds and then seeking contract work in order to develop additional technical competence, push the state of the art, explore a new technology, or determine if commercial applications may begin to be drawn off. In these situations, firms deliberately select areas of government research to match their commercial interests in order to generate product ideas with commercial possibilities. New research firms with strong technical abilities and limited capital typically follow this pattern, as do specialized firms that have concentrated their business in a limited area of technology.

In the second pattern, firms isolate government work from their commercial operations and pursue these activities separately. Frequently, inventions derived from government contract work will be assigned automatically to the government to avoid title conflicts or commingling with company-sponsored R&D. In other cases, government R&D will be undertaken only in areas where there is no potential conflict with corporate proprietary objectives and in order to enhance the corporate image. The technical value of government contracts to the commercial interests of these firms is rarely considered a valuable supplement to in-house research and development.

The majority of firms following the second business pattern have no proprietary expectations from government contracts. Any change in government patent policy respecting license and title rights would have little effect on these firms since they have already divorced their main corporate interests from government contract work and do not regard government-sponsored R&D as a source of commercial ideas. Firms following the first pattern, however, would be severely affected since their business activity is based largely on government-sponsored research that may develop commercial applications. Corporate ownership of patents is, therefore, an essential feature of the growth strategy of such firms. If title to inventions arising from government-sponsored research were to become unavailable, such firms would either have to change their mode of business or refuse to contract with the government.

Company N, an example of the first pattern, allotted 70 percent of its business to sales to the government during the sample years. Accurate statistics are difficult to compile, however, since every product the company manufactures has some commercial application and those products sold on the commercial market are often purchased by government prime and subcontractors. The company was classified as a high utilizer, applying of five of its 13 survey inventions commercially, all of which it owns.

Company N considers patent rights essential to protect design features of products and valuable for license income and cross trading. The company has no explicit criteria for participating in government work. But when new ideas are developed in-house, it is careful to establish protection for anticipated patents whenever possible before undertaking government contracts. This practice places some restraint on the company's involvement in certain government programs, but does not constitute a general policy of separating government and commercial research. The company rarely separates the two efforts since to do so would require unnecessary duplication of laboratory facilities and manpower.

Company N almost always grants licenses upon request, refusing only if its sales would be jeopardized or if use of the license would be difficult to police. Licenses are most readily granted if:

- (i) Most of the future sales incorporating the patent will be to the government and the latter already has a license to the invention;
- (ii) The patent is legally or technically weak;
- (iii) The time and expense of litigation are not worth the effort; or
- (iv) Sales incorporating the patent are primarily due to company expertise rather than to the patent itself.

The company occasionally advertises patents as available for license, but more often takes licensing action through informal contacts with companies known to be interested in the technology involved.

During the sample years, Company N utilized 38 percent, or 5, of the 13 inventions it developed from government research—thus classifying it as a high utilizer. In each case, the company owned the patent and publicly listed it as available for licensing. Anywhere from two to ten firms applied for the patents and in all cases licenses were granted. The most important patent in the group played a critical role in achieving commercial sales of $15 million in the years from 1954 to 1967. Additional sales of $50 million are anticipated in the next five years. The company invested $400,000 in a relative lack of interest in patents arising from government work. The primary purpose of securing patents on government-sponsored research discoveries as in the case of the wholly government-oriented firm, is to provide professional recognition for technical personnel.

Company S ascribes slightly less than half its sales to government work. The company is a high utilizer, applying 43 of its 174 survey inventions commercially (with title in 153 and license to 21 survey patents).

During the sample years, Company S expected substantial yields from patents generated under government contract and, as a result, sought title to a large number of inventions. Subsequent experience, however, has indicated lower levels of utilization than were expected and, as a consequence, the company has changed its policy. Now, unless commercial applications are foreseeable at the time of the invention disclosure or unless a proprietary position in a commercial market is threatened, the company does not apply for patents but assigns title to the government. Thus, patents developed under government contracts are seldom a critical factor in the company's decision to enter a new market. A shift in government policy toward greater ownership of inventions would, therefore, probably have little effect on its participation in government programs or its utilization of resulting inventions.

In contrast, patents are more important in some of its commercial product lines where inventions developed at private expense may be relied on to establish proprietary positions in the market.

PART III. Commercial Utilization of Public Service-Oriented Agency Inventions

A. Scope of Task

Part III concerns the sample inventions of three public-service oriented agencies: the Department of Agriculture, the Department of the Interior, and the Tennessee Valley Authority (TVA). The inventions of these agencies were studied to determine whether they, because of the agencies' consumer orientation, achieved a greater rate of commercial utilization than the inventions of mission-oriented agencies such as the Department of Defense that sponsor research and development for their own use.

Part III research was based on the study sample of 62 inventions developed under government contract or in government laboratories. Twenty-five case studies were conducted on 47 patents—all of the inventions for which data were available.[1] Whenever necessary, government personnel were contacted to obtain background information in the invention. In each case, one or more users of the invention were interviewed to answer the following questions:

(i) What was the apparent risk and payoff to the utilizer at the time the invention was assigned or licensed to the commercial firm?

(ii) What was the nature of the market need at that time?

(iii) What was the nature of the market structure, that is, was it regional, national, or competitive?

(iv) How sophisticated was the invention relative to the state of the art of the product or process prior to the invention?

(v) How much did the utilizing firms invest in developing the invention for commercial use?

(vi) What is the utilizer's policy in licensing inventions it owns?

(vii) Was the product on the market prior to the issue of the patent?

(viii) Were patents used defensively either to preclude another firm's developing superior products or to allow more design freedom for the owner's products?

[1] Fifteen patents could not be documented for various reasons and were dropped from the sample. Eleven of these did not, in fact, result from government contracts, two involved a refusal of the licensee to participate in the research, and one involved a licensee who could not be located.

Five of these 47 patents were from TVA, 12 from the Department of the Interior, and 30 from the Department of Agriculture. Twenty-four of the 47 patents were utilized (see Figure 1) and 23 were not (see Figure 2).

An earlier study of government efforts to promote utilization (Volume III) indicated that since Agriculture and TVA—and the Interior to a lesser extent—perform much of their research in house, most of their patents are available only on a nonexclusive royalty-free basis. Thus, the need for exclusive rights to an invention as an incentive to utilization as well as the commercial potential of public-service agency inventions has been tested.

B. Findings

Some significant patterns emerged from the case studies. To the extent that the public-service oriented agencies select their research to fulfill civilian needs, they function—with one essential difference—like industrial firms looking for new markets: Since they are not required to earn a profit, they are freer than most industrial organizations to sponsor high-risk research with future rather than imminent utilization prospects. This pattern was particularly significant with Agriculture and TVA since their programs benefit conservative industries, such as food, textile, or fertilizer, which perform little of their own research or development. These agencies have become, to a large extent, the research arm of these particular industries. This relationship is noted in a number of the cases where the companies involved attribute lack of utilization to the government's failure to carry development of the invention far enough.

In other cases, also involving fertilizer or agricultural products, the government proved the commercial feasibility of an invention and, by doing so, stimulated industry to carry the work through to utilization. Case 7, the "Textile Fiber Cleaning Machine," reflects this pattern. Here, government research removed much of the financial risk from private commercial development and the company developed a proprietary position on patentable improvements to the basic invention.

However, development alone will not insure commercialization of TVA or Agriculture inventions; often intensive promotion is needed to convince potential users of the inventions' commercial value. For example, in Case 5, "Potato Flakes," the Department of Agriculture market tested the product in supermarkets before

FIGURE 2
NONUTILIZED INVENTIONS
(PUBLIC-SERVICE AGENCIES)

	Case	Sponsor Agency	Patents Involved	Licensees	Reasons for Nonutilization	Private Investment
11.	Solar Still	Interior	1	1	Only technical feasibility demonstrated; government now funding alternative methods	None
12.	Electrolytic Process for Desalination of Water	Interior	1	1	Development work not finished	None
13.	Hydrate Process for Desalination of Water[1]	Interior	5	1	Development work not finished; patent rights issue with firm	$495,000
14.	Centrifugal Compression Distillation	Interior	1	1	Utilization tried but severe technical problems encountered	Some[3]
15.	Shale Oil	Interior	1	1	No market need yet, although thought to have promise; patent rights problems	Some[3]
16.	A Calcium Carrying Agent for Medicinal Applications	Agriculture	1	1	Research not yet complete; thought to have promise	$100,000
17.	Gelsoy (Manufacture of Sausages)	Agriculture	1	1	Lack of availability of raw material; no USDA follow through	Some[3]
18.	Textile Fiber Cleaning Machine	Agriculture	1	4	Utilization tried but severe technical problems encountered	$20,000
19.	Flameproofing of Fabrics	Agriculture	5	5	Chemical and raw material problems	About $80,000[4]
20.	Coumarone Derivatives	Agriculture	1	1	Technical problems; reorganization of firm	None?
21.	Preservation of Walnuts	Agriculture	1	1	More practical alternative method developed concurrently	Some[2]
22.	Vinyl 9, 10-Epoxystearate	Agriculture	1	1	Chemical limitations and high cost relative to other methods	None
23.	Honeycomb (Uncapping Apparatus)	Agriculture	1	25	No market need; too complex for commercial application	None
24.	Deamidized Gliadin	Agriculture	1	1	No market need; licensee not in business related to potential use	None
25.	Mechanical Crabpicker	Interior	1	2	Development unsuccessful to date	None

[1] This case also documented in Volume II.

[2] Development undertaken on cooperative basis with USDA (amounts not available).

[3] Records not available.

[4] Amount spent by only one of several commercial firms attempting to utilize.

("Foam-mat Process for Drying Foods"), and Case 3 ("Sugar Beet Extraction") exemplify this pattern. These cases represent small firms who recognize government-sponsored research as an extension of their own research and development organizations.

• *In industries with small producing units or little technological change, such as agriculture, a strong research-oriented agency can make an extremely impressive contribution to commercialization through technical development and nonexclusive licensing.* In the case of TVA, who issues nonexclusive licenses but who also undertakes extensive development and promotion of its inventions, very broad utilization was achieved. On the other hand, when there is no extensive development and promotion, nonexclusive licensing more frequently discourages than promotes commercial utilization. Industry hesitates to risk investing its own funds in commercial development of products that do not have proven technical and economic feasibility without prior patent protection. Both the "Shale Oil Processing" and "Hydrate Process for Desalination of Water" cases (nonutilized inventions) involve patent rights disputes between the government and private industry. In both cases, the companies undertaking development work want to protect themselves with exclusive licenses.

D. Inventions in the Sample

1. Utilized Inventions

Figure 1 lists the 24 utilized patents according to market size. Except for Agriculture and its potato flakes, TVA, with all four of its sample patents in active use, has achieved the most successful utilization. Utilization of these four patents and associated government-owned patents not covered in the sample but necessary to manufacture the fertilizer products development by TVA has brought about significant improvements in the state of the art of fertilizer technology, a revitalization of the industry, and higher agricultural yields to the farmer as well. The Department of Agriculture has achieved fairly successful utilization: Potato flakes and dialdehyde starch are its most successful products in the sample in terms of generating new sales, although utilization of dialdehyde starch has required a large private investment in research. The cotton opener and the sugar beet extraction process inventions appear to be contributing modestly to industry sales and the foam-mat process for drying foods has potential value for dehydrating fruit and vegetable pulp and juices. Particularly with instant coffee and instant orange juice, the foam-mat process may be cheaper than those currently used.

The Department of the Interior is represented by one case of modest utilization (synthetic mica) and one case of marginal use (low-temperature phase equilibria cell)—both inventions are associated with the relatively patent-sensitive chemical and raw materials processing industries.

Government patent policy played a role in all of the inventions utilized. In every case the government owned the patent, with rights licensed to the users. In the TVA cases, in particular, utilization might have been severely crippled, if one or a few dominant firms in the industry had been able to obtain exclusive rights under any of the government patents. It is significant in evaluating the effect of patent policy on utilization of public service agency inventions that, in the case of the utilized inventions, all patents resulted from in-house government work and not from outside contracts, and that in each case, the government research was related to an identifiable need for technological improvement in the product area which the government was supporting. Summary descriptions of the utilized inventions follow.

(i) *Dialdehyde Starch (Agriculture).* The sole supplier of dialdehyde starch currently sells a million pounds of the product annually at $.75 a pound. This market has more potential than has been realized, and has involved a large R&D investment by one firm over and above that initially invested by the government.

(ii) *Synthetic Mica (Interior).* Synthetic mica seems to have generated disappointing returns when compared to the amounts invested in its development. The major utilizer states that he has spent over $2 million in developing synthetic mica and has had annual sales of approximately $600,000 from the product.

(iii) *Liquid and Mixed Fertilizer Processes (TVA).* When relating annual market to private capital investment required to achieve utilization, TVA's liquid and mixed fertilizer processes probably have been most successful. TVA developed the inventions to the point where the agency was able to demonstrate production in its own factories; it then licensed the processes to any manufacturer interested in copying the processing plant. The most successful utilizer purchased a processing plant for $40,000 and is producing approximately $417,000 worth of liquid fertilizer annually.

(iv) *Cotton Opener (Agriculture).* Like the liquid fertilizer process, the cotton opener is a profitable (though small) market item when compared to the modest investment required to market the machine. In this case, however, only although the government now is funding alternative methods similar in theory to the one described in this patent. There have been mechanical difficulties with the compression distillation apparatus and better alternative methods have become available.

With the availability of government funding for water desalination research, the field is currently undergoing rapid development; and, although it is impossible to predict which of the 30 or more technical approaches now available will prove most successful, it is fairly certain that some will achieve commercialization. Volume II, Part IV identifies several patent problems experienced in water desalination research. Although these problems probably have not been the major factor in preventing further development of either the solary still or the compression distillation process, the hydtrate process is the subject of a disagreement between OSW and the contracting firm. This case, documented in Volume II from government records and interviews, is presented again here from the point of view of the contractor who has extensive development funds committed to the project.

(ii) *Shale Oil Processing (Interior).* The shale oil processing case is similar to the desalination cases in that ways of exploiting the market have not yet been specifically defined. There were patent problems too, arising out of the policy of nonexclusive licensing of government owned patents. The Department of the Interior, which has administrative cognizance over most of the oil shale lands in the western mountain states, has now proposed to issue leases for oil shale research. Title to patents would be governed by the president's patent policy statement. In accordance with "exceptional circumstances" set forth in paragraph IA of the statement, title may be left with lessees under appropriate circumstances.

(iii) *Calcium Carrying Agent (Agriculture).* The development of the calcium carrying agent triggered a related research program at a chemical firm which has resulted in a number of improved compounds now marketed by the firm. The specific invention involved in the patent served only as a catalyst and, although no utilization can be attributed strictly to the patent, utilization clearly grew out of the government-initiated work.

(iv) *Gelsoy (Agriculture).* Perhaps the most frustrating case of nonutilization is that involving gelsoy, a soybean-based material useful in the manufacture of sausage developed by the Department of Agriculture. It illustrates the conservatism of some segments of industry and their dependence on government research in their product areas. A consultant identified four possible commercial applications for the product, and Agriculture terminated its work at that point. An American firm, interested in marketing a product using the invention, could not obtain the appropriate materials for the product because the soybean industry was not interested in conducting further research in the area. However, the Japanese are currently using the process.

(v) *Textile Fiber Cleaning Machine (Agriculture).* USDA research laboratories developed a successful prototype model of this machine, but unforeseen technical problems arose in developing a commercial model. The firm closest to achieving commercialization invested approximately $20,000 in development and anticipated sales of more than $1 million.

(vi) *Flameproofing of Fabrics (Agriculture).* This is another case where none of the patents were actually utilized, but where the initial government-sponsored research led to further development of better products. The Department of Agriculture laboratories initially developed a technical approach which was subsequently improved by a raw materials supplier who is currently exploiting it. Although the firm patented the improved process, it clearly grew out of the USDA research.

(vii) *Coumarone Derivatives (Agriculture).* The coumarone derivatives case was hard to document because the company that undertook commercialization was completely reorganized in 1966. That the patent was not utilized is due largely to the technical problems associated with this invention.

(viii) *Preservation of Walnuts (Agriculture).* In this case as in the calcium carrying agent and the fabric flameproofing cases, the government research project contributed new knowledge to a field of agriculture (that is, the preservation of many kinds of nut products) that has enabled the industry to improve its marketing and distribution programs. The invention itself

E. CASE STUDIES

DEPARTMENT OF AGRICULTURE UTILIZED INVENTIONS

Case 1: Dialdehyde Starch
Case 2: Cotton Opener
Case 3: Sugar Beet Extraction
Case 4: Foam-mat Process for Drying Foods
Case 5: Potato Flakes

CASE 1
DIALDEHYDE STARCH

Background of the Invention

The eight patents involved in this case cover the processing and use of dialdehyde starches for three end uses:

(1) As a starting point for the synthesis of erythritol and ethylene glycol;

(2) As a leather tanning agent;

(3) As an agent contributing wet strength to paper. The inventions were developed at a Department of Agriculture (USDA) laboratory as part of an ongoing research program to find new uses for corn and corn products–a mission objective of the Department. All are a part of a large research effort in the USDA and industry laboratories to develop commercial applications for dialdehyde starch.

There are several licensees under these patents, but the MM Company has licensed all eight. USDA has reduced the scale of its research since the eight patents issued.

Private Development and Commercial Utilization

The basic USDA patent–critical in the conversion of cornstarch to dialdehyde starch–stimulated the MM Company to begin work with the product. The company chose to work on the basic process and leave development of applications to the USDA thus, when the firm was well into development of the process, the USDA stopped its own work in that area and concentrated on applications.

MM Company improved the process and strengthened its proprietary position through improvement patents and trade secrets. In fact, executives of MM Company stated that one of the reasons it decided to work on dialdehyde starch was that they would be able to develop a commanding technical position in the area in spite of the nonexclusive license on the basic invention. They have, indeed, developed such a position and are presently the only manufacturer of dialdehyde starch in the United States. The technology is not so advanced, however, that this market lead would foreclose competition from any other interested firm.

Since the MM Company began research on dialdehyde starch in 1958, it has invested substantial funds in the development of the product, including scale production facilities. Having successfully developed improvement patents for dialdehyde starch, the company looked to the market for paper additives for its sales opportunity. The market for wet strength additives is presently \$80 to \$90 million per year, and polymeric resin additives manufactured by a number of companies account for the largest share of it. The market is very competitive, however, and has low profit margins.

In 1962, the MM Company had to decide whether to market dialdehyde starch itself or through another firm. At that time, it had no experience with the paper industry, and a decision to do its own marketing would entail learning a new field, training personnel, and establishing close enough contacts with members of the paper industry to obtain mill trials of the product. Nevertheless, the company decided to proceed on its own. Its marketing effort has not been a large one, however–from 1962 to 1964, it was essentially carried on by its own research staff.

The company presently sells its starch at 75 cents a pound, whereas dialdehyde starch imported from Japan sells for 50 cents a pound. MM Company research personnel feel, however, that if its production were on a ten-million-pound-per-year basis, it could better the Japanese price. Since it has only a small share of the market, the company does not license its dialdehyde patents. The company believes that its patents on the manufacturing process and its technical knowhow in the dialehyde starch area are sufficient to maintain a lead in the face of potential competition.

Comment

In this case, the iterest of USDA and one firm happened to coincide on a series of patents. USDA was looking for ways to use cornstarch more profitably, *The BT Company*

In 1958, the BT Company took out a license to the SRRL cotton opener. It invested several thousand dollars to develop and patent an improved model. But, it took its opener off the market after selling several because the sales were not very profitable. The project manager of the cotton opener at the BT Company indicated that market resistance was associated with the machine, since it combined a number of operations (opening, cleaning, blending) which customarily were performed by separate machines, or even by hand, in some firms in the industry.

The TF Company

In 1957, SRRL presented the machine to the TF Company. The company assessed the invention and, although no market projections were made, it decided to take out a license, as the risk of producing the cleaner appeared small when compared to the potential demand. The first cleaner was sold in 1958, after a few thousand dollars had been spent for modifications. Sales of the machine now account for about 10 percent of company sales, after some nine years of production with little additional investment and continuing demand envisioned.

Comment

In this case the government conceived the idea, conducted research and development in-house, and actively promoted the invention. Thirteen companies took out licenses, but very few developed the original invention for commercial application or attempted to sell it to the textile industry. The SRRL concept was sound, but the construction of the machine presented problems. Continued private development under license modified the original invention, and other more practical cotton openers were patented and developed for commercial application.

One small firm interviewed said the government could benefit by working more closely with the textile mills and the machine manufacturers. They claimed the SRRL had lost time by dealing only with the top management of the large firms in the industry, and not directly with the mills. The original SRRL cotton opener was said to be only 5 percent applicable to the mills.

Competition follows fast on the entry of a new machine into the textile machine industry market, particularly if the product looks promising. A general distrust of patents prevails in the industry because competition is so keen as to prohibit the effectiveness of patent protection. It is the rule rather than the exception for companies to keep their inventions secret, particularly if a new machine is involved, or to file only improvement patents, because patents tend to disclose the nature of the invention, threaten market position, and invite competition. For the same reasons, companies are usually unwilling to license a competitor; neither the BT or TF companies will issue licenses on their patents.

Taking licenses to government-sponsored inventions is looked upon with equal reluctance. The AC Company, for example—partly, perhaps as a result of its costly experience with the cotton opener—would rather work under an exclusive license to another company—produce the machine, pay the royalty, and sell it to a third party—than work under a license issued by the government. Licenses to government-sponsored inventions are not viewed as valuable in this industry because the technology involved is in the public domain, and free for anyone to exploit.

The AC Company experience also shows that the original SRRL invention needed further development and hence provided the company an opportunity to build a patent portfolio around improvement patents resulting from private development of a government-sponsored invention.

Despite the industry's wariness of patenting, Company BY and XYZ aggressively file for patents. XYZ's policy is to apply for a patent if the sales potential extends over three years. If a unique process is developed, only for the short term, no patent application will be made.

CASE 3
SUGAR BEET EXTRACTION

Background of the invention

The two government patents in this study involve a sugar beet extraction process. The first reduces the extraction of colloidal substances from the beet tissue in recovering sugar from beets by introducing aqueous ammonia solutions and carbon dioxide gas. The second is a combined counter-current extraction process (in which the shredded beets move in one direction through a series of diffusion extractors, and the aqueous extraction solution moves in the opposite direction), and a recirculation process. The recirculation technique described by the patent (i) solves the problem of what to do with the water that is extracted and (ii) is cheaper and more convenient than other techniques.

Both inventions were developed to the point of commercial application by the Department of investment in process and apparatus development for commercial application of the foam-mat-drying process. The firm envisioned a return on its investment in the design and sale of commercial plants to companies that wanted to use the process.

GN's research work yielded a number of equipment and apparatus patents. The company does not charge royalties on its own patents, which are incorporated in equipment design, but obtains its return on inventions and patents from either design and/or installation of equipment as was attempted with the foam-mat process. GN installed a foam-mat pilot plant for a firm which subsequently lost interest in the process because of a lack of technologists to run it. However, another GN equipment has been installed for a firm which is investing in the development of foaming agents and stabilizers. The plant investment, he noted, is much smaller for a given output than for other dehydration methods.

The DX Company

The DX Company's principal product lines relate primarily to fiber processing and industrial drying equipment, specially designed for particular industries. It manufactures and sells continuous conveyor dryers for the food, chemical, textile, and tobacco industries with two U.S. and two foreign plants. DX Company's sales volume for 1966 was nearly $20 million.

Because of the seemingly small risk and great potential associated with making and selling foam-mat drying machinery if the process were successful, the company obtained a license. Although the DX Company's business is building machinery, a large food processing client asked the company to test and evaluate the foam-mat process. The DX Company spent a modest sum on testing, over about six months. Although the machinery performed satisfactorily, other problems arose with regard to (i) getting the right foam; (ii) stabilizers; (iii) mixing techniques; and (iv) quality. The DX Company sent the results to the food processing company, and no follow-on work resulted.

According to the chief engineer at the DX Company, the foam-mat drying process is unique, and possibly ahead of its time. He believes that until the problems indicated above are solved, no commercial development will ensue. The DX Company plans no further work on the process unless the food processing contractor offers a firm contract.

The CA Company

The CA Company offers engineering services to the food industry. The company president, observing a dryer that used the foam-mat process, realized that it would be good for hard fruits, but might damage other products. CA customers were interested in the process, but did not want to risk product damage. The CA Company president recognized that it would not be profitable to make the machine for the segment of the food industry he served, but he decided to apply for a license, to have the option to produce if the demand changed. The CA license request was granted in 1962, but the company has not spent any funds on development, and future work is not planned.

The LOT Company

The LOT Company, which is in the food processing industry took an interest in the foam-mat drying process as it applied to potatoes, the company's principal concern, and applied for a license several years ago.

Not after initial investigation, LOT Company decided not to use the inventions commercially for dehydrating potatoes or to invest in research because (i) the USDA development was incomplete; (ii) development cost would be too high; and (iii) the technology involved was too sophisticated for commercial use.

Comment

Although, according to the USDA, the foam-mat process for drying foods could be a billion dollar business, most of the big companies in the food industry do not ordinarily do much research or development in processing; the big return in the food industry is in packaging and marketing rather than in processing. Consequently, the industry relies heavily on government research and technology for the development of new techniques. In this case, a USDA laboratory, WRRD, developed a new process as far as laboratory use, obtained a patent, and granted royalty-free licenses to the industry. The laboratory then stopped work, leaving complex technical problems associated with commercial exploitation of the invention for industry to solve.

The number of licenses sought indicates industry interest in the process, but all but one company declined to pursue development because of apparent technical problems in the inventions. It is still too early to tell whether the company which has tried to exploit the invention, the GN Company, will recoup its investment, although chances seem good. It is interesting to note that GN Company has a portfolio of patents on foam-mat machinery it developed--while under contract to another food processor--from an idea developed initially by the government. The three other licensees interviewed failed to utilized their licenses.

developed by the Department of Agriculture fitted the EE Company's needs perfectly.

The bulk of the potato flakes marketed under the DD Company label prior to 1956 were produced by the EE Company under a cooperative agreement. The processing information outlined in the patents was sufficiently developed so that the company could produce the final product without additional engineering development expense. The current process used by EE is modified, however, by addition of an emulsifier to the mix, which it uses under a license from the DD Company.

Comment

The food processing industry relies heavily, if not exclusively, on government research and technology for the development of new products. Government agencies, both state and federal, seem to accept this relationship and carry out fairly extensive campaigns to promote the products of their research. In the situation under study, the USDA not only developed the potato flake process but also conducted market surveys. Additional promotional activities were provided by the Maine Potato Commission and the Maine State Department of Agriculture.

The potato flake patents are perhaps a model success story for USDA utilization policies. A highly profitable low-risk product was created, market-tested, and promoted to a conservative industry which looks to the size of its market, rather than the ingenuity of its product, for the payoff. Under this set of circumstances, a government policy which retains title rights and grants licenses on an industry-wide basis appears essential to achieve fullest utilization of the patent.

DEPARTMENT OF AGRICULTURE NONUTILIZED INVENTIONS

Case 6: Flameproofing of Fabrics
Case 7: Textile Fiber Cleaning Machine
Case 8: A Calcium Carrying Agent for Medicinal Applications
Case 9: Gelsoy
Case 10: Deamidized Gliadin
Case 11: Honeycomb Uncapping
Case 12: Coumarone Derivatives
Case 13: Preservation of Walnuts
Case 14: Vinyl 9, 10-Expoxystearate

CASE 6 FLAMEPROOFING OF FABRICS

Background of the Invention

This series of five related inventions involves the preparation of polymers to be used in the flameproofing of textiles.

One of the inventions, in addition to being useful for producing flameproof textiles, is a resilient solid polymer material that can be used in the production of synthetic plastic articles, protective coatings, paints, and varnish. These particular chemicals possess unique properties of high water swellability and pronounced ability to absorb water. Another invention, an improvement on the first, is a refinement in the method of producing the polymers--it provides for their production in a plastic powder form, thus facilitating their use as a flameproofing agent. In powder form, the polymers can be shipped, stored, and, subsequently, combined with other textile modifying agents such as wetting agents, softeners, mildewproofing agents, water repellents, abrasion resistant materials, and so forth, and, in addition, can be readily adapted to jet injection molding processes. The remaining three inventions overcome problems associated with the use of the two principal inventions, extending their utility to the treatment of any of the natural or synthetic organic textile materials such as cotton, flax, rayon, wool, and silk in the form of fibers, yarns, threads, or fabrics.

These inventions represent only a few of those coming out of a DOD-sponsored, Department of Agriculture (USDA) research program at the Southern Regional Research Laboratory (SRRL) to develop a suitable fire retardant for military clothing. Although a number of fire-retardant, textile-treating agents had been developed prior to this program, none had met military requirements or were suitable for civilian application. These five inventions, developed specifically for the Department of Defense, have achieved purely military applications.

Because all the inventions use phosphorous compounds that are difficult to make and relatively dangerous to handle, Department of Agriculture devices growing out of an in-house Department of Agriculture (USDA) Southern Regional Research Laboratory (SRRL) program initiated in 1944.

This research was widely encouraged from within the textile industry because the transition from hand to mechanical harvesting methods in cotton farming increased the trash content of cotton delivered to the textile industry. From 1949 to 1958, the proportion of mechanically harvested cotton rose from 6 percent to 34 percent of the total harvest and, in 1958 alone, an additional 23 percent of the cotton was harvested by hand-snapping, a quick hand method of harvesting which produces a high proportion of trash. During this same period (1949 to 1958), increasing cost pressures made anything that increased production speed or yield attractive to industry.

The invention, called the "SRRL Carding Cleaner," was first reported in 1955. Laboratory tests indicated the machine capable of an average cleaning efficiency of 50 percent at 435 pounds for each hour of production, with no damage to the cotton and with a remarkably low—7 percent—"line-in-waste" content. SRRL attempted to encourage industry interest in the invention with promotional literature and by sending speakers out into the industry.

In 1958, SRRL developed a prototype machine which was found to remove 50 percent of the trash in cotton with a negligible loss of lint and with no fiber damage, no increase in neps (balls of tangled fibers), and no impairment of yarn properties. Loose-fiber losses were about one-fourth of the losses occurring in the conventional cleaner and the cleaning efficiency was very high. Subsequently, in 1959 and 1960, four southern firms licensed the invention from USDA on a nonexclusive, royalty-free basis.

Private Development and Commercial Utilization

Of the four companies that took out nonexclusive licenses on the invention, only one, the TF Company undertook commercial development. TF first became interested in the machine as a result of the SRRL promotional campaign. At that time, the laboratory tests looked excellent, and the company estimated that the new machine would replace about 1 percent of the 30,000 earlier model pickers in use in the industry. With a modest unit cost to the company and a selling price with good profit margins and a price low enough for mill managers to pay without consulting top corporate management—the company anticipated sales of over $1 million.

With the help of the SRRL inventor and at a development cost of several thousand dollars, the TF Company built a prototype model for mill testing. Technical difficulties were encountered during the tests and the fibers were badly damaged. TF and SRRL worked together for a short time to solve this problem, but the technical difficulties and emergence of other machines with similar capabilities convinced them to abandon the effort.

The TF Company feels that there is still a demand for the invention. Today the machine could be used as a synthetic fiber opener as well as a cleaner, and it continues to promise better performance at lower cost than presently available equipment. The company does not, however, wish to spend any more of its already limited funds on the machine's development.

Comments

This case represents a government-financed in-house effort to develop a textile fiber cleaning machine and a company's efforts, unsuccessful for technical reasons, to utilize the fruits of the government program. Following prototype development and testing, nonexclusive, royalty-free licenses were granted to four industrial firms, of which only one undertook further development efforts; that firm had the full and close cooperation of SRRL in its efforts.

TF and the other three small companies who licensed the invention based on their decision on whether to attempt commercial development on intuition rather than on formal market studies. With regard to inventions it has developed itself (TF owns a small number of patents and a few licenses), the company applies for a patent if the idea is technically sound and has market potential. Once it gets a patent, the company is not likely to license to its competitors. In commenting on this policy, one TF executive indicated patents are not particulary meaningful since mechanical device patents are fairly easy to design around and infringement suits are too expensive to be worthwhile.

Other executives in the industry felt that the nonexclusive license available from SRRL for this invention discouraged them from developing it. One such company, which normally requires either title or an exclusive license to an invention prior to undertaking commercial development, would probably have tried to commercialize the fiber cleaning machine if it had received title to the invention or if it had received an exclusive license for the life of the patent.

TWX filed four patent applications, one of which concerned the sausage application. When the NRRL decided not to pursue the commercial applications derived from the company's contract research, TWX, lacking the investment capital required to exploit the market, stopped work. A cursory exploration of the soybean industry (consisting of the government sending samples of the sausage of many firms) proved that there was no interest in providing the raw material needed to produce Gelsoy.

The AZ Company

The AZ Company, a sausage manufacturer, was impressed by the government sample of Gelsoy and consequently, applied for a license. When the company learned that it would not be able to get Gelsoy regularly, it decided to discontinue its investigation of product application. The AZ Company has not used its license and declares it has no future intentions of using the invention.

Comment

In this case, a government laboratory invented a process, awarded two contracts to determine the commercial applications, found several promising applications, and discontinued development at that point. Three applications, including the sausage application of this invention, were developed and patented by the TWX Company, with title assigned to USDA. The NRRL decided not to pursue the invention further at that point.

Commenting on the TWX experience, an executive of the company believes that a gap that exists in the NRRL effort to get a product from the laboratory to the market. He believes that the province of the USDA personnel is science and that new processes are not fully developed because they do not know how to commercialize them. If the government had put more emphasis on the commercial utilization of the subject invention, he asserts, and had advertised in the soybean industry, the product could have been on the market today: in 1967 a million pounds of Gelsoy per year could have been sold at a cost from $.35 to $.50 per pound, assessing the market at from $350,000 to $500,000 annually. No comment was made as to why the government, rather than industry, should be expected to undertake full responsibility for developing products to the point of commercial utilization.

CASE 10
DEAMIDIZED GLIADIN

Background of the Invention

The patent describes the use of deamidized gliadin, a proteinous substance available from wheat, in the preparation of dessert toppings, cake frostings, candies, and the like. Before this invention, materials used for the same purposes included egg whites, soy proteins, modified milk proteins, gelatins, and unmodified gliadin. All these materials function as stabilizers, maintaining the original properties of a composition by preventing release of air from aerated products, separation of fat from aqueous products, drying out, and development of graininess in a smooth textured product. Deamidized gliadin has been shown to be a better stabilizer than the other materials, providing smoother textures and higher glosses.

This use for diamidized gliadin was developed in the USDA Western Research Laboratory, in Albany, California, by a Department of Agriculture food technologist, as part of a research program on food processing. One nonexclusive, royalty-free license has been issued under the patent.

Private Development and Commercial Utilization

The invention may be utilized in the preparation of all types of food products requiring a stabilizer. However, no known commercial utilization has been made of the invention; although it is possible, as noted in previous cases, that the invention may be in use without licenses.

The sole licensee under this patent is Company XX, a trucking firm. Company XX management has not utilized the invention because it is outside the firm's line of business, and the cost of commercializing the discovery would be prohibitive, if indeed the invention were marketable at all.

Comment

In the research that developed this invention, the Department of Agriculture was focusing on commercial utilization. Although the research appears to have disclosed a potential commercial use for deamidized gliadin, it does not appear that the invention has been used.

CASE 13
PRESERVATION OF WALNUTS

Background of the Invention

This invention is a process for preserving walnuts, and involves conditioning the walnuts by drying them to a kernel moisture content of 2 to 3 percent and then storing them at that moisture level. It was developed as a method of preventing rancidity in walnuts, of preserving them, and of lightening their color. The moisture content of the walnuts is an important factor in flavor preservation since flavor components begin to oxidize when moisture concentration is more than 4 percent, a concentration beyond the optimum level for preserving flavor over a long period.

Because of an extraordinary equipment requirement and the time needed to treat walnuts as prescribed by this invention, as well as some changes in technology between the filing and issuing of the patent, the invention has not been utilized.

The sample invention was a product of a cooperative government and private research effort, lasting from 1952 to 1963. Under an agreement between HW, Inc., a large western walnut cooperative, and the Department of Agriculture Western Regional Research Laboratory (WRRL). HW paid the salaries of technical personnel working in the USDA Pasadena Food and Vegetable Chemistry Laboratory, and the USDA supplied the laboratory, instruments, and direction for the program.

In the course of examining the effect of moisture content on the preservation of walnuts, the sample invention arose. Although the overall program was quite productive and yielded many valuable results to the walnut industry, the sample patent, was the only patent generated by the program.

Private Development and Commercial Utilization

In 1955, HW's own laboratories were working on the development of antioxidants–a different method of preserving walnuts. This program had been initiated because it was found that the moisture-controlled method of preservation described by the sample patent required substantial equipment and time to reach the prescribed level of 2 to 3 percent, at which point a package was needed that would retain that level. At that time, there were no packages available suitable for maintaining the proper moisture level–with the exception of the tin can–and the walnut cooperative had already decided that the best package for marketing was a transparent one.

Comment

Because walnut processing operations are standard, important inventions in the walnut industry are few; and patents are correspondingly few. For example, HW designs and makes its own equipment for walnut processing, and while it originally had a patent on a basic cracking machine, the patent has now expired. In many instances, HW has given away its technology to other producers. With a reasonable capital investment, anyone may be assured entry into the market without proprietary technology playing an important role.

In this case the government provided facilities for research, on a cooperative basis, with an industrial partner. Most of the direct cost of the research, however, was borne by the partner, HW, Inc., who stood to benefit most from the research even though title to all inventions generated under the project rested with the government.

Because of the close partnership of the government and industry in this work, the chance of commercial utilization of the results were more probable than those of many other government research projects. However, other commercial research pursued concurrently with this work rendered the results of the project commercially obsolete.

CASE 14
VINYL 9, 10-EPOXYSTEARATE

Background of the Invention

The invention, vinyl 9, 10-epoxystearate, is a chemical compound having potential applications in plastics, dyes, and certain process applications. Compared to other alternative materials, however, it is too costly to be competitive; certain chemical problems also limit its applicability.

The invention resulted from a basic research program into the chemical and physical properties of vinyl stearates–a program started in the early 1950's by the Eastern Utilization Research and Development Division (EURDD) of the Department of Agriculture (USDA). The initial idea for the invention was conceived in 1948, and the EURDD developed it entirely in house. From 1954 to 1962, three USDA scientists worked on the compound part time and tried to promote it by writing articles in journals, holding conferences, and talking to salesmen. Prior to the issuance of the patent in 1962, two articles in the *Journal of Polymer Science* created a great deal of interest in the invention. The patent was applied for by the USDA in 1954 and issued in 1962.

The TVA process has been licensed on a nonexclusive basis to more than 110 fertilizer manufacturers and is used in over 100 plants in the country. In addition, the ammoniator unit design has been licensed to 30 engineering firms, 22 of which report sales and installation of the unit in various sizes.

Private Development and Commercial Utilization

In 1966, mixed fertilizers accounted for nearly 60 percent of all the fertilizer materials consumed in the United States. Industry sources expect the demand for mixed materials to remain at the current level or possibly to increase in proportion to total fertilizer consumption as intensive crop cultivation continues. The growth of mixed fertilizers, and especially mixed granulated fertilizers (produced by the TVA process), is shown in the following table which displays fertilizer consumption in the United States for a 25-year period and sales growth for a 10-year period. The significant increase in consumption of granulated fertilizers after 1955 can be attributed to introduction and utilization of the TVA continuous ammoniator-granulator. The industry clearly recognizes the invention's impact and maintains enthusiastic support for TVA and its technical developments.

The fertilizer industry, historically, has lagged in new product development and in improvements to basic technology. Fertilizer materials are among the cheapest commodities in commerce. At an average price of $50 per ton, they are second only to cement and sand in terms of the volume of material which must be sold per dollar of profit. Distribution costs are a substantial factor in the selling price of fertilizer, and the chemical composition of the available raw materials (phosphate rock and potash) strongly influences the quality and

TABLE 1

U.S. FERTILIZER CONSUMPTION

1940 - 1966

(Fiscal Years Except 1940)

	1940	1950	1955	1957	1960	1963	1966
All Types (million tons)	–	18.3	22.7	22.7	24.9	28.8	34.5
Mixed Fertilizer (million tons)	5.5	12.3	15.3	14.7	15.6	17.2	19.7
% of All Types	–	67	68	65	63	59	57
Granulated Mixed Fertilizer							
(million tons)	0.05	1.2	1.4	3.5	5	6	10
% of Total Mixed	1	9	10	24	30	35	[1] 49

U.S. FERTILIZER SALES

Year	Sales - All Types ($ in billions)
1954	$1.0
1958	1.1
1964	1.4
1966	1.8

[1] Over three-fourths of the solid mixed fertilizer was granular, and most of it was produced in equipment and with technology developed by TVA.

inside the government laboratory. Industry took the entire technology and applied it directly without need for further development.

This case represents a low-risk, high-potential invention for which the market for the product is large (sales of $1 billion per year) and the development cost to a commercializing firm is negligible. Without question, TVA's retention of title to the patent and its practice of making licenses available on an industry-wide basis were vital to wide-scale utilization. The developments covered by the invention were so significant and the potential market which this technology made available was so great that the additional incentive of exclusive rights to the invention was not necessary to commercializing firms. In fact, granting of exclusive rights would have inhibited utilization.

CASE 16
LIQUID FERTILIZER PROCESSES

Background of the Invention

These TVA developments, involving improved processes for the manufacture of liquid fertilizer materials, greatly advanced technology for production of new types of fluid fertilizers.

The first invention, developed during the late 1950's, is a process for the manufacture of clear, high analysis liquid fertilizer from superphosphoric acid and ammonia. The process is simple and can be carried out in inexpensive equipment.

The second invention provides an improved process for the manufacture of stable liquid fertilizer from wet process phosphoric acid, superphosporic acid and ammonia.

Research into liquid fertilizers, on-going in the TVA, was spurred by a recognition that mixed liquid fertilizers have many advantages over mixed dry fertilizers: (i) the costs of drying and bagging are eliminated, (ii) plant nutrient can be applied to soil more simply, and (iii) the segregating and caking often encountered in dry fertilizers are eliminated.

Nonetheless, the liquid fertilizers previously produced were not without outstanding disadvantages, that often outweighed the advantages. Raw material costs proved to be relatively high; some of the solutions produced were corrosive, which resulted in high maintenance and storage costs, and were limited to a maximum content of plant-food units of about 33 weight percent because concentrations in excess of this amount crystallized and precipitated salts out of solution.

After the research and pilot plant development for the first invention had been completed, a small plant unit was set up by TVA, and the process was tested on a semi-works scale (3 tons/hour of product). TVA's policy is to actively promote inventions, and the industry was invited to see the unit in operations and to examine the procedures involved. Licenses were offered to fertilizer producers under the usual nonexclusive, royalty-free arrangement.

The TVA has continued to develop liquid fertilizers, primarily to apply new processes to various new materials in an effort to produce new, higher analysis products.

Private Development and Commercial Utilization

The TVA inventions contributed significantly to advanced liquid fertilizer technology. Before the TVA processes were used, liquid mixed fertilizer consumption was extremely low. Since then, consumption of liquid fertilizers has increased as compared to all types, while liquid mixed fertilizers continue to represent about 20 percent of the total liquid fertilizer consumer. (Refer to the table below). Nonexclusive licenses for the first process have been issued to 103 fertilizer manufacturers of which 30 have installed production facilities. One fertilizer manufacturer has a nonexclusive license for the second process and reports a production installation. Industry sources vary widely in their estimation of the future demand for liquid mixed fertilizer. Of these firms, 15 look for increased consumption while 15 forecast that consumption will remain stable or decrease.

The following table shows the growth pattern of liquid mixed fertilizer for selected years beginning in 1964. In 1954, before TVA processes were used, liquid mixed fertilizer consumption was extremely low. Since then, consumption of liquid fertilizers has increased as compared to all types, while liquid mixed fertilizers continue to represent about 20 percent of the total liquid fertilizer consumed.

The introduction of the TVA processes in the industry during this period definitely accounts for the increase in consumption of liquid mixed fertilizer. Virtually all of the companies in this field seem to consider TVA as their research arm, and they frequently visit the TVA labs to seek new ideas and encourage various aspects of the research being conducted there.

The ZBQ Company

The ZBQ Company operates 13 manufacturing process plants, producing a variety of liquid and dry prompted the R Association to conclude that it was more economical to buy the fertilizer material than to produce it.

This license is one of the only two that this firm holds and both are TVA fertilizer processes. The R Association has a close working relationship with TVA, meeting at least six times a year with TVA representatives to discuss its products. Although the R Association spends funds on research and development work, it looks to TVA for new product and process development in fertilizers.

Comment

This case is another instance of a government agency actively promoting utilization of an invention. The agency's charter and objectives not only support technical research and development in fertilizer technology, but also promote its use and improved agricultural techniques among farmers; the agency's staff is experienced in new product promotion.

The case also demonstrates the divergent approaches taken to commercial utilization by fertilizer manufacturers. On the one hand, a large manufacturer took the process as defined in the invention, manufactured and marketed a product only to find that it had a number of disadvantages. Since the company had parallel products which overcame a number of these disadvantages, it promoted them and allowed sales of this product to diminish.

On the other hand, a very small firm began by recognizing what the needs of the market were and then used the invention as a catalyst to spur ingenuity to further develop the process to improve market acceptance.

In the first invention, TVA's research provided a process which could be commercially exploited relatively easily, with the result that it had many licensees. In the second case, TVA research triggered further research and development by revealing the technical possibilities available to further increase performance capability of the new product.

CASE 17
SUPERPHOSPHORIC ACID

Background of the Invention

The invention is a process for the manufacture of superphosphoric acid containing high proportions of polyphosphate species with unique properties particularly suited to the production of superior liquid and solid fertilizers. The invention is covered by a patent applied for in 1956 and issued in 1961. A second patent covering a process improvement was granted in 1962. Four commercial firms have been licensed to use the development. TVA development of the process has gone as far as designing commercially useful hardware, demonstrating the feasibility of commercial-scale operations, and producing the commodity for market, on a limited basis.

Private Development and Commercial Utilization

To demonstrate the production of superphosphoric acid, TVA built a plant costing about $1 million. In the opinion of a consulting engineering firm, had TVA not built the plant the invention would not have been developed by private industry. By building a functioning plant at Wilson Dam, in Alabama, TVA inspired confidence in the process and its market potential on the part of private industry.

Commercial utilization of this process has come about as a result of TVA's producing and selling several thousand tons of the acid to demonstrate the product's economic feasibility. TVA has continued production, but has kept a ceiling on production volume in order to stimulate private industry to take on more of the greatly expanding market. In 1965, TVA estimated electric furnace-process production of superphosphoric acid to be 200,000 tons.

Comment

TVA typically demonstrated the technical and economic feasibility of the process by engaging in market production limited enough not to intimidate private industry. Industry's role to date has been merely to visit TVA, copy the process, and set up for production for the initiated and expanding market. As its contribution to commercialization of this patent, TVA has limited its production in favor of industry satisfaction of market needs.

The invention is utilized in still another form: processing plant construction. Consulting Engineers, Inc., a small consulting engineering firm specialize in the design and construction of chemical and metallurgical process plants and equipment and is licensed to utilize the invention. Consulting Engineers, however, would not have invested the amount that TVA did to construct a demonstration plant using the patented process. Thus, the effort in commercialization, through design and construction of plants on contract, has depended entirely on cooperative development by TVA.

Mica constitutes 50 percent of the AA Corporation's products and 50 percent of this mica is now synthetic (300,000 to 400,000 pounds annually as compared to just 10,000 pounds in 1966). Profits from its mica operations come largely from fabricated products rather than from the mica itself, even though the company still sells some unfabricated natural and synthetic mica.

The BB Corporation

The BB Corporation, another licensee of the original Bureau of Mines patents covering the production of synthetic mica, first learned of the synthetic mica process from contacts at the Bureau and subsequently secured a license under the Bureau's patents, but did little to utilize the process. When the AA Corporation entered the glass-bonded mica field with a synthetic product, BB Corporation found that it had to follow suit to protect its market position. In the following four years, it invested significant funds in developing a production process. The company became involved in an infringement suit with a competitor and, after winning the case, began producing synthetic mica as a second source. The BB Corporation's sales of synthetic mica represent about 3 percent of the company's annual sales. It has begun to look for new uses for synthetic mica—particularly for the home consumer—but the high cost of the material discourages entry into new fields.

Comment

In this case the government, having a critical military need for a better material available on the domestic market, provided the initial stimulus for development. The government carried development of the invention close to commercial utilization through the Bureau of Mines cooperative agreement with the AA Corporation in 1953 and, since commercial needs for the product developed in the meantime, industry was prompted to carry development further. Industry found, however, that the government-developed and -licensed process was only a starting point and that further development was necessary both to improve the process and to establish proprietary positions in the market.

CASE 19
LOW-TEMPERATURE PHASE EQUILIBRIA CELL

Background of the Invention

This device will simulate certain actual helium plant conditions, preestablished, so that these conditions can be observed visually, an advantage not known heretofore in phase equilibria research. The invention consists of a cell with a pyrex window, a stirring rod, a temperature control mechanism, and a pressure regulator.

The invention was developed as a result of low-temperature phase equilibria studies of helium-bearing bases conducted by the Bureau of Mines Helium Research Center in Amarillo, Texas. The object of the studies was to improve the quality and increase the quantity of commercial helium.

The principal motive for filing for a patent for the sample invention was to accord professional recognition to the inventor, as the invention, at the time of filing, was considered a significant technological breakthrough. Continued research, based on this invention, has produced further breakthroughs, however, which provide a means of achieving lower temperatures and higher pressures in phase equilibria cells.

This invention was promoted actively in the Bureau of Mines investigation reports. A technical article in *Industrial and Chemical Engineering* magazine disclosed a design of the apparatus. The installation at Amarillo was opened for public inspection, and personnel from numerous firms in the natural gas industry, for which the invention is applicable, came to view it.

Private Development and Commercial Utilization

Although this phase equilibria cell invention was a significant breakthrough, it has little commercial potential, since its primary application is in helium R&D studies. A nonexclusive, royalty-free license has, however, been issued to one firm, which declined to be interviewed, stating only that the invention was used to arrive at data on behavior of gases at very low temperatures, to evaluate the possibility of constructing and operating a plant to extract helium from its natural gas holding. Many other natural gas firms in the industry may have designed similar equipment to use in their research without applying for a license.

Comment

Despite the promotion given it by the Bureau of Mines, this device did not achieve widespread commercial utilization because of its limited use in research apparatus. Even though a number of firms' representatives visited the Helium Research Center to investigate the invention and despite their avowed interest in building the equipment, none ever secured licenses. Nonetheless, the invention did stimulate further research by government scientists, by the sole licensee, and possibly by further nonlicensed industrial users. In fact, the possibility of nonlicensed industrial users points to the government's liberal effort to attract industry interest to government-sponsored R&D and lenient policing of licenses. Technology transfer may have been accomplished in this case, albeit not through the medium of patent or license therefrom.

which the Fish and Wildlife Service published these figures was $1 per hour. The average spread between costs and selling price then was estimated at 1 cent per pound. The minimum wage in 1967 was $1.25 per hour. The marginal producers are starting to drop out.

Aware of the lack of a commercializing industry for the automation of shellfish processing, the government has attempted to interest several machine tool companies in developing machinery. It has been unable to do so without promising substantial future government funding. The Fish and Wildlife Service has tried to promote private development by pointing out to industry that the manufacturer who developed the machinery could not only look forward to sale of machines to the blue crab industry, but would also gain access to the entire shellfish industry because of the widespread interest in the project. The only company sympathetic to that point of view is the CQ Company, which arrived at the same conclusion through its own market research, and is interested in developing a product line and providing automation equipment for the blue crab pickers in particular and the shellfish industry in general.

The speculation within the agency that an *exclusive license* to the government patents might have encouraged private investment in the inventions and a few machines might have been built and sold has not been confirmed by investigation. The CQ Company is critical of the BX Corporation inventions, and the other firms whom the agency thought might be attracted by an exclusive license are simply not interested in entering the field.

As matters stand, there appears to be little commercial potential in the invention at its current stage of development. Exclusivity in patent rights apparently will not promote utilization because industry does not consider the potential market large enough to justify the risk of development.

CASE 21
HYDRATE PROCESS FOR DESALINATION OF WATER

Background of the Invention

The invention involves five improvement patents for purifying seawater through the use of solid-hydrate-forming reactions. The hydrate process is one of several methods of desalinating water currently being investigated by the Department of the Interior and industry.

A number of processes can be used to derive fresh or potable water from salt water, including distillation, freezing, and hydrate-forming. Distillation is the oldest and most common system, but is hindered by scale-information and heavy fuel requirements. The hydrate-forming process has an advantage over both distillation and freezing in that its heat requirements are low. The major problem in water purification, however, has been to accomplish the separation on a large scale at a cost low enough to make the product a practical substitute for water from natural sources.

OP Company, a patent-conscious firm, saw great commercial potential in water purification and, in the late fifties, invested a substantial sum in research on the hydrate-forming process. The firm anticipated receiving production contracts, as well as royalties on process machinery. No market predictions were made, but company management was attracted to the industry.

Private Development and Commercial Utilization

Officials from the Office of Saline Water (OSW) expressed interest in OP Company's work on water purification, and a seven-month R&D contract for several thousand dollars between the OSW and OP was signed, stipulating that the firm and OSW would share equally the cost of the work. It was agreed that the first two inventions would be in OP's name, and the government would receive a non-exclusive, nontransferable, worldwide license. The government agreed to pay as royalty a percentage of the cost for all utilization facilities installed. All follow-on inventions were to be treated similarly, except they would be royalty free.

OP Company continued its work on a small experimental apparatus in its own plant and under cost-sharing OSW contracts. With sizable investment, three improvement inventions were developed and patented, to which the government received royalty-free licenses.

In 1963, an economic study by OP Company indicated that commercial utilization of the hydrate process would not generate adequate returns to reimburse the company for its investment before the end of its patent protection in 1976. This estimate was based in part on the fact that five distillation plants had been built, putting this separation process far ahead of the hydrate process in terms of commercial utilization.

At the same time, the Department of the Interior initiated negotiations with OP for a revised patent clause under its interpretation of The Saline Water Conversion Act, Public Law 87-295. Negotiations between OWS and OP Company resulted in an agreement whereby the government undertook full sponsorship of the research while OP Company continued the work without fee. In addition, concessions in the patent article granted by the company included a paid-up license as soon as the government's royalties (at half the rate of commercial

$87,000, from which additional inventions issued. Under these contracts, the government has title to any patents that have been or may be issued, as well as to any apparatus developed. In 1967, the OSW gave SR a one-year, $80,000 contract to develop a production prototype of the invention.

Subject to the results of the current contract, the SR Company will license the invention to companies interested in manufacturing desalination equipment. There is no search at present for a firm to license the invention because investment at this time would be highly speculative.

Private Development and Commercial Utilization

Before mid-1968, SR expects the invention to have been fully tested in all kinds of water, and its applicability to commercial utilization to be better known. The SR Company does not expect any profit because it will not commercialize the invention. As a nonprofit research concern, SR's interest is not in production, but in sponsorship of their research work in their field. Company executives indicated that OSW might award further contracts after mid-1968 to fund efforts toward commercialization of the process.

The invention is one of several dozen competing water desalination methods that share a market estimated by SR engineers at roughly $20 million. SR expects the total cost of company-financed efforts that will be required to commercialize the invention after completion of its current OSW contract to range from $100,000 to $900,000 (if a new plant is needed), half of which will be for production facilities and half for marketing and sales promotion. No detailed studies have been made to substantiate these estimates.

Comment

This case represents a government-financed effort to develop an invention for commercial use. The particular invention, however, is only part of one process that is competing with many other processes being developed by the same government agency for the same application. The government has license rights to the process and title rights to all the machinery patents developed under the contract, and OSW is continuing to sponsor development of the process. It is unlikely that all processes will find equally successful commercial acceptance.

Technically, this invention and its competitors are all feasible in pilot-scale applications; the risk lies in scaling up the process for commercial markets. The market risk for these desalination processes, taken as a group, is low because of predicted shortages of pure water in many parts of the world; however, the market risk for a private investor in any specific process is high because competing technical approaches are being developed through OSW.

CASE 23
CENTRIFUGAL COMPRESSION DISTILLATION

Background of the Invention

One of a number of distillation techniques known today for water desalinization, this invention improves recompression distillation of crude feed water and other liquids under partial vacuum. The major objective of the invention is to combine degassing and purging techniques to remove interfering gases from compression stills. The primary market anticipated for it is industrial and government users of distilled water.

The invention was developed under two Office of Saline Water (OSW) research contracts with AB Company. In 1953, the inventor approached the AB Company, a major manufacturer of stills, with ideas for improving his centrifugal-type compression still for commercial development. The inventor and the AB Company, in turn, approached OSW with their plans for commercial development of an improved still. In 1954, OSW awarded a cost reimbursement contract to the AB Company for developing a pilot plant. This contract was followed several years later by a second contract for the construction of a large-scale plant for OWS testing and evaluation. In this same year, the inventor applied for a patent on an invention arising out of the contracts, and under the patent policy prevailing at the Department of the Interior at that time, the inventor received title to the patent with a license to the government.

Private Development and Commercial Utilization

Following development of the invention under the OSW contracts, Company AB attempted to commercialize the centrifugal-type compression still which, in effect, embodied the invention. The centrifugal distillation still, however, failed to penetrate the market because it was too large, had mechanical difficulties, was difficult to maintain and was not more efficient or economic than existing units.

In 1956, the ZZ Company, a major manufacturer of household appliances, secured from the AB Company an option to license the invention, but soon thereafter let the option expire because it discovered that it could not manufacture the unit at a low enough cost to make it the least investment and has the highest thermal efficiency.

The gas combustion process was developed by Bureau of Mines laboratories. The federal government began work on shale oil processing in 1948, when its Rifle, Colorado, plant was built. The plant was later shut down and put on a standby basis when the Congress refused to fund its continued operation.

Government research and development on shale oil processing was undertaken as a routine investigation by the Bureau into means of developing the government's vast oil shale holdings, and was carried to the point of a small pilot plant operation. However, the operation must be greatly scaled up in order to produce the oil economically enough for commercial utilization.

The sample patent is one of several government-owned patents relating to the gas combustion process. Consultants, Inc., a small firm which consults in several areas of mineral processing, is the sole licensee under the patent.

Private Development and Commercial Utilization

In 1964, approached by the Colorado School of Mines, the Bureau leased the Rifle facility to the school, which planned to contract with private industry for additional shale oil processing research. Since then, private industry has spent over $7 million on this program. Though the process has been somewhat improved, there have been no technical breakthroughs; the oil companies are using the Rifle plant largely as a training facility.

Arrangements have been negotiated whereby the companies still report all discoveries and inventions to the government, but the Department of the Interior has agreed to keep this information confidential for three years after disclosure. The companies may retain title to inventions derived in the course of this cooperative research, provided they issue nonexclusive licenses at a reasonable royalty to anyone desiring them. Since the oil companies had some background patents relating to the gas combustion process and a great deal of information on the process in their files, the Department of the Interior policy of taking title to all inventions and making them freely available was unacceptable to private enterprise.

In the course of research and consulting on shale oil, Consultants, Inc., and the oil companies with whom they contracted have invested several millions of dollars in development of equipment to be used in the commercial operation of the gas combustion process. Consultants, Inc., retained United States patent rights on its inventions, while foreign patent rights went to the foreign firm for which they were working. To support its equipment patents, the firm took out a license on the government process patent when it became available.

Although Consultants, Inc., currently has little design or construction business in shale oil processing, it is active in the field, reporting and consulting on shale oil problems. As yet its equipment patents have not been commercially utilized; the firm has not made promotional efforts because the oil companies, who would be using its equipment, are not risking the considerable investment necessary for a commercial-scale point.

Comment

Commercial shale oil processing plants are currently in operation in other countries, but no commercial processing has been done in the United States. In this case, government laboratories developed a potentially useful commercial process and demonstrated its technical feasibility. However, developing an economically feasible process will still be a costly undertaking.

Although no commercial shale oil industry exists in this country at present, the potential of such an industry seems great particularly in view of the development of a shale oil industry in this country and commercialization of the subject patent depend on land availability, oil import restrictions, and governmental policies. Federal policy is particularly relevant since approximately 60 percent of the oil-bearing shale lands in the country is owned by the government. The remaining 40 percent is owned mainly by oil companies.

The Department of the Interior is currently developing an oil shale lands policy, and has solicited private industry comments on a suggested government approach. The suggested policy would make government lands available, but with a provision for government retention of title to inventions stemming from joint government-industry efforts. Industry finds the provision unacceptable. Many individuals feel that shale oil development is so large and significant an undertaking that government-industry cooperation is necessary, but the proposed patent regulations are a major deterrent to industry commitment to the effort. The oil companies are doing their own research, but are unwilling to work with the government under policies which offer no protection to industry.

Consultants, Inc., expressed the opinion that the government has done its share by demonstrating the technical feasibility of the gas combustion process, leaving scale-up and equipment design to private enterprise. The firm feels that retention of title by the government, which will issue nonexclusive licenses, is a desirable approach because it will allow equal opportunity for participation by all firms; in any event, the importance of exclusive rights is diminished by the fact that those firms working on development of the process will have an opportunity to design, patent, and sell commercial processing equipment.

PART IV. Patent Utilization by Universities and Nonprofit Organizations

A. Background of the Task

Educational and nonprofit institutions have played a major role in government research and development programs since the end of World War II. They have been heavily involved in basic research and, to a lesser but still significant extent, the design and sometimes the development of prototype items. Their programs frequently lead to patentable discoveries and inventions which are subject to the same disclosure requirements as their counterparts in industry.

The Kennedy Memorandum does not include any specific policy guidelines concerning inventions of education and nonprofit institutions. Proponents of allowing institutions to acquire patent rights assert that the Kennedy Memorandum is broad enough to permit it. However, others claim that such institutions cannot satisfy the "established nongovernmental commercial position" criterion which makes it more difficult for such institutions to acquire rights under the policy.

The importance of the question became clear during research on the NIH medicinal chemistry programs (see Volume II, Parts II and III). Prior to 1962, institutions developed, under NIH grants, new compounds with potential medicinal value, which drug firms tested free of charge. In 1962, NIH began enforcing more strictly the requirement that testing firms sign patent agreements allowing the Surgeon General to determine all patent rights in the compounds. Because of this change, most drug firms curtailed testing NIH-sponsored compounds fearing that their proprietary R&D work might be endangered by the parallel research of NIH grantees. This drug industry withdrawal created a significant block in the transfer of new drug technology, which has not yet been removed.

The medicinal chemistry problem suggested that universities and nonprofit institutions, acting as buffers between government and industry, might play an important role in the transfer of new technology if permitted to acquire patents and promote their utilization. With this in mind, and recognizing educational and nonprofit institutions as a significant source of inventions, we studied 67 representative institutions–including 16 case studies–to determine their role in the utilization process. The results of our investigation are reported below.

B. The Study Task

Of the 3,689 patents in the total sample of inventions, 415 arose out of government-sponsored research at 67 universities and nonprofit organizations, with patents being issued to all but one of these institutions. Because educational and nonprofit institutions neither manufacture, use, nor sell products based on their inventions, their licensing policies and practices, rather than their direct use of sample inventions, were the focal point of this task.

Responding to the same utilization questionnaires that were sent to commercial firms, many universities did not answer questions framed more directly for industry, and, hence, only limited information could be derived from the statistical data. For example, a question using the word "sales" was more likely to be left blank than to be answered in terms of "cost."

The questionnaire data were supplemented, however, by detailed investigation into the patent management practices of 16 institutions, selected jointly by the Committee on Government Patent Policy and Harbridge House from the larger sample. These institutions were selected to cover the range of factors affecting utilization policies and practices in the institutional environment, including the public or private character of an institution, its technical or liberal arts orientation, its size, its geographic location, and whether or not it operated laboratories under contract for the government. Research was conducted to determine the effect of these and other factors on patent utilization programs, with particular attention given to the difference between the published programs and the actual practices of the institutions.[1] The incidence of invention utilization was found to be extremely low among the universities and so attention was given to all their inventions in the sample rather than to only the utilized inventions. Figure IV-1 below lists the institutions and licensing agencies investigated in this task, the number

[1] A comprehensive survey of the patent policies, practices, and procedures of universities, technological institutions, and nonprofit organizations was commissioned by the Patent Policy Survey of the National Research Council (National Academy of Sciences) in 1946. Dr. Archie M. Palmer published five monographs between 1952 and 1962 depicting the patent activities of 945 institutions, with a description of the situation at each of the 349 institutions which conduct scientific and technological research and have invention policies.

M.I.T.'s Lincoln Laboratory, the Jet Propulsion Laboratory of the California Institute of Technology, and the Los Alamos laboratories of the University of California, were either analyzed and reported as independent institutions or were excluded from consideration when researching their parent organizations.

The term "nonprofit organization" is used generically in the report to apply to both educational institutions and research corporations, and any such reference does not necessarily include both types of organization.

2. Research Approach

The Harbridge House research approach called for three major investigations: (i) library research on government contract practices and the patent policies of each of the institutions involved, (ii) a study of government agency regulations pertaining to inventions arising out of university-sponsored research, and (iii) personal interviews with the individual in charge of patent policy at the college, university, technical institute, or patent development firm under investigation, as well as supplementary interviews with government contract administrators, educational administrators, and inventors.

Whenever possible, our data on each of the organizations included:

- Transcripts of formal research and patent policies, or descriptions of generally accepted practices;
- Descriptions of practices followed in implementing formal policies;
- Identification of outside agencies retained to manage patent programs;
- Identification of the total patent portfolio, and the income derived from it;
- Total dollar amount of government-sponsored research, by federal agency;
- Attitudes concerning recognition of the equity of an inventor in his invention, and the extent to which an inventor shares in royalty income.

C. Analysis of Task Findings

1. Utilization of Inventions from the Institutional Environment

Private and public institutions of higher education, in need of funds as educational costs outrun traditional sources of revenue, are searching for income-producing activities, including commercialization of institutional research findings. Patent activity in nonprofit research corporations has also been increasing, as a means of financing independent research and development programs.

The rise of interest in patents among nonprofit institutions has been fanned by reports in the press and popular periodicals about the "gold mine" of patentable research findings. Scarcely a month goes by without a report or a feature article on a cigarette filter and Columbia University, ammoniated dentifrice at Indiana University, Wisconsin's vitamins, or a super-juice called "Gator Ade" at the University of Florida. These reports are invariably sprinkled with seven-digit royalty income figures–$14 million from Vitamin D at Wisconsin, $7 million from streptomycin at Rutgers, and so on. Finally, there are allusions to the profit potential in the ocean outside of the Scripps Institute of Oceanography, in the sky above the California Institute of Technology, and in the black boxes of M.I.T.

The facts, however, do not support the thesis that the average nonprofit research organization can expect to realize any substantial income from patent royalties. The liberal arts college in Case 10, below, which has enjoyed an unexpected and large return on a pre-World War II invention, acknowledges it as a windfall and de-emphasizes patents accordingly. The technical institution in Case 5, below, one of the five organizations interviewed that actually receive annual royalty incomes of six figures, still regards patent administration from a purely financial point of view as a marginal activity. The average net annual royalty income of the three institutions of higher learning with the most active programs in the study was $100,000. Several institutions were enjoying higher current incomes attributable to a single invention or the settlement of a lawsuit, but in no case did we find royalty income on an industrial scale.

As reported by *The Patent, Trademark and Copyright Journal,*[2] the average annual gain for each utilized patent held by corporations is about $70,000. This figure seems high to us, since our study revealed that firms frequently overstate the value of a patent by equating the invention with end-product sales. In addition, the figure of $70,000 does not resemble the return on inventions to nonprofit institutions.

Overall, only 10 percent of inventions from nonprofit institutions reach commercial utilization. One of the patent development firms interviewed in our study estimates that 10 to 15 percent of the disclosures it received result in patents three to four years after submission; twenty-five percent of these patents are eventually licensed, and three of these are profitable. In dollar terms, once every three years an invention at some university is likely to result in an annual royalty of $50,000 or more.

[2] "The Economic Impact of Patents," 2:340-362, 1958.

3. Characteristics of Inventions of Nonprofit Institutions

Inventions arising out of nonprofit research have a distinctly different character than the patentable ideas arising from R&D contracts with industry. In nonprofit research, the end product is normally "software"–scientific findings–and patentable ideas take the form of concepts rather than hardware. In industry R&D, on the other hand, the result is usually "hardware"–a product, process, or component–and a working model, at least, will have been developed.

The task of nonprofit organization is over and the contract has been fulfilled when the organization submits a research report. Funds are rarely available to reduce the discovery to any practical application, and interest and motivation to seek utilization are often also absent. The idea of following an invention through development and production to a marketable product is alien to the academic and nonprofit environment. For this reason, the patent licensing profession refers to academic invention as a "bare bones patent." Industry must take it from there.

In contrast, under comparable government research contracts, the industry contractor normally seeks to promote follow-on work that will further develop his findings–ultimately, into a product. Should contract research result in an invention with commercial possibilities, in-house funds may be assigned to develop and exploit it.

Nonprofit research inventions usually require a larger investment for commercialization than industry discoveries because nonprofit inventions are frequently at an earlier stage of development. In our investigation, the nonprofit institutions repeatedly emphasized the additional investment industry has made to develop products based on nonprofit discoveries. In Case 1, below, for example, the industrial licensee invested a quarter of a million dollars in the tomato harvester after eleven years of university research developed a patentable prototype. The patent development firm in Case 16, below, has already made a comparable investment in seeking applications of holography, and still the patented disclosures relate only to the mathematical theory of wavefront reconstruction, rather than to any marketable three-dimensional imaging device.

The institute in Case 3 has been extremely critical of development firms that license university patents to companies which are not prepared to invest the necessary development capital. In short, inventions from nonprofit concerns are grains of sand about which a pearl may be formed only if industrial development is undertaken.

Another characteristic of nonprofit inventions is that they stand alone. Their isolation is a major obstacle to utilization, since most inventions are not marketable products in themselves. (In only 55 contract inventions investigated by Harbridge House was the patented discovery regarded as critical to the commercially utilized product.) The industrial product is often protected by a cordon of patents, as illustrated by the list of patents on a packet of Polaroid film. A university inventions, on the other hand, is a one-shot patent. Even if the patent specification discloses an ingenious invention, the patent claims which define the scope of the monopoly are likely to be narrowly drawn. Whereas industry will add to its patent arsenal as a product is improved, a university patent, if it is to be licensed at all, must be licensed on the initial effort. Thus, the patent development firm in Case 16 did not begin to see a return on an invention which revolutionized an industry until the basic patent had run for thirteen years. By then, however, the industrial developer had patented a line of industrial improvements over the basic invention.

Industry can profitably keep an innovation "on the shelf" until the time is right to market it. Furthermore, cross-licensing agreements between firms extend the economic utility of the industrial patent. Nonprofit inventions, on the other hand, remote from the market to begin with, are perishable if unlicensed, since the nonprofit organizations do not have manufacturing operations. All the above characteristics of inventions developed by nonprofit institutions make them high-risk commercialization ventures.

4. Patenting Versus Publishing Research Results

Another major factor which affects invention utilization by academic institutions is the drive to publish research results. This drive produces a dilemma where utilization of inventions is concerned, since patents are the only protection for the inventions of nonprofit institutions. In the nonprofit environment, there is no economically useful equivalent of "proprietary data" or industrial trade secrets. While industry may benefit from these alternatives to patenting, the secrecy involved is counter to the tradition in university and nonprofit research.

This tradition reflects the relative values academic institutions place on publishing and patenting the results of their work. Publications are central to scholarly pursuit. Invariably, the results of research, except those limited by the terms of a grant or contract, are fully disclosed through articles in scientific and technical journals. Patents, on the other hand, have traditionally been regarded as irrelevant at best and, at worst, as an

Energy Commission and the Department of Health, Education, and Welfare. The sources of federal funds are given in Table 1, below, and the distribution of these funds to the various schools, colleges, or institutes of the university is indicated in Table 2, below.

In all instances, grant requests were initiated by the investigator himself. As the university is consciously and proudly oriented toward the acquisition of grant capital, writing proposals to the government is a highly developed art. Faculty members are often hired for the amount of research money they can bring to the university.

Inventions in the Sample

While the university had 53 inventions in the sample, the great majority of these arose out of research at special laboratories operated by the university for various government agencies, all of which normally take title to their inventions. In none of these cases, therefore, did the university make any effort to file patent applications on its own behalf or to seek out licensees.

TABLE 1
SOURCES OF FEDERAL FUNDS
(FY 1965)

Agency	($ in Millions)	Percent
Department of Health, Education, and Welfare	33.6[a]	43.2
National Science Foundation	12.4	15.9
Department of the Navy	9.5	12.2
National Aeronautics and Space Administration	7.7	9.9
Atomic Energy Commission	6.1[a]	7.8
Department of the Air Force	3.3	4.2
Department of the Army	1.8	2.3
Department of Agriculture	.68	.9
Vocational Rehabilitation Administration (HEW)	.4	.5
Agency for International Development	.04	.1
Others	2.3	3.0
TOTAL	77.82	100.0

[a] Excluding funds for laboratories operated wholly under government sponsorship.

TABLE 2
DISTRIBUTION OF FEDERAL FUNDS
1966

	Total Expenditures ($ in Millions)	Percent
School, College, or Institute		
Agriculture (includes Veterinary Medicine, Water Resources Center)	7.19	9.2
Business Administration (includes Institute of Business Research)	.46	0.6
Chemistry	1.05	1.3
Criminology	.23	0.3
Dentistry	.24	0.3
Education	.84	1.1
Engineering	4.77	6.1
Environmental Design	.15	0.2
Interdisciplinary College	3.84	4.9
Letters and Science	16.86	21.7
Medicine	15.28	19.6
Nursing	.17	0.2
Public Health	3.10	4.0
Pharmacy	.33	0.5
Oceanography (includes Marine Resources Institute, Marine Laboratory)	8.46	10.9
Graduate Division	3.82	4.9
Research Laboratories, Centers, Institutes, and so forth		
Radiation Physics	.66	0.9
Brain Research	2.18	2.8
Geophysics	2.36	3.0
Space Science	1.04	1.3
Computer Centers	.99	1.3
Air Pollution	.36	0.5
Nuclear Laboratory	.96	1.2
Primate Center	1.48	1.9
Toxicology Center	.28	0.4
All Other	.72	0.9
TOTAL	77.82	100.0

investment without some pledge of exclusivity. The university itself has sporadically attempted to improve the prototype to being it closer to the marketable product, but as long as the basic invention is in the public domain, they do not expect to be able to attract private capital.

The university urges the adoption of a uniform government patent policy for all agencies. It regards the Kennedy Memorandum as merely an effort to rationalize inconsistencies and argues (as do all of the institutions in our study) that any invention requiring private investment of capital for commercial development is not likely to find its way into the marketplace unless the licensor can offer the developer a limited period of exclusivity within which development costs can be recovered.

Management of Patents Within the Institution

Patent administration has been vested by the governing body in a board of patents having 11 members selected from among the faculties and administration of the university. Each member serves for a three-year term. The duties of members of the board as set forth in university regulations include:

1. Appointment of a committee of experts to examine the merits of each potentially patentable invention;
2. Determination of the relative equities or rights held by the inventor, the regents, or a cooperating agency and recommendation of an agreement among all parties with respect to their individual interests;
3. Filing of patent applications, retaining patent counsel, and conducting litigation that may arise therefrom;
4. Release of patent rights to the inventor under certain circumstances;
5. Negotiation of licenses and agreements;
6. Arranging for and directing the collection of royalties;
7. Assisting in negotiating patent rights in university grants and contracts.

The extent to which disclosure and invention are encouraged is suggested by the fact that an inventor will occasionally be requested to hold up publication of his findings until a patent application has been filed. We found this request for delay to be unique among the academic institutions. This internal policy may occasionally create a problem since, although many department chairmen encourage patent prosecution, none affords a patent the same weight as a publication in evaluating academic competence.

Faculty members are encouraged to consult with industry, and the principal means of encouragement is to make time available for consulting. Inventions that are conceived or reduced to practice during consultations and are unrelated to any investment in time, money, or facilities by the university belong either to the inventor or to the consulting firm. Conflicting claims arise from time to time, and these are resolved by the board of patents.

CASE 2
A SMALLER WESTERN STATE UNIVERSITY

The Institution

This western state university has about 23,000 students and a faculty of 1,800. In addition to its principal campus, the university maintains an agricultural school, a school of veterinary medicine, and other installations throughout the state. The reputation of the school attracts students nationwide. The university does not favor any particular department or academic discipline, and the level of competence is fairly uniform among its schools.

Government-Sponsored Research

Federal grants in significant volume have come to the university only in this decade. Since the early sixties, however, government-sponsored research has been growing rapidly. Excluding grants to the school of medicine, federal research and development funds in the university for the fiscal year 1964-1965 were $3.9 million. In the 1965-1966 fiscal year, the amount increased to $4.2 million. These figures include both research and "sponsored instruction," that is, experimentation with teaching techniques and associated behavioral sciences, under National Science Foundation grants.

The federal agencies providing major grants to the university are the National Science Foundation, the Office of Education, the National Institutes of Health, the National Aeronautics and Space Administration, and the Air Force. The National Science Foundation accounts for approximately 50 percent of the total grant funds. The major share of grant funds go to the physics department, although the college of engineering, the chemistry and biology departments, and the behavioral science center also receive federal money.

Inventions in the Sample

The university owned one invention in the study sample—a microfilm electric heater. It has not been used

TABLE 1
GOVERNMENT - SPONSORED RESEARCH - ON CAMPUS
(FY 1967)
($ in thousands)

Agency	Schools and Special Laboratories				Other Labs.	Totals
	Engineering	Humanities	Management	Science		
Department of Defense	5,107	388	38	2,493	9,450	17,476
Atomic Energy Commission	977	62	–	713	6,337	8,089
Public Health Service	266	577	–	4,640	690	6,173
National Aeronautics and Space Administration	1,481	166	165	1,106	3,349	6,267
National Science Foundation	982	166	63	2,681	1,617	5,509
Other	1,217	212	3	204	150	1,786
TOTALS	10,030	1,571	269	11,837	21,593	45,300

search is under way to anticipate systems to justify use of the apparatus. In the case of several inventions in the computer field, licensing efforts consist of trying to convince manufacturers to utilize the inventions in products they are currently marketing. However, the lag between current industrial technology and the advanced university inventions suggests that some patents will lapse before industry feels any pressure to market the inventions.

Patent Policy and Utilization Philosophy

A formal research and patent policy was adopted by the institute in 1932. The policy provides that the institute shall have the sole right to determine the disposition of inventions and other developments resulting from research supported wholly or in part by institute funds, space, or facilities. (In the instance of an invention being licensed, the inventor receives 12 percent of gross royalties.) Although inventors are not entitled to acquire personal ownership of inventions developed on government-sponsored projects, all other inventions produced by staff or students along lines not related to institute programs are reserved to the inventor. As a matter of policy, when the institute has the option of acquiring patent rights under government-sponsored research, the option is exercised only when "it appears that (the university's) basic aims would be furthered by such action."

The institute's patent policy is administered by two full-time employees, under the guidance of a local law firm. The institute is the only nonprofit organization in the study employing patent attorneys on its staff to manage its program.

The institute's patent portfolio currently includes about 200 patents, 30 of which are actively licensed. With the exception of royalties from one major invention, net royalty income to the institute averages around $100,000 a year. The single high-income patent—which is not in the study sample—covers a high-speed random access memory for digital computers, from which the institute has realized over $15 million to date through royalties, infringement actions, and an interference settlement.

The marketing approach of the institute, like that of the university discussed in Case 1, is largely personal. The patent staff maintains close contacts with commercial concerns in fields of technology related to institute research. The staff may grant nonexclusive or exclusive licenses, depending upon the market. Since institute inventions are rarely marketable without additional development, however, an exclusive license is normally granted.

The institute shares the predominant academic view that acquisition of patent title by the government discourages utilization. It points out that title acquisition also may be costly to the government. The government, though its royalty-free license, benefited from the institute's success in the computer memory patent litigation. If the institute had not pressed the suit and won, the government, like all other licensees, would have had to pay royalties. While it is true that the relation between the subsidiary and its academic parent.

Management of Patents Within the Institution

In theory, a standing committee on patents has the primary responsibility of determining whether an invention should be patented, whether the invention should be submitted to an outside organization for prosecution and exploitation, or if some other arrangement should be made. In practice a department head receiving a disclosure will normally send it directly to the sponsor; if there is no sponsor, the disclosure is returned to the inventor.

Since the institute staff are oriented toward applied technology, the official lack of interest in patents is by no means universally shared by the faculty. Some faculty members would like to see the patent program stepped up, if only to provide more professional recognition. Other faculty members have, in fact, exercised their options to take title to inventions arising out of their nonsponsored research.

CASE 5
A MIDWESTERN TECHNICAL INSTITUTE

The Institution

This midwestern technical institute organized in 1940 through the merger of two small urban institutions, has a student body of 7,500 and a faculty of 600 and offers a B.S. degree in various disciplines of the sciences and humanities and graduate degrees in most technical disciplines. It is a technologically oriented educational and research center. Its major school is the college of engineering and physical sciences.

Government-Sponsored Research

Essentially all of the departments of the institute are involved in some government-sponsored research, primarily with the National Science Foundation and the National Institutes of Health. Government-sponsored research, which 10 years ago was 15 times larger than nongovernment-sponsored research, has expanded by a factor of 17, whereas nongovernment R&D has increased by only a factor of 10. The following table shows this increase by year and dollar amount.

SPONSORED RESEARCH

Year	Government R&D ($ in thousands)	Nongovernment R&D ($ in thousands)
1954	150	10
1958	250	20
1963	1,172	40
1964	1,793	50
1965	2,385	75
1966	2,720	100

Inventions in the Sample

The institute had only one patent in the sample, a method for producing easily oxidized, high melting point metals and their alloys. The invention was developed under a Navy contract and the institute owns the patent. The invention has not been commercially utilized. There have been no inquiries concerning licensing and, although the institute would welcome such inquiries, it has not actively solicited them.

Patent Policy and Utilization Philosophy

As a general rule the institute retains neither title nor license to any invention arising out of research, feeling, as do several other institutions in the sample, that a preoccupation with patents is not compatible with performance of research in an academic environment. The staff is not required to sign a patent waiver except as required by specific government regulations, and if, as has happened a few times, an inventor wishes to file a patent on a particular invention arising out of government-sponsored research, arrangements are made directly between the faculty member and the sponsoring government agency without the institute's becoming involved.

The institute has no patent management agency other than its own board of trustees. It feels that patents are not worth the effort to administer since the probability of a commercially successful invention arising out of the small amount of nongovernment-sponsored basic research is negligible, and the chances of one's arising from government-sponsored research are even less. Sponsored research of an applied nature is generally referred to a nearby independent research laboratory which is governed by the same board of trustees as the institute, a relationship, which more than any other fact or attitude, colors the institute's patent practices.

Patent Philosophy

Although privately owned, the institute feels that it—like the state universities—is obligated to the public and the learned professions to maximize the commercial utilization of inventions arising out of scholarly pursuits. It views with concern the failure of the government to make provisions in its patent policy for patents developed within the academic community and, in fact, views the government's policy of compelling universities to sign over its patent rights as self-defeating. If a fundamental purpose of government grants and contracts with the academic community is to make the fruits of research available to all, the institute argues, then patent policy should incorporate into its patent policy provisions for maximizing utilization.

In asserting its position, the institute does not distinguish between inventions in the area of public health and welfare and those in other areas, but it points to its refusal to issue exclusive licenses to several pharmaceutical firms as evidence of its ability to act in the public interest in public health and welfare matters.

Management of Patents Within the Institution

Postwar growth of government grants and contracts has necessitated the institute's expanding its patent staff from a part-time business manager to a full-time and experienced patent attorney (patent administrator) and secretary. This staff administrates patents from an on-campus foundation established in 1940 to handle the institute's patents and inventions. The foundation, whose activities are integrated into the overall institute administration, bears the costs of patent exploitation.

The reputation of the institute draws a certain amount of inquiries regarding patents and a number of licenses are issued purely through this process. In addition, the patent administrator actively promotes utilization of the institute's inventions—which are often theoretical—primarily through personal contacts in industry. He has found that utilization of its patents, which often involve sophisticated new technology and sizable investments to develop, is effected most successfully by small companies or corporations which have an autonomous new product staff where decisions can be made quickly by a few people. These firms, unlike some larger companies who involve many personnel in extended evaluation of inventions, are able to make rapid decisions concerning the institute's theoretical inventions.

CASE 7
A BIG-CITY UNIVERSITY

The Institution

In the past decade this large, private, big-city university has significantly increased its scientific and technical graduate study and research programs and, concomitantly, has received increasing amounts of federal funds for research. Since the sale of its major independent laboratory to private industry several years ago, all university laboratories are affiliated with teaching departments or the university-affiliated medical school which has had years of experience in clinical research. Fifty percent of the beds in the city hospital are under the auspices of the university, and associated research at clinical, physiology, and chemistry laboratories servicing the hospital are administered by the university.

Government-Sponsored Research

With its increased commitment over the past decade to graduate study and research programs in the fields of science and technology, the university has simultaneously experienced a proportionate rise in government-sponsored research. In 1966 the university received approximately $12.5 million in grant and contract funds from the National Institutes of Health (HEW), the Office of Education (HEW), the National Science Foundation and the Department of Defense. Seventy percent of the funds came from the Department of Health, Education, and Welfare—primarily for medical and related research; 20 percent from the Army, the Navy, and the Air Force; and the balance from the National Science Foundation.

Inventions in the Sample

The university's only invention in the sample, a phosphate fractional carrier for medicinal use, was developed under a Public Health Service grant. The government owns the invention and the university has no plans for utilizing it.

Patent Policy and Utilization Philosophy

In the past, the university has not had much interest in promoting patents, but recently its patent activity has increased to the point where it now processes about six disclosures annually. In the hope that patents will prove a valuable source of funds for its hard-pressed research budgets, the university has established a formal activity for processing disclosures and has contracted with a engineering and applied physics, who by common consent is in charge of patents, indicated that no inventions had been reported during the six years in which he has held his present position. Notwithstanding its lack of sample patents, the school was included in the study to illustrate one common academic attitude toward patents and utilization.

Patent Policy and Utilization Philosophy

The university has a strict policy against involvement in patent matters—and thus has, except in the areas of therapeutics and public health, no formalized patent policy. In line with its policy of noninvolvement in the generation of nonacademic income, the university does not promote invention utilization. This policy is so much a part of the operating philosophy of the institution that it has, in the past, declined to accept patents as gifts because it did not wish to become involved in policing them.

Only in the fields of therapeutics and public health does the university have an explicit policy—which requires the dedication of all inventions to the public—either by publication or by providing assistance to the sponsoring government agency to prosecute its own patents. The university not only refrains from filing patent applications itself, but also provides legal advice to any faculty or staff member who wishes to prevent the patenting of such discoveries or inventions by others. This policy is a matter of public record with the National Institutes of Health (NIH) and an informal agreement (through an exchange of letters) with the Secretary of Commerce.

Management of Patents Within the Institution

Because of its policy of noninvolvement with patent matters, the university has no formal mechanism for their management. Outside the area of public health, where inventions are dedicated to the public, the usual procedure is for the principal investigator to sign such patent agreements as the sponsoring government agency may require after the grant is negotiated. Thereafter, relations concerning inventions conceived under the contract or grant are strictly between the principal investigator and the agency involved; the university has absolutely no interest in the financial or legal details of any such agreements. The inventor can request and secure title, he can prosecute patents at his own expense and keep all the royalties,or he can negotiate with industry if he so desires. Actually, the university expects an inventor to make a private arrangement with industry on a promising invention and assumes that any such arrangement will promote utilization. In the absence of invention records, however, there is no evidence that any inventor has ever availed himself of this opportunity.

Individual arrangements between inventors and government agencies are subject to a master agreement between the institution and the Department of Defense which acts as audit agency for all government contracts. This agreement specifically sets forth "march-in-rights" for the government which provide for title reverting to the government if a principal investigator owns a patent and has not taken steps to utilize the invention within three years. Except for the formal rules of contract compliance required by sponsoring government agencies, there is no difference between the handling of government-sponsored and other research.

CASE 9
A SMALLER EASTERN LIBERAL ARTS COLLEGE

The Institution

This college was founded in the 19th century through a private endowment from a local religious group to serve as an institution of higher education for the rapidly developing area of the state in which it is located. Initially, it consisted of faculties of arts and science, music, and medicine. After Worls War II, it expanded into engineering, education, and business administration. It is particularly noted in the fields of music, medicine, optics, and psychology. Approximately half of its 8,000-student enrollment come from the geographical area in which the school is located. The balance of students are selected from applicants around the world.

Government-Sponsored Research

It is the established policy of the college that the faculty will spend only one-half its time teaching and devote the remainder to research or other scholarly activities. As a result, active research programs are under way in all departments. Research funds have grown significantly since the late 1940's with the expansion of the faculty and the increased availability of government sponsorship from such agencies as the National Science Foundation and the National Institutes of Health. From a relatively stable level of $1.5 to $2.0 million per annum in the decade preceding 1953, research capital at the college expanded to $3.5 million in 1955, $7.5 million in 1960, $14.5 million in 1965, and $18.5 million in 1966. The government financed $13.7 million of the 1966 research expenditures. A breakdown of patent applications by the faculty because the paper work involved in disclosures, reports, clearances, applications, and licenses. However, the college does not feel that patents conflict with the publication of scientific findings or are otherwise inconsistent with academic values. In negotiating government contracts, it secures the most favorable rights for the inventor consistent with the policy of the agency involved.

CASE 10
A LARGE WESTERN PRIVATE UNIVERSITY

The Institution

This large western private university is a leading academic institution in the U.S. today. Its faculty of 1,100 instructs a student body of over 10,000 in virtually every discipline of the arts, sciences, and humanities. Research-based industries have been encouraged to build facilities on real estate owned by the university adjacent to its campus, and, like the institution discussed in Case 5, it is physically adjacent to a large nonprofit research institution.

Government-Sponsored Research

Research at the university is performed within academic departments and in special laboratories which are affiliated with the departments. These departments and laboratories have a high degree of autonomy within the institution. Thus, for example, the directors of the high energy physics, microwave, and biophysics laboratories are responsible jointly to the dean of research and a dean of humanities and science. The directors of a food research institute and a nuclear facility, operated under an AEC contract, report directly to the president. An electronics laboratory is administered independently of related academic departments, even though the laboratory personnel consists of faculty members, professional staff, and students from the school of engineering. Excluding the nuclear laboratory, government-sponsored research over the 1956 to 1966 period has grown more than sixfold as Table 1, below, indicates.

TABLE 1
GROWTH OF FEDERAL R&D FUNDS, 1956-1966
($ in millions)

Year	Amount
1956	$ 5.3
1958	8.1
1960	12.7
1962	18.5
1964	25.9
1966	33.0

Operating expenditures for the nuclear facility, which is located on campus, have increased at a comparable rate since 1961, and by 1966 totaled $14.7 million per year. Thus, the operating budget of the nuclear facility is a substantial portion of the total amount of government-sponsored research carried on under grants and contracts by the university.

Inventions in the Sample

The university has 10 inventions in the sample arising out of research in electronics and physics. The inventors hold title to six of the inventions and have nonexclusive licenses in four others, titles to which are held by the government. The technology described by the patents ranges from such theoretical inventions as space harmonic amplifiers to a practical method of making insulated terminals. No records were available to determine the extent and nature of utilization, however.

Patent Policy and Utilization Philosophy

Originally the policy of the university required that title to all inventions be assigned to the institution but no written agreements to that effect were required of the faculty. The board of trustees later changed the policy to reflect the operating practices of the university. All faculty members and staff employees are now required to execute a patent agreement with the university. However, the agreement, in the case of faculty members, provides that the inventor retain all proprietary rights in inventions except as otherwise required by research contracts or grants. Nonfaculty staff members must assign all such invention rights to the university. The university, however, may waive its rights to a particular invention if the contractual rights of the sponsor demand. In practice, the university has invariably done so for personnel at the level of research associate and above, putting them on an equal footing with the faculty.

In general, the university feels that concern over patents tends to encourage faculty members to become more secretive about their work and restricts academic communications. Moreover, most of the administrators feel that patents arising out of university research are not too profitable and that the myths of large successes are based upon a few notable exceptions rather than the average invention. At least one university school, which has close ties with industry, believes that retention of title by the university would improperly place it in competition with industry.

For these reasons, the university leaves promotion of inventions to the inventor. It may be involved in patent four-year history. The bulk of the Atomic Energy Commission expenditures support a Plasma Physics Laboratory.

Inventions in the Sample

The college developed two inventions in the sample which arose out of Air Force research contracts. Both were in the field of chemical engineering, and neither was utilized.

Patent Policy and Utilization Philosophy

Published by the board of trustees in 1961, the college's patent policy recites the contractual arrangements with a patent development firm (although there are actually contracts with two firms), and sets forth a basis for dividing royalties from inventions between the sponsor, the college, and the inventor. If a disclosure becomes the subject of a patent,the inventor is paid 15 percent of the gross income from royalties, and the college and the patent development firm divide the balance. If the invention is not developed in the course of sponsored research or through the use of the college's facilities, the inventor has an option to have this invention processed by the college, in which event he will receive 47.5 percent of net royalties.

The college does not have an internal utilization program because it lacks the requisite commercial expertise and has no desire to acquire it. Moreover, it accepts the traditional view that a patent is an invitation to a law suit, and it does not wish to become involved in litigation. Its total royalty income from patents in the past quarter century has been $100,000. Last year it did not earn anything from this source. Were it not for the presence of a skilled staff which administers sponsored research, the patent program would most likely be nominal, as in Cases 2 or 4. The administrators feel that their research program is large enough to sustain the hope of a valuable commercial invention, but no candidate seems to be at hand.

Management of Patents Within the Institution

The office of research administration, established in 1946, employs a staff of 14, including two attorneys, and administers all elements of research, grants, applied engineering, and the industrial program. In the matter of inventions, the office is under the jurisdiction of a special faculty committee on inventions comprised of six faculty members, a dean, the director of the office of research administration, a university vice president for finance, and the treasurer. The committee evaluates disclosures in accordance with the university's patent policy.

CASE 12
AN EASTERN RESEARCH INSTITUTE

The Institution

Prior to World War II, the institute was a part-time graduate laboratory used principally by university scientists for seasonal research in oceanography. During the war, however, the institution became involved, full time, in defense work related to oceanography. After the war, there was speculation as to whether the laboratory should remain a full-time facility or whether it should be returned to its part-time status. At the Navy's request, the laboratory was maintained as a major center of post-doctoral scientific research, devoted to entirely nonprofit research.

Government-Sponsored Research

Table 1 shows the magnitude of sponsored research at the institute. Unlike all the institutions previously discussed, sponsored research is the institute's total source of income. The small amount of nongovernment-sponsored research comes primarily from the academic community, since the institute avoids applied research as much as possible.

TABLE 1
SPONSORED RESEARCH
($ in millions)

Year	Government R&D	Nongovernment R&D
1954	1.76	.079
1958	2.88	.137
1963	7.39	.153
1964	8.49	.165
1965	8.53	.152
1966	8.44	.171

TABLE 2
PERCENTAGE DISTRIBUTION OF GOVERNMENT-SPONSORED R&D, BY AGENCY

Year	ONR	NSF	AEC	NIH	Other
1954	95	1	–	–	4
1958	83	9	3	–	5
1963	56	29	8	–	7
1964	57	30	7	1	5
1965	58	31	5	1	5
1966	56	31	7	1	5

firm because there is much less to share after the development firm has charged its 50 percent fee.

There are also noncommercial reasons for filing patent applications at the institute. Even if the patent committee believes that the invention will never be commercially utilized, it will apply for a patent on a technically important disclosure to recognize the inventor. In addition, if the inventor believes that his invention has merit, it is very difficult for the committee, comprised of fellow scientists, to rule to the contrary. In some instances the institute has waived its patent rights, subject to contractual constraints, to the inventor when neither it nor the patent development firm was willing to invest the cost of patent prosecution.

CASE 13
A MIDWESTERN RESEARCH INSTITUTE

The Institution

This independent nonprofit research institute has a common board of trustees with the educational institution discussed in Case 5 above. Except for the common board, and a geographical proximity, the two institutions operate independently, with basic research being predominant at the educational institution. The institute is a research organization, not a teaching organization, and only two members of the institute's technical staff numbering 1,200, have faculty appointments elsewhere. The two organizations operate under separate funds, and in the instances when the same president serves both institutions, he acts independently of his association with the other. The institute presently conducts research in nearly 1,000 projects in virtually every physical and biological science and related technology.

Government-Sponsored Research

Approximately 5 percent of a total research budget of $27 million is devoted to independent R&D, in order to open new fields of technology or to develop an idea to the point of soliciting further funds from a government or industrial sponsor. During the fiscal year ended August 31, 1966, the Department of Defense sponsored 70 percent of the government research, NASA 14 percent, and all other agencies 16 percent. The growth of its sponsored research program is shown in Table 1 below.

TABLE 1
SPONSORED RESEARCH
($ in millions)

Year	Government R&D	Nongovernment R&D
1954	7.48	3.29
1958	10.16	3.76
1963	18.52	5.48
1964	18.84	5.08
1965	20.65	4.35
1966	21.47	5.37

Ordinarily, the institute's industrial contracts provide for patent rights to pass to the sponsor. Hence, all institute-owned patents arise out of internal or government-sponsored research and development.

Inventions in the Sample

The institute owns eight of its 19 sample inventions and has a license for the remaining 11. The scope of technology involved is suggested by the range of inventions–two are in the electronics field, two electrical, five chemical, eight mechanical, and three combine several fields of technology. All the inventions arose out of research sponsored by the Department of Defense; only one has been used commercially.

The single utilized invention is an electromagnetic transducer head for use with magnetic tape recorders, one of a series of approximately 200 inventions in magnetic recording, developed since 1942, patented by the institute, and licensed as a group. Licenses are outstanding with some 100 firms in the recording business. Because of the number of patents involved, it is rather difficult to define the degree of utilization of any particular invention or the royalties accruing. Because of the predominant position it holds in magnetic recording, the institute has some specific provisions relating to contract research in the areas which are discussed below.

Patent Policy and Utilization Philosophy

In the past, the institute's patent committee often elected to prosecute a patent despite its lack of commercial promise. Though gratifying to the inventor, this practice was inconsistent with the institute's management objectives and at least one patent committee was reconstituted to avoid this practice.

Management of Patents Within the Institution

The institute's patent program is administered by a patent attorney who examines all reports and laboratory notebooks for patentable ideas. Staff members, by written agreement, assign all inventions arising from their work to the institute. Where the option to file is left with the institute, a committee decides whether it will seek a patent or whether title should be assigned to the government. If the committee sees commercial potential in an invention, it refers the invention to patent counsel, and his staff conducts a study of its commercial possibilities. The committee reviews the study, and, if it concurs, it will commission a more detailed market analysis. Concurrent with the market analysis, interested industrial firms are contacted to commence licensing negotiations. Institute licenses normally include a clause requiring licensees to conduct further development of the invention. As noted above, the institute negotiates *nonexclusive* licenses whenever possible, the case of fiber metallurgy being a notable exception.

CASE 14
A WESTERN RESEARCH INSTITUTE

The Institution

Like the institute discussed in Case 13, this organization is an affiliate of a large university. The trustees of the university elect the board of directors of the institute. The two organizations operate independently of each other. A number of the institute's 3,100 staff hold positions on the university faculty, however.

Government-Sponsored Research

As shown in Table 1, government-sponsored research at the institute grew to $44.2 million in 1966, an increase of some 50 percent since 1963. Government work accounts for about 75 percent of the sponsored research, and Department of Defense projects account for one-half to two-thirds of this percentage. However, the majority of patents owned by the institute—about 60 percent—arise out of its own research programs. The institute has no endowment and is sustained completely by income from sponsored research.

Inventions in the Sample

The institute has one invention in the sample—a rotary target projector developed under a Navy contract, with title assigned to the government. The institute knows of no commercial use for the device. The two commercially utilized inventions noted below did not fall within the sample years of this study.

TABLE 1
SPONSORED RESEARCH
($ in millions)

Year	Total R&D	Government R&D
1963	36.8	29.2
1964	42.6	34.2
1965	51.9	42.6
1966	56.7	44.2

Patent Policy and Utilization Philosophy

The institute did not publish a formal patent policy until 1965, until which time the sole patent policy had been to accommodate research sponsors. Since the institute's objective is performing sponsored research, the board of directors felt that patenting inventions arising out of sponsored research would only lead to a conflict of interest and be disadvantageous. Its industrial contracts usually stated that the sponsor retained all rights to inventions arising out of its research. Inventions arising out of government-sponsored research were only used to attract new research contracts, without any effort being made to exploit them commercially.

Until 1966, the institute had neither an inventory of disclosures nor an active licensing program. Over the past few years, however, there has been a growing desire to finance research projects internally, for which industrial and/or government sponsorship could not be found. The institute's new interest in patents is based upon need for income rather than desire to promote utilization of inventions. If the institute had a substantial endowment, official interest in patents would be negligible. However, its emerging concern for royalty income causes it to look to its government-sponsored research for inventions with commercial potential. It is too soon to tell whether the institute will be successful in acquiring and promoting commercially useful inventions from its government-sponsored work.

Management of Patents Within the Institution

In 1963, the institute retained a part-time patent counsel rather than reestablish relations with a law firm every time an intermittent disclosure was to be prosecuted. In early 1967, an existing but inactive patent review committee was reorganized to include the patent attorney, the institute counsel, and representatives of does not believe that a uniform government patent policy is necessary or even desirable in light of the wide differences in agency missions. What it does feel is necessary is clarity in the government's applications of its policy. It believes the Kennedy Memorandum has engendered in the academic community an increased awareness of patents, with the result that university patent committees have become more sophisticated and are now more concerned with disposition of patent rights and invention utilization.

The foundation contrasts its own relative success in promoting patent utilization with what it believes to be the relative lack of success of similar promotional programs within the federal government. It observes that the "title" agencies have tried to promote utilization, and avoid monopoly, by granting nonexclusive licenses to all interested firms. The foundation, on the other hand, sells industry a limited exclusive license which gives one company lead time to stimulate demand and recoup its investment, and then makes the invention available to the public on a nonexclusive basis. It does this in the belief that mass utilization invariably follows a pioneer success. The government's nonexclusive licensing, it argues, fails to encourage utilization. Furthermore, the foundation believes it is unequitable, since it favors only those companies which are large enough to invest capital without proprietary protection—that is, those whose competitive position is already established. The foundation prefers to seek out a company uniquely qualified to exploit an invention and permit it to stimulate a market demand which will then be satisfied by many competitors after the limited period of exclusivity has expired.

While the foundation does not argue for a patent policy which treats all situations alike, it does feel that a uniform utilization program operated through a government corporation established for that purpose is desirable. It notes that both Great Britain and Canada have taken this step in their National Research Development Corporation and Canadian Patent Development Limited. It agrees with its clients that the vast majority of worthy inventions conceived by the nonprofit institutions under government-sponsored research merely die on the shelf.

Management of Patents Within the Institution

The foundation provides a broad range of patent assistance services to the universities, including evaluation of faculty and staff inventions, applying for and obtaining patents, and licensing them to industry. Royalty income from the inventions is apportioned among the inventor, his institution, and the foundation. Although the foundation rarely has direct relationships with the government, as it manages patents for hundreds of nonprofit organizations, it is, perhaps, more directly concerned with government patent policy than any of its clients.

In promoting the inventions of others, the foundation operates under two general forms of agreement with assignees. Under the first, the inventor receives 15 percent of the gross royalty from his invention and the balance, subject to special expenses such as foreign applications and litigation, is evenly divided between the foundation and the assignor. About half the foundation's agreements take this form.

For the other half, the assignor receives 57.5 percent of the proceeds and the foundation receives 42.5 percent. The assignor makes its own decision regarding the inventor's share.

Although the solicitation of disclosures is acknowledged to be the single most difficult task for patent managers at academic and nonprofit institutions, the foundation provides only a minimum of assistance in soliciting. Except for its annual visit to its clients, the foundation's work begins when it receives disclosures from them. Only 5 percent of the institutions with which the foundation has agreements now submit five or more invention disclosures per year.

The agreements with assignees do not allocate or restrict the foundation's use of its royalty income in any way. The foundation's royalties are deposited in a general fund which it uses to cover its administrative expenses and to make annual grants for scientific research and development in educational institutions. In 1966 these grants amounted to a little less than $3 million, the bulk of which were used to promote science programs at liberal arts colleges, and for public health nutrition projects in Latin America.

CASE 16
A WESTERN PATENT DEVELOPMENT FIRM

The Institution

The foundation discussed in Case 15 was the nonprofit parent corporation of a manufacturing subsidiary. The Western Patent Development Firm discussed here is one of three affiliated corporations which span the entire technical development and commercial utilization cycle.

The parent corporation is a large nonprofit research institute like those discussed in Cases 12, 13, and 14 above. Employing 25, the patent development subsidiary is a patent promotion and licensing firm, whose principal engineering for the parent corporation. Pointing to their own experience, they insist that they never would have been able to attract a single dollar of sponsored research for their major industrial inventions unless they had had a basic patent position. Perhaps, they concede, investors *should* realize that their principal protection is in engineering innovation rather than proprietary rights in basic inventions. But they do not. The manager of the patent development firm observed that it takes five to ten years from the date of an invention to the realization of its utilization potential. He could not conceive of investing the required capital, or soliciting other investment, without the guarantee of proprietary rights. Approximately 10 percent of the patent development firm's portfolio comes from government-sponsored research at the parent corporation itself or from one of its academic clients for inventions that are, characteristically, so far removed from the marketplace that years of engineering are required before a product could be marketed.

Views of the Manufacturing Affiliate

The general manager of the manufacturing affiliate flatly states that his company will not look at an invention if the government has title. He feels that his technological and market risks are great enough without inviting competition at a delicate stage of development.

The business-oriented management of the three companies all agreed that patent rights may not motivate the scientists or even inspire the engineers but that they are absolutely essential to the investor. Citing an invention from their laboratories which literally created an entire industry, they argue that the commercially successful inventions surrounding the product would not have arisen if the research sponsor had not had the myth of the basic patent protection in the first place.

This institution is a classic illustration of the competing attitudes of technical and business personnel, who necessarily view inventions from different vantage points in the R&D spectrum. While they agree that investment capital is important in achieving utilization, they disagree as to the conditions needed to attract it. However, those closest to investment decisions emphasized the importance of patent ownership to the prospective investor, regardless of where his true business interests lay. This fact, and the noncommercial nature of most government-sponsored inventions arising out of institutional research, they assert, point up the need for strong incentives—such as exclusive patent rights—to carry such inventions into the market.

PART V. Effect of Government Patent Policy on Business Competition

A. Introduction

Safeguarding business competition is a fundamental concern of the government. The patent study, therefore, included tasks to determine whether government patent policy promotes or restricts business competition. Our objective was to gather data which would permit the government to establish the degree to which business competition should be a concern in setting government patent policy.

Data on this question were gathered from four sources:

(i) Questions on licensing were included in the utilization questionnaire to provide a data base for statistical analysis and case studies;

(ii) A pilot study was conducted within the synthetic quartz crystal industry to determine the feasibility of using case studies to explain the effect of patent policy on competition;

(iii) Case studies were conducted on sample patents involved in infringement suits to determine the effect on competition of inventions important enough to involve litigation; and

(iv) Interviews were conducted with patentees who reported inventions unavailable for license to determine the importance of the inventions and their effect on competition.

In evaluating the impact of government patent policy on competition, it is important to distinguish the effects of patent policy from other effects which may result from industry participation in government programs. Competitive advantages in commercial markets may well accrue to government contractors through knowledge gained in new technologies, through sharpening of technical skills, and through government funding of R&D work, which has parallel commercial areas of interest. But these are quite separate from the advantages of owning patents to specific inventions. This study has tried to measure only the latter. And, it has tried to measure it in terms of the inventions included in the survey sample. While a broader study of the cumulative effect of government-sponsored inventions patented over several years might have provided more definitive data, we believe that the study data provides a representative and useful picture of the effects of patent policy on competition. The study indicates that both in number of inventions utilized and in sales volume, the patents sampled appear to have had small impact on commercial markets. Although over 80 percent of both sample inventions and utilization were concentrated in 50 firms, only 55 inventions owned by contractors—2.7 percent of the sample—played a critical role in their commercial use, and five were responsible for $201 million out of the $406 million in cumulative sales attributable to contractor inventions. This utilization of critical-role contractor-owned inventions is low compared with the total sales of these firms and the industries in which they participate. Of equal importance is the fact that very few instances were reported where owners of government-sponsored inventions refused to license their patents. Only 15 inventions—less than 1 percent of the sample—involved such refusals and these 15 refusals involved just five companies. Furthermore, despite the large number of sample inventions available for license, responding firms reported only 175 license requests, 138 of which actually resulted in license agreements.

These statistics suggest that government patent policy has limited effect on business competition, a conclusion that is corroborated by the case data. Four of the five highly utilized inventions mentioned above were available for license from the contractors who owned them, and the fifth competed with alternative technology. None of the infringement suits investigated involved attempts by the patent owner to limit use of the patent to himself. On the contrary, the evidence is that the patent owner, despite a general willingness to license, may find his competitors using the patent first and negotiating a license only when he claims infringement. Lastly, most of the inventions from defense-aerospace work, which account for over 98 percent of government contract patents, are included in broad, industry-wide cross-licensing agreements in the defense, aerospace and electronic industries.

The study did show that government retention of title, when coupled with active government promotion of inventions having high commercial potential, has promoted competition. A striking example of this is the fertilizer industry where TVA developed high-concentrate fertilizers, patented them, proved their effectiveness on pilot farms and their commercial feasibility in pilot production, and aggressively promoted their use among farmers and fertilizer manufacturers. Industry sales have increased greatly through the manufacture of these fertilizers by many small regional producers. In circumstances like these, government retention of title can be an effective spur to competition because licenses are available to all comers. But several

FIGURE V-2
NUMBER OF LICENSED INVENTIONS USED BY LICENSOR

Frequency
(Percent)

	Size of Firm (in millions)				
Pct. Govt. Business	Total	0-5	5-50	50-200	Over 200
Total	26 (100.0)	2 (7.7)	9 (34.6)	0 (0.0)	15 (57.7)
0 - 20	2 (7.7)	1 (3.8)	0 (0.0)	0 (0.0)	1 (3.8)
20 - 50	5 (19.2)	0 (0.0)	3 (11.5)	0 (0.0)	2 (7.7)
50 - 80	8 (30.8)	1 (3.8)	5 (19.2)	0 (0.0)	2 (7.7)
80 - 100	11 (42.3)	0 (0.0)	1 (3.8)	0 (0.0)	10 (38.5)

FIGURE V-3
NUMBER OF CRITICAL INVENTIONS LICENSED AND IN USE BY LICENSOR

Frequency
(Percent)

	Size of Firm (in millions)				
Pct. Govt. Business	Total	0-5	5-50	50-200	Over 200
Total	8 (100.0)	2 (25.0)	2 (25.0)	0 (0.0)	4 (50.0)
0 - 20	2 (25.0)	1 (12.5)	0 (0.0)	0 (0.0)	1 (12.5)
20 - 50	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (12.5)
50 - 80	3 (37.5)	1 (12.5)	1 (12.5)	0 (0.0)	1 (12.5)
80 - 100	2 (25.0)	0 (0.0)	1 (12.5)	0 (0.0)	1 (12.5)

Part II of Volume IV, industrial firms reported commercial use of only 200 inventions in the sample, and just 49 of these played a critical role in their commercial application. The low levels of activity reflect, for the most part, the limited commercial value of most government-sponsored inventions. In comparison, one of TVA's fertilizer patents is used by at least 32 licensees, reflecting both its high commercial potential and the effectiveness of TVA promotional efforts. And, a DOD process patent for growing synthetic quartz is used by every firm in the synthetic quartz crystal industry, because the invention increases the commercial yield of quality crystals.

2. Licensing Time Lags

The time lags between applications for patents and the dates they were first licensed were computed from the utilization questionnaire data to determine if patentees were delaying licensing inventions to gain a competitive advantage. Figure V-4 tabulates the time lag data. Fifty-eight percent of the licensed inventions were licensed within three years of the application for a patent, comparing very favorably with the 68 percent used by patentees within that same period.

Perhaps an even more meaningful test of diligence in licensing is the time that elapses before an agreement is reached once a license request is received. A check of 13 respondents who reported a time lag of one year or more between first commercial use of an invention and issuance of a license showed that 10 issued licenses within one year of the request, two had answered the question incorrectly and have been disregarded, and one issued a license within three years. In the latter case—involving a high-speed printer—we found no effort to delay licensing. The initial request was an informal inquiry for information. The requester then decided to purchase printers over the next year. When he did finally request a license, it was quickly granted.

Further analysis of Figure V-4 indicates that:

- Firms with prior experience in the field of the invention issued licenses sooner than firms without prior experience.
- Inventions which were end products resulted in licenses sooner than those which were materials, components, or processes.
- Firms doing over 50 percent of their business with the government licensed inventions more quickly than firms with less than 50 percent government work.
- Firms with sales of $50 million or less licensed inventions sooner than firms with sales over $50 million.

FIGURE V-5
REFUSALS TO LICENSE

	Invention	Company	Size of Firm ($ Millions)	Commercial Sales	Private Development Cost	Role of Invention	Reason for Refusal to License	Sponsoring Government Agency
(1)	Turbine drive mechanism for miniaturized jet fuel flowmeter	1	over $200	$1 million	$450,000	Supporting	Establish market position with new product	DOD
(2 & 3)	Design features and fluid seals for jet fuel flowmeter (two related inventions)	1		$800,000	$1 million	Supporting	Establish market position with new product	DOD
(4)	Porous metal and process for manufacture	1		$13,000	$300,000	Supporting	Establish market position with new product	DOD
(5)	Gas turbine motor scroll structure	2	over $200	$60 million	Not Available	Critical	Avoid direct competition	DOD
(6)	Punch guide for microfilm mounting	3	over $200	$500,000	$30,000	Supporting	Avoid direct competition	DOD
(7)	Bead breaker for tire mounting machine	4	under $5	$66,000	$2,000	Critical	Avoid direct competition	DOD
(8)	Electromagnetic pump for liquid metals	5	$5 - 50	$1.25 million (commercial and government)		Supporting	Avoid direct competition	DOD
(9)	Reagent for carbon dioxide analysis	5		$11,000 (commercial and government)	Not Available	Critical	Avoid direct competition	DOD
(10)	Safety helmet with eye shield	5		Negligible	Not Available	Supporting	Avoid direct competition	DOD
(11)	Gas detection techniques	5		No commercial sales anticipated	Not Applicable	Not Applicable	Avoid direct competition	DOD
(12)	Shaft seal for liquid metal pumps	5		No commercial sales anticipated	Not Applicable	Not Applicable	Avoid direct competition	DOD
(13)	Contaminant analysis for liquid metals	5		No commercial sales anticipated	Not Applicable	Not Applicable	Avoid direct competition	DOD
(14)	Apparatus to maintain low oxygen atmosphere	5		No commercial sales anticipated	Not Applicable	Not Applicable	Avoid direct competition	DOD
(15)	Head positioner for helmet	5		No commercial sales anticipated	Not Applicable	Not Applicable	Avoid direct competition	DOD

Working from the listing of contractor-owned patents issued in 1957 and 1962 and from the patent sections of *Shepard's Citations* (including current supplements through July 1967[4]), we identified patents which had been involved in lawsuits between private parties regarding infringement or validity. The search of *Shepard's Citations* disclosed 16 private suits involving 11 patentees or assignees.

Next, the court files of these lawsuits were examined to determine the nature of the dispute and to decide whether the cases were relevant to the study.[5] In this step, four patents and six suits were eliminated because the main issues did not involve the patents, but were primarily claims for appropriation of trade secrets–one involved use of a patented invention under a government contract rather than commercial utilization. The remaining nine patents involving seven patentees or assignees were selected for further study. In addition, a tenth patent was added during the course of our research. Issued in 1960 to a firm already under study, it had far greater importance than the two related 1957 patents which were the starting point for the research. In each case, interviews were conducted with patentees or assignees to obtain information about the inventions, their commercial development, their licensing and use, and their effect on business competition.

Much of the data provided to us by the companies interviewed were given in confidence. We have, therefore, disguised both the inventions and the companies involved and reported them only in summary fashion. For identification, we give the following titles to the cases:

(i) Case 1 – The Small Business Case
(ii) Case 2 – The Sophisticated Devices Case
(iii) Case 3 – The Impressive Patent Case
(iv) Case 4 – The Ninety-Percent Government Business Case
(v) Case 5 – The Declining Business Case
(vi) Case 6 – The Commercial Company Case
(vii) Case 7 – The Nonprofit Institution Case
(viii) Case 8 – The Critical Process Patent Case

[4] The patent law requires that when a patent is the subject of a court suit, the Clerk of Courts must notify the Commissioner of Patents, who, in turn, publishes this information in "The Official Gazette " *Shepard's Citations* picks up these listings from "The Official Gazette" and publishes a complete listing of the patents with citations to the court suits.

[5] No patent was adjudicated in any of these proceedings. While there were some interlocutory opinions and hearings on such matters as change of venue, all the proceedings, except those still continuing at the date of our research, were settled by the parties through stipulation of settlement, withdrawal, or voluntary dismissal.

2. The Patents Involved in Lawsuits

a. *The Small Business Case.* The invention involved in "The Small Business Case" is a critical component of a capital equipment item which sells for from $25,000 to $35,000 and which is the primary product of the company. The patentee is an individual inventor a type who is sometimes thought to no longer exist in this era of group research by large companies–who owns a small business. His company has about 65 employees and has an expected sales volume for fiscal year 1967 of between $700,000 and $1 million, a record for the firm.

The patentee has licensed two domestic firms and the patent is available for license to others. The licenses include a complete transfer of technology. An infringement suit to collect royalties is in process against the largest firm in the industry. There is a widely used alternative technology to the invention and there are other more inexpensive ways of accomplishing its functions that have advantages in some applications.

b. *The Sophisticated Devices Case.* The invention in "The Sophisticated Devices Case" is a critical component of a specialty device which has its main use on government work, but which also has some sophisticated commercial applications that contribute annual sales of about $200,000 to the patentee. The firm has been trying to promote utilization of the invention commercially, a major factor in deciding to form a small subsidiary company to manufacture it and other less sophisticated devices (amounting to about 80 percent of the commercial market in the total product line) that are in the same product line. The commercial market for the sophisticated device has not yet developed to the extent the patentee expected. The company has licensed three domestic firms to use the invention, including its major competitor.

c. *The Impressive Patent Case.* The invention in "The Impressive Patent Case" is the most important patent of the ten studied. The invention is basic to a product line of capital equipment that has total annual industry sales of $22 million to $30 million. About 70 percent of this market is now government, but commercial sales are increasing. No alternative technology to the invention appears available.

The patentee does not manufacture the invention itself, but has entered into an exclusive license with a large diversified manufacturer, who is estimated to account for about 50 percent of the market. The exclusive licensee has negotiated two sublicenses with its major competitors and another two are close to agreement.

- The combination of technological and marketing talents required to produce and market the equipment limited the attractiveness of producing the equipment to a few firms.
- The stated licensing policy of the exclusive licensee is to license all comers on reasonable terms.
- Government business still occupies about 70 percent of the market.
- Improvement patents in the field are held by various companies.
- The wide market for less sophisticated equipment not covered by the subject patent is part of the competitive environment of the sophisticated equipment because buyers may choose between these two types of equipments for many applications and among the 10 or so manufacturers of the less sophisticated equipment. The exclusive licensee does not have the major share of that market for the less sophisticated device.

In the "Critical Process Patent Case," the invention appears to give the exclusive licensee sufficient leverage to control the industry. We believe it is untypical of government inventions in this respect. But, provision for government "march-in-rights" to require licensing at reasonable rates would appear to provide the necessary safeguard to protect against the occurrence of such cases.

Similarly, the effect on competition of the other cases studied can be summarized as follows:

(i) *"The Small Business Case."* The activities of the small business in this case have increased competition and lessened concentration within its business area. The company's licenses have involved a full-scale transfer of technology.

(ii) *"The Sophisticated Devices Case."* The commercial market in this case is small, sophisticated, and, in large part, experimental; and government sales are four times commercial sales. Whereas the patentee has the major share of the government and commercial markets, the potential economic leverage of the invention is small since the patentee has licensed its major competitor and two others at low royalty rates.

(iii) *"The Ninety-Percent Government Business Case."* The patentee of this invention does not manufacture it and would like to see as many other firms as possible use the invention. Therefore, it has licensed six manufacturers and one user, and would license others. In addition, firms have used the invention rather freely without obtaining a license.

(iv) *"The Declining Business Case."* Since new companies have been entering this market during the life of the patent and the company's business in the market has declined, it is clear that the patent ownership has not had an adverse effect on competition or concentration.

(v) *"The Commercial Company Case."* Competition was not adversely affected in this case since the entire industry is licensed and the other commercial patents that the patentee developed were equally basic to the system.

(vi) *"The Nonprofit Institution Case."* The patentee here does no manufacturing and would like to see as many companies as possible use the invention. Over the life of the patent, four firms have desired to develop the equipment and have received licenses.

b. *Licensing Terms.* Licensing, of course, is a very important factor in the conclusions outlined above. Although many aspects of existing licenses, licensing policies, and royalties were discussed in the research at the various companies, copies of licenses were not available for examination. Much of this information is considered confidential by the companies interviewed.

Some firms did, however, reveal royalty rates. In "The Small Business Case," one license included a 5 percent royalty, based on the net selling price of the equipment. Another license, now inactive, required a 3 percent royalty on manufacturing and sale of the invention and 1 percent on the entire device embodying the invention. Licensees had strong bargaining positions here and were able to negotiate low royalty rates. Another firm stated that royalty rates in its existing licenses are 3 percent to 5 percent and that the method of computing the royalty is based on a customary industry formula.

Representatives of other firms made more general statements about royalty patterns and rates. In "The Impressive Invention Case," the patentee stated, "we license all comers at reasonable rates." The sublicense agreements are fixed-sum agreements payable over a period of years, and the exclusive licensee pays a certain royalty to the patent owner on each item it manufactures as well as a share of the sublicense royalty payments it receives.

With regard to licensing policy, all firms represented that licenses were available for licensing or—perhaps more realistically—that, "If it comes to our attention that someone is using or wants to use the patent, we will do something about it." This remark appears to reflect industrial patent situations more accurately than the statement that a patent is available for licensing. Often a patent owner is in the frustrating position of having to find out who is infringing on his patent in order to

APPENDIX A

PATENT POLICY STUDY
FOR THE
COMMITTEE ON GOVERNMENT PATENT POLICY
OF THE
FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

INVENTION UTILIZATION QUESTIONNAIRE
FOR
CONTRACTORS WITH RIGHTS IN INVENTIONS

1. Title of Invention ____________________
2. U.S. Patent No. ____________________
3. Patent Application No. ____________________ Filing Date ____________________
4. Contracting Government Agency ____________________
5. Contractor Rights in Invention ____________________ Title ____________________
   License ____________________
6. Name of Company ____________________
7. Address ____________________
8. Person Completing Questionnaire ____________________ Title ____________________
   Telephone No. ____________________
   Area Code ____________________
9. Contract Number ____________________
   (government contract under which invention was made)

PART I

BACKGROUND INFORMATION

1. Please briefly describe the invention ____________________

____

____

____

____

2. Please briefly describe the scope of work of the contract under which the invention was made. ____________________

____

____

____

____

3. Prior to the contract, did you sell goods or services closely related to the invention:
   ☐ a. To the U.S. government ☐ b. Commercially

December 1966

PART II

COMMERCIAL USE OF THE INVENTION

1. Please state briefly how the invention is used commercially.
   (For example, "as a component of the x product," or "in manufacturing y products," and so forth)
   ____
   ____

2. What role did the invention play in such use?
   ☐ critically important role ☐ supporting role
3. When was the invention first used commercially? 19_____
4. If the invention is incorporated in a product(s) please estimate:
   a. Sales of such products to date in each of the following markets:
      (1) Domestic commercial ____________________
      (2) U.S. government ____________________
      (3) Foreign ____________________
   b. Anticipated total sales of such products over the next five years.
      ____
5. Please indicate the approximate total cost of company-financed efforts that were required after completion of government work to develop the invention for commercial use:
   a. $____________________ ☐ b. None
6. Please estimate what percent of the costs specified in question 5 were incurred for:
   a. Technical development ___% b. Production facilities ___%
   c. Marketing and sales promotion ___%

PART III

INVENTION WITH EXPECTED FUTURE USE

1. Please state briefly how your company intends to use the invention commercially.
   (For example, "as a component of the x product"; or "in manufacturing y products," and so forth)
   ____
   ____

2. What role is the invention expected to play in such use?
   ☐ a. critically important role ☐ b. supporting role
3. Please estimate when the invention will first be used commercially. 19____
4. If the invention is expected to be incorporated in a product(s), please estimate the anticipated sales volume of such products. ____________________
5. Please indicate the approximate total cost of company-financed efforts that will be required after completion of government work to develop the invention for commercial use:
   a. $ ____________________ ☐ b. None
6. Please estimate what percent of the costs specified in question 5 will be incurred for:
   a. Technical development ___% b. Production facilities ___%
   c. Marketing and sales promotion ___%

PART I

BACKGROUND INFORMATION

1. Please briefly describe the invention. ____________________

____

____

____

2. How did your company learn that the invention was available for licensing?

____

____

3. Prior to the license, did you sell goods or services closely related to the invention:
   ☐ a. To the U.S. Government ☐ b. Commercially
4. Please indicate the annual sales volume of your company at the time the license was obtained:
   ☐ a. Less than $5 million ☐ b. $5 - $50 million
   ☐ c. $50 - $200 million ☐ d. Over $200 million
5. Approximately what percent of company sales was made in connection with government contracts and subcontracts at the time the license was obtained?
   ☐ 0-20% ☐ 20-50% ☐ 50-80% ☐ 80-100%
6. Has your company used the invention in sales to the government?
   ☐ Yes ☐ No
   If yes, please give brief statement about the nature of government use.

____

____

7. Please check whether the invention:
   ☐ a. Is or has been in commercial use by your company.
   If question 7a is checked, please answer Part II, below.
   ☐ b. Is expected to be used commercially by your company in the future, even though it has not yet been used.
   If question 7b is checked, please answer Part III, below.
   ☐ c. Is not expected to be used commercially.
   If question 7c is checked, please answer only question 8, immediately below.
8. If you do not intend to use the invention commercially, please rank the applicable reasons for lack of commercial potential numerically by assigning the most important reason the rank of (1) and grading the others in numerical order.
   ___a. Development cost too high.
   ___b. Development showed serious flaws.
   ___c. Development personnel not available.
   ___d. Invention became obsolete.
   ___e. Expected market failed to materialize.
   ___ f. Technology too sophisticated for commercial use.
   ___g. Channels of distribution lacking.
   ___h. Invention falls outside of company product line.
   ___ i. Other (please specify). ____________________

PART II

COMMERCIAL USE OF THE INVENTION

1. Please state briefly how the invention is used commercially.
   (For example, "as a component of the x product," or "in manufacturing y products," and so forth.)

____

____

2. What role did the invention play in such use?
   ☐ critically important role ☐ supporting role

3. When was the invention first used commercially? 19_____
4. If the invention is incorporated in a product(s) please estimate:
   a. Sales of such products to date in each of the following markets:
      (1) Domestic commercial ______________________________
      (2) U.S. Government ______________________________
      (3) Foreign ______________________________
   b. Anticipated total sales of such products over the next five years.

      ____
5. Please indicate the approximate total cost of company-financed efforts that were required to develop the invention for commercial use:
   a. $______________________________ ☐ b. None
6. Please estimate what percent of the costs specified in question 5 were incurred for:
   a. Technical development ___% b. Production facilities ___%
   c. Marketing and sales promotion ___%

PART III

INVENTION WITH EXPECTED FUTURE USE

1. Please state briefly how your company intends to use the invention commercially.
   (For example, "as a component of the x product," or "in manufacturing y products," and so forth.)

   ____

   ____
2. What role is the invention expected to play in such use?
   ☐ a. critically important role ☐ b. supporting role
3. Please estimate when the invention will first be used commercially. 19_____
4. If the invention is expected to be incorporated in a product(s), please estimate the anticipated volume of product sales. ______________________________
5. Please indicate the approximate total cost of company-financed efforts that will be required to develop the invention for commercial use:
   a. $______________________________ ☐ b. None
6. Please estimate what percent of the costs specified in question 5 will be incurred for:
   a. Technical development ___% b. Production facilities ___%
   c. Marketing and sales promotion ___%

PART IV

LICENSING

(To be completed only by contractors having exclusive rights to the invention)

1. Is the invention available for licensing?
   ☐ Yes ☐ No
2. If the answer to question 1 is "yes," please briefly identify the methods used to make the invention available for licensing. ______________________________
   ____
3. Have there been specific requests to license the invention (apart from automatic cross licensing)?
   ☐ Yes ☐ No
4. If the answer to question 3 is "yes":
   a. Approximately how many requests have been received to date?
   ____
   b. In what year was the earliest request made? ______________
   c. How many licensing agreements were made? ______________
   d. In what year was the earliest agreement made? ______________
5. Do you know if any licensees are using the invention?
   ☐ Yes ☐ No
   If yes, how many: ______________

PATENT POLICY STUDY FOR THE COMMITTEE ON GOVERNMENT PATENT POLICY OF THE FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY

INVENTION UTILIZATION QUESTIONNAIRE
FOR
LICENSEES OF GOVERNMENT-OWNED PATENTS

1. Title of Invention ______________________________
2. U.S. Patent No. ______________________________
3. License Agreement No. ______________ Date of License ______________
4. Licensing Government Agency ______________________________
5. Name of Company ______________________________
6. Address ______________________________
7. Person Completing Questionnaire ______________ Title ______________
   Telephone No. ______________
   Area Code ______________

December 1966

4. Please identify the division or other major organizational element of your company (referred to hereafter as the *inventing division*) that made the invention.

____

5. Please indicate the sales volume of your company in the year the patent application was filed:
   - ☐ Less than $5 million
   - ☐ $5 - $50 million
   - ☐ $50 - $200 million
   - ☐ Over $200 million
6. Approximately what percent of *company* sales was made in connection with government contracts and subcontracts in the year the patent application was filed?
   - ☐ 0-20%
   - ☐ 20-50%
   - ☐ 50-80%
   - ☐ 80-100%
7. Approximately what percent of the *inventing division* sales was made in connection with government contracts and subcontracts in the year the patent application was filed?
   - ☐ 0-20%
   - ☐ 20-50%
   - ☐ 50-80%
   - ☐ 80-100%
8. In what product line(s) did the inventing division or company specialize at the time the patent application was filed?
   (Please answer in terms of the *inventing division* if the group was responsible for developing inventions to the point of a marketable product or commercially useful process. In all other cases, please answer in terms of the *company*.)
   a. Inventing division

   ____

   ____

   ____

   b. Company

   ____

   ____

   ____

9. Has the invention ever been used by or for the government?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

   If yes, please give brief statement about the nature of government use.

   ____

   ____

10. Please check whether the invention:
   - ☐ a. Is or has been in commercial use.
     If question 10a is checked, please answer Part II, below. If you have exclusive rights to the invention, please also answer Part IV.
   - ☐ b. Is expected to be used commercially in the future, even though it has not yet been used.
     If question 10b is checked, please answer Part III, below. If you have exclusive rights to the invention, please also answer Part IV.
   - ☐ c. Is not expected to be used commercially.
     If question 10c is checked, please answer question 11 immediately below. If you have exclusive rights to the invention, please also answer Part IV.
11. If the invention is not expected to be used commercially, please rank the applicable reasons for lack of commercial potential, giving the most important reason the rank of 1 and grading the others in numerical order.
   - ____ a. Development cost too high.
   - ____ b. Development revealed serious flaws.
   - ____ c. Development personnel not available.
   - ____ d. Invention became obsolete.
   - ____ e. Expected market failed to materialize.
   - ____ f. Technology too sophisticated.
   - ____ g. Too much competition.
   - ____ h. Channels of distribution lacking.
   - ____ i. Invention falls outside of company product line.
   - ____ j. Other (please specify). ____

     ____

attempt to obtain royalties. This certainly was the case in "The Ninety-Percent Government Business Case" and in "The Nonprofit Institution Case" and "The Small Business Case" as well.

Several factors contribute to this situation. A number of firms take the attitude, "Why not use a patent, as necessary, before negotiating a license, since most patent suits are settled out of court and preliminary injunctions are rarely granted?" and the ideal corporation in which engineers and patent attorneys review all corporate actions for infringement of the patent rights of others does not widely exist. This situation changes the competitive environment from one in which the patentee may limit use of the invention to one in which he may have to aggressively seek out potential infringers.

On the other hand, the tendency to go sailing into infringement situations is certainly not universal. In connection with the two most important patents in our cases, for example, the same large firm was the first to be licensed because it expressed awareness of the patent to the patentee and initiated negotiations for a license. The licensee is widely known to have a patent policy based on deliberate action and advance planning.

Research showed that license negotiations can be very complex. To establish the proper royalty base and to decide what patents are to be included in the license, large companies having numerous divisions or subsidiaries may engage in protracted bargaining. Such bargaining did occur in a number of the selections considered. In one case, delay was encountered in arriving at a proper royalty base and, in another, in working out arrangements suitable for various divisions of the licensee. In a third case, a pending merger of the licensee caused delay. Moreover, in some of the cases, lengthy negotiations were terminated, and resulted in a lawsuit.

c. *Extent of Private Development to Commercialize the Inventions.* Four of the cases involved are inventions used in capital equipment sold in both commercial and military markets.[6] In all four of these cases the commercial application of the invention could have been anticipated at the time of invention disclosure. In this respect, these cases run contrary to assumptions often made about ability to anticipate commercial use of items developed under military contracts. A fifth case[7] also involves general purpose capital equipment that has wide use in many industries, but the military use is specialized and does not have major commercial possibilities.

One would expect that only a small amount of private investment would be necessary to commercialize an invention whenever it can be used in the same basic configurations for both the government and commercial markets. The "small business" and "declining business" firms indicated that this expectation is correct; however, the exclusive licensee in "The Impressive Patent Case" reported that each firm that entered the field spent substantial amounts of private funds to being the invention to market.

Another way of looking at the question of private investment is to ask, "Would the invention have been commercialized to the same extent once it was patented if the government had retained title?" It appears that in all but "The Sophisticated Device Case" this would have been so, but this does not answer the question whether the licensees under those circumstances would promote the invention as aggressively as when they had title. The inventor in the small business case would have been in a precarious position however if he did not have the protection of the patent and its royalty income to support his entry into a market of much bigger competitors. Based on all observations of the sample inventions, we have not found an adverse effect on business competition by permitting contractors to retain title to government-sponsored inventions.

[6] "The Small Business Case," "The Impressive Patent Case," "The Declining Business Case," and "The Nonprofit Institution Case."

[7] "The Ninety-Percent Government Business Case."

The exclusive licensee also manufactures a less sophisticated device in the same general product line covered by another basic government-sponsored patent not included in the sample. The two products compete in the market. Some 10 manufacturers produce the less sophisticated device, one of which has the major share of the market and was the first to sublicense the more sophisticated device.

d. *The Ninety-Percent Government Business Case.* "The Ninety-Percent Government Business Case" involves three patents owned by a patentee who is among the 50 largest defense contractors and does no commercial work in the field of the patent. Two of these, improvement patents issued in 1957 for which there is a significant amount of alternative technology, are available for licensing and are part of a broad cross-licensing agreement.

The third patent—issued in 1960—is the second most important one studied. It has been basic to important and extensive commercial applications involving sales to date of some $20 million. The patentee has licensed six manufacturers and one user; one manufacturer under a broad cross-licensing agreement.

e. *The Declining Business Case.* The patentee in "The Declining Business Case" has had declining commercial and military sales in the field covered by the two improvement patents involved in the study, even though it owns basic patents in the product line. The company's overall sales have also declined over the last several years.

Although the two improvement patents are available for licensing, there have been no requests from interested firms. The patentee's three basic patents and others in this field, however, have been licensed to its major competitor under a broad cross-licensing agreement. The two improvement patents were issued after the cutoff date of that agreement and were, therefore, excluded from it. An infringement suit is in process in a foreign country to collect royalties on the improvement patents.

f. *The Commercial Company Case.* The patentee in "The Commercial Company Case" applied its knowledge in a commercial field to develop a device for an entirely different application for the Department of Defense. It then applied the resulting invention—along with some other basic patents it owned—to a system used by one of its major commercial activities. Every competitor in the industry except one uses the patented equipment under license from the patentee.

g. *The Nonprofit Institution Case.* The patentee in "The Nonprofit Institution Case," is a nonprofit institution connected with a university. The organization does no manufacturing. The invention is critical to a device having modest market potential. When companies began using the invention commercially, the patentee made the decision to collect royalties under license, if possible, rather than dedicate the invention to the public and has licensed the invention to four companies.

h. *The Critical Process Patent Case.* The patentee in the "Critical Process Patent Case" does not practice the invention commercially, but has granted an exclusive license instead. The invention is critical in synthesizing an important mineral used in the electronic industry. The process makes the synthetic mineral produceable at a cost which is competitive with the natural product and, as such, has been instrumental in creating a small, but growing industry. The exclusive licensee is willing to license others, but at a royalty which may make their operations unprofitable. The validity of the patent is currently being tested in a suit involving an infringing user.

3. The Effect of Litigated Patents on Competition

a. *General Conclusions.* Each situation studied is unique, but the general conclusion is that healthy competition exists in all of the cases involving litigated patents. There appears, at first blush, only two situations—"The Impressive Patent Case" and the "Critical Process Patent Case"—in which there might be enough economic leverage to raise concern over concentration. But in the former the total dollar amount of industry sales in an increasing market is relatively small in comparison with the dollar volume of sales in other major industry product lines. As noted previously in "The Impressive Patent Case," five companies occupy the market for the equipment, and the exclusive licensee has at least one half of the market. We believe that the current degree of concentration arose from circumstances other than the fact that patent title was retained by the original R&D contractor:

- The exclusive licensee obtained an early start in the technology. Even before it began negotiations for the exclusive license, it was working on a machine which performed many of the functions of the patented equipment to be used in its own internal manufacturing operations. The exclusive licensee, after receiving its license, completed the first production application of equipment embodying the invention and gained further momentum when it received a substantial government order for the equipment.

bead-breaker and was directly responsible for sales of about $66,000. Nominal development costs of $2,000 were required to commercialize the device. Since the device is specialized and has a limited market, the patentee has no interest in encouraging entry of a competitor into the market by licensing the invention. The second–a reagent for analysis of carbon dioxide (invention 9, Figure V-5)–generated sales of only $11,000, both commercially and to the government.

The six other inventions which were commercially used played supporting roles in their commercial products. Three, relating to various design aspects of jet fuel flow-meters (inventions 1 to 3, Figure V-5), represent improvements in a basic patent already owned by the company. The patentee did not wish to license the inventions because it was trying to penetrate a market with a new product. The company invested $1.45 million to commercialize the product, and since 1962 when the invention was first put on the market, commercial sales have been $1.8 million.

This same company owns the fourth invention which played a supporting role–a process for the manufacture of formed metal of uniform density and pore size (invention 4, Figure V-5). It has been trying to commercialize the invention since 1950 at a cost of $300,000. The company refused a request for license in 1963 because it wished to develop the market from a protected position. But since it has been over five years since receipt of the patent and very little commercial utilization has been achieved–to date, commercial sales have amounted to $13,000–the company expects to turn the invention over to its licensing group for licensing to other manufacturers.

The fifth invention relates to an apparatus for cutting microfilm strips and matting them on aperture cards (invention 6, Figure V-5), and is part of microfilm processing equipment manufactured by the patentee. The company considers the machine to be highly specialized with only a limited market. Since commercial sales during the past 10 years have only amounted to some $500,000, the company feels quite capable of handling the entire future demand for the equipment and is not interested in licensing competitors. The company has invested some $30,000 in the invention to commercialize it. The sixth invention–a safety helmet with eye shield (invention 10, Figure V-5)–has had negligible sales.

The last company interviewed showed a somewhat different pattern than the companies discussed above. It refuses to license patents in any new or existing markets in which it is interested. Thus, none of the eight inventions it owns in the sample are available for license. Only three of these (inventions 8, 9, and 10, Figure V-5, described above) had any commercial sales. The company anticipates no commercial sales of the remaining five patents, which include a shift seal for liquid metal pumps, contaminant liquid metals, an apparatus to maintain low oxygen atmosphere, gas detection techniques, and a head positioner for a helmet.

Table V-1 shows the effect of the size of the firm on these refusals to license. Only 1 percent of the inventions of larger firms (over $50 million) were unavailable for licenses compared with 7.6 percent for smaller firms. With respect to utilized inventions, smaller firms again kept a larger percentage for their own use (13.0 percent) than did larger firms (3.8 percent).

TABLE V-1
EFFECT OF SIZE OF FIRM ON REFUSAL TO LICENSE

	License Available (Percent)	License Not Available (Percent)
Size of Firm		
Under $50 million	92.4	7.6
Over $50 million	99.0	1.0
Size of Firm Where Invention Is in Use		
Under $50 million	87.0	13.0
Over $50 million	96.2	3.8

However, the total number of refusals in the survey is negligible, and with the exception of the gas turbine motor scroll structure, none of the inventions described above made any appreciable impact on a commercial market. Even the turbine motor scroll was competing with alternative methods of performing the same function. There is little evidence in the survey inventions that refusals to license have had a material effect on business competition in commercial markets.

C. Sample Patents Involved in Lawsuits

1. Research Approach

Anticipating that patents involved in court proceedings were likely to be important and have a significant commercial impact, sample patents involved in law suits were investigated to identify inventions which have a significant effect on competition after a pilot study of the "Critical Process Patent Case," was performed.[3] The purpose, however, was not to study the law suits in themselves, but to determine the effect of the patents on competition.

[3]The critical process patent was not issued in the sample years but was selected as a pilot study because of known patent problems having an effect on competition.

FIGURE V-4

TIME LAG BETWEEN PATENT APPLICATION AND FIRST LICENSE AGREEMENT MADE: OUTSIDE CONTRACTOR ACTIVITY FOR SAMPLE YEARS 1957 AND 1962

Independent Variables	0-3 Years	4-8 Years	≥9 Years
Sales of Firm			
Less than $5 million	5	3	0
$5 - $50 million	12	2	0
$50 - $200 million	4	1	0
Over $200 million	26	23	4
TOTAL	47	29	4
Prior Experience			
Yes	21	6	0
No	26	25	3
Percent Government Business			
0 - 20	3	3	0
20 - 50	9	6	0
50 - 80	9	2	0
80 - 100	26	18	4
Field of Technology			
Mechanical	12	8	0
Other	35	21	4
Form of Invention			
Material	3	3	0
Process	1	1	0
Component	21	17	1
End Product	22	8	3
Kind of Agency			
DOD	45	27	4
AEC	0	0	0
Other	2	2	0

3. Refusal to License

The utilization questionnaire data were also analyzed to determine the frequency and character of refusals to license sample inventions. A high rate of refusals would indicate that industry ownership of patents might have a material effect on competition if significant commercial applications were found for the invention. Initial analyses of the data identified 35 inventions as unavailable for license. All were investigated to determine the reasons for refusal.

Interviews revealed that 20 of the 35 inventions did not really involve refusals to license:

- Nine had either been sold outright or were involved in exclusive license agreements.
- Four were developed by companies which held only a license to the invention from the government.
- Seven involved questionnaires which were answered incorrectly and, consequently, were dropped from this aspect of the study.

The remaining 15 patents, involving five companies, reflected explicit management decisions to withhold licensing as part of their business strategy. (Figure V-5 lists pertinent information on these inventions.) Five inventions were owned by three large firms (over $200 million) and 10 were held by two firms with less than $50 million in sales. Licenses were refused for two basic reasons: (i) to establish new markets for the company and (ii) to protect existing markets from competitors. One company, (Company 5), holding 8 of the 15 patents, categorically refused to license competitors when either of the above situations existed. The remaining four companies refused licenses selectively, depending upon their evaluation of the patents and specific market conditions. The first reason—establishment of new markets—was usually associated with specialized new products of limited applicability or with attempts to penetrate markets of well-entrenched competitors. The second reason—protection of existing markets—was a position generally adopted when the company was either competing against industrial giants or attempting to retain its market share through product superiority.

Nine of the 15 were used commercially (inventions 1 through 9, Figure V-5). Only three played a critical role in their commercial use. The most successful of these was a gas turbine motor scroll structure (invention 5, Figure V-5) which was critical to a gas turbine motor involving commercial sales of $60 million to date. The patentee has several active competitors in the gas turbine field and there are alternative ways of performing the function involved in this patent. Given the competitive conditions in this market, the company does not wish to make its design expertise available through license of the patent.

The other two critical inventions involved very modest sales. The first—a device which breaks a tire bead away from the wheel rim on an aircraft landing gear (invention 7, Figure V-5)—was developed under Navy contract and was an outgrowth of a smaller model which the contractor had invented, patented, and produced for many years. The invention played a critical role in expanding the commercial application of the additional factors must be present for patent policy to have this effect. It must be evident to licensees that the invention has good commercial potential. The invention must be producible in commercial quantities and marketable at a cost that is competitive with alternative products. And the risks of recouping development costs must be no greater than similar investment opportunities available to the licensee.

In most cases, government agencies have to go far beyond discovery of an invention to create these conditions. Some agencies do—as described in the Volume III report on government efforts to promote utilization of government-sponsored inventions. The Department of Agriculture, for example, has an active program of developing inventions to the point of commercial feasibility. Potato flakes and frozen orange juice are two of its well-known successes. That agency, in promoting potato flakes, sponsored pilot production of the product and performed a market study in supermarkets in a major city to determine the product's consumer appeal. The study was then made available to the food industry to stimulate interest in the product.

In other cases, allowing industry to retain title to inventions has promoted competition. The clearest example of this is the small firm which penetrates a market of larger competitors on the strength of a patent on a government-sponsored invention. Just such a case is described in Section C, on patent infringement suits discussed below.

Notwithstanding the utilization programs employed by government agencies, none except AEC has an express statutory mission to increase business competition in commercial markets for its own sake. When it does occur, however, it is an indirect result of their efforts to accomplish their basic mission. From our observations of the study inventions and insofar as the effect of patent policy is involved, competition does not appear to have been adversely affected by this lack of direct concern, for three reasons: (i) The rate of utilization of government inventions has been low. (ii) The agencies—such as TVA and Agriculture, whose inventions are most likely to be utilized—either developed them in-house or took title to them when developed under contract. (iii) And industrial owners of government-sponsored inventions have been willing to license them upon request or, where they were unwilling to license, alternative technologies were available to competitors in the great majority of cases.[1]

[1] Except for several case studies which investigated the field of the sample patents involved, studies were not conducted on the effect of a series of or cluster of government financed inventions over a period of years.

The sections following present the findings which support these conclusions. Section B reports on the licensing of sample inventions and Section C investigates the sample patents involved in infringement suits.

B. Licensing of Inventions in the Utilization Sample

1. Licensing of Sample Inventions

In reviewing the utilization questionnaire data, it was found that the industrial firms responding held exclusive rights on 1,618 patents in the utilization sample. Ninety-five percent—or 1,539 of the inventions—were reported to be available for license. The sample inventions generated 175 requests for license which resulted in 138 licensing agreements.[2] Industrial firms reported use of inventions by 77 licensees (Figure V-1). Only 26 licenses (Figure V-2) covered inventions in use by industrial patentees and only eight (Figure V-3) were critically important in the patentees' use of them.

The small amount of licensing reported by patentees is consistent with the reported low level of commercial utilization among the sample inventions. As noted in

FIGURE V-1

NUMBER OF LICENSES IN USE BY LICENSEE

Frequency

(Percent)

		Size of Firm (in millions)			
Pct. Govt. Business	Total	0-5	5-50	50-200	Over 200
Total	77 (100.0)	5 (6.5)	28 (36.4)	8 (10.4)	36 (46.8)
0 - 20	14 (18.2)	1 (1.3)	0 (0.0)	8 (10.4)	5 (6.5)
20 - 50	18 (23.4)	0 (0.0)	1 (1.3)	0 (0.0)	17 (22.1)
50 - 80	29 (37.7)	0 (0.0)	26 (33.8)	0 (0.0)	3 (3.9)
80 - 100	16 (20.8)	4 (5.2)	1 (1.3)	0 (0.0)	11 (14.3)

[2] These agreements were individually negotiated and were not the result of automatic cross-licensing arrangements. No estimates were provided for the extent to which sample inventions were used under cross-licensing agreements.

PART V: Effect of Government Patent Policy on Business Competition

LIST OF FIGURES AND TABLES

mission is "to support scientific research and to make the results available to industry for the benefit of the public." The third member of this corporate family is a manufacturing subsidiary which engages in the prototype development of promising inventions for which the patent development firm cannot find industrial licensees. The following discussion considers aspects of all three affiliates because the character of the combined organization is unique.

The patent development firm focuses its efforts on the identification of inventions and promoting their development to a point where usefulness is demonstrated. It evaluates some 1,000 inventions annually.

Government-Sponsored Research

The research arm—the parent corporation—in its early years did not participate in the little government-sponsored research and development available. Today, government contracts in all fields of science and technology constitute 55 to 60 percent of its annual funded research of $40 million, excluding income from a separate laboratory operated for the Atomic Energy Commission, or that of its overseas operations. Approximately one-third of the dollar volume of government-sponsored research at the principal laboratory of the parent corporation is also under contract to the AEC.

Inventions in the Sample

The patent development firm had 11 inventions in the sample, all of which had been assigned by its parent corporation and sponsored by the Department of Defense. Nine of the 11 were processes and new compounds in metallurgy and unrelated chemical fields. The tenth was an electrical switch and the last was a device which automatically measured and dispensed liquids. The parent corporation owned seven of the 11 patents and had a nonexclusive royalty-free license for the other four. Whenever title was retained by the research institute, the patent development firm attempted to find manufacturers and promote a market. Except for the liquid measuring and dispensing system, which had limited utilization, none of the inventions have been used commercially. The license on the liquid measuring system was terminated by the licensee as an alternative to paying a minimum royalty when the expected market failed to materialize.

Patent Policy and Utilization Philosophy

Transferring technology into marketable products is a major objective of the combined corporation. However, each of the three affiliates expressed the attitudes toward patents typical of an organization with its type of mission. Thus, the parent corporation voiced opinions similar to the research institutes reported in earlier cases. The views of the patent development firm resembled those of the foundation in Case 15, and, the manufacturing subsidiary shared industrial attitudes discussed in Volume II, Part V. These contrasting views help explain, in the context of a single organization, how technology is, in fact, transferred to the marketplace.

Views of the Parent Corporation

Because of the parent corporation's charter, the director of technology of the parent research corporation insists that the possibility of commercially successful inventions arising out of research does not influence his or his colleagues' management thinking. The mission of his laboratory is to solve the sponsor's scientific problem and to approve the general quality of research. If an invention should incidentally result while pursuing this mission, the scientist simply reports it to one of the patent attorneys at the installation. Yet he did feel that inventions in his laboratory arising out of industrial research were more likely to be utilized commercially than inventions arising out of government-sponsored research, unless the latter were specifically related to the statement of work in the contract. The virtual loss of such creativity to science and industry disturbed him, and he was at a loss to understand why the government will not grant limited exclusive licenses to encourage industrial technologists to pursue promising ideas. On the other hand, he could see no particular reason why a contractor in whose laboratory the invention was conceived should require title to pursue further development, since the technological lead implied in the invention should protect against the business risks of development.

The director's attitude is shared by the chief of engineering physics at the parent corporation, himself the holder of almost 100 patents. The chief carries the director's last point a step further. He argues that the more basic an invention the less protection should be required to encourage investors to finance utilization. According to his view, the larger the investment required for utilization, the greater the likelihood that a series of patents will issue on the many engineering breakthroughs which normally occur during the marketing of a product. The necessary patent protection can be obtained through these improvement patents.

Views of the Patent Development Firm

The officers of the patent development concern vehemently disagree with the view of the chief of the various research divisions. A full-time patent attorney will be retained within the next year and will report directly to the president of the institute. His charter will include management of the patent licensing program; licenses are now negotiated by inventors or by staff members in soliciting new research contracts for industry.

The new emphasis on patents attracted 27 disclosures in 1965 and 36 in 1966. No records were available for prior years. There are ten licensed patents in the institute portfolio, two of which arose out of government-sponsored research. The industrial rights to a Department of Defense invention are exclusively licensed; a nonexclusive license has been issued on a second invention, a NASA-sponsored device used in data control machines. The license to the first invention was terminated by the licensee; the license is still active for the second invention because it was closer to the industrial market. (Royalty income was not disclosed.) As a general rule, the institute issues nonexclusive licenses because it is concerned that exclusive licensing might endanger its tax-exempt status as a nonprofit institution.

CASE 15
AN EASTERN PATENT DEVELOPMENT FOUNDATION

The Institution

The patent development foundation was founded to use income from inventions in support of scientific research. Its endowment consisted of patents on an invention donated by the founder and his associates. The endowment which, for tax reasons, was recently conveyed to a fully owned profit-making subsidiary of the nonprofit concern, provides the main support for the foundation's grants and patent programs. Substantial support for these programs also comes from royalties on patents which have been assigned to the foundation by individual inventors and by educational and scientific institutions. In 1957, one-third of the stock of the profit-making subsidiary was sold in the open market. It is contemplated that the remaining two-thirds will be liquidated over a period of time, thus divesting the foundation of its business subsidiary and making it a completely nonprofit foundation.

Government-Sponsored Research

The foundation's own research is centered in its business subsidiary; it confines its activities to grant and patent programs. Approximately 90 percent of the inventions it receives have derived from government-sponsored research at colleges and universities.

Inventions in the Sample

Although it conducts its own research, the patent development foundation is principally known as an assignee of inventions from academic and other nonprofit institutions distinguishing it from the other nonprofit institutions discussed. None of the foundation's eight inventions in the sample were conceived or reduced to practice by it. Three arose out of National Science Foundation-sponsored research at educational institutions; the balance arose out of Department of Defense-sponsored research. They range in technology from a method for imparting energy to charged particles in a nuclear accelerator to an improved lathe chuck.

Two of the inventions have been utilized commercially. A high-pressure press, conceived under an NSF grant, can subject materials to 1.5 million pounds per square inch pressure at temperatures up to 3,000° C. A center adjusting device, which permits work to be centered on a lathe while it is rotating, was developed under an Army contract. The limited commercial use it has seen appears to be declining because the expected market failed to materialize and the invention falls somewhat outside the product line of the manufacturing concern.

Patent Policy and Utilization Philosophy

The foundation avoids any involvement in its client's internal affairs. It does not recommend or discourage consulting relationships between inventors and licensees. It does not tell the university how it could or should share royalties with inventors or otherwise use the proceeds of the invention. And it does not use its own grant program to promote or reward inventiveness.

The foundation, in promoting inventions, offers exclusive licenses for a limited term. It will not sell a patent to industry or grant it an exclusive license for the term of the patent because it thinks it improper to use academic property to foster monopoly and excess profits. It has excellent working relations with industry. It knows its markets, has personal relations with the decision-makers within most of the companies with which it deals, and appears to enjoy a relationship of confidence and trust with them much like that of a bank and its clients.

This foundation probably has more experience with patents from academic and nonprofit institutions than any other organization interviewed during the study. It

In order to avoid a conflict of interests, the institute will not perform the same kind of research for two different customers. Where parallel research appears desirable for financial or technical reasons, the institute secures the approval of the earlier sponsor. In some instances, if the institute has developed a patentable invention under a research contract, the second sponsor will be obliged to pay royalties to the first on the application of the patent to his work.

The institute prefers to keep its own investment in research at a minimum. It fully understands this approach may require it to assign proprietary rights in inventions to the sponsor. It views its primary mission and source of income, however, as sponsored research, and regards royalties as incidental revenue. For its size, therefore, few inventions arise out of internal research and development.

A striking exception to this reluctance to fund is the area of magnetic recording, in which the institute has maintained a dominant position for many years. The royalties from its licenses in this area are used to finance continued research in the art. Because of its established industrial position in this particular case, the institute insists upon retaining proprietary rights in inventions from research sponsored either by the government or an industrial customer. Pointing to its policy of granting nonexclusive licenses, the institute feels that had it not observed this practice in its magnetic recording patents, there might well not have been a competitive magnetic tape recording industry in the United States.

For inventions it owns, the institute normally grants *nonexclusive* licenses whenever possible. The field of fiber metallurgy, in which it holds a basic patent describing a process for sintering metal fibers to form a solid body, is an instance in which the institute has had to depart from its policy of nonexclusive licensing. Institute-sponsored research proved the feasibility of the method and established a proprietary position; it was unable, however, to attract the additional capital required to exploit commercial potential without granting an exclusive license. With respect to improvements in basic patents it owns, the institute does not reserve proprietary rights in order to attract capital to the field of technology. However, it always informs customers of its basic patent position before undertaking sponsored work in the technical area.

The institute shares royalty income with inventors who are on its staff when the royalty accrues. The distribution formula is based on a sliding scale depending on royalty income during a given year. Over the past few years, inventors have averaged approximately 2.5 percent of gross royalties received by the institute for their inventions.

The pressure to publish research results at the institute is far less than in the academic environment. Scientists are retained not as scholars whose principal mission is to publish new knowledge, but as investigators whose purpose it is to produce results for a sponsor. The principal measure of success in the institute is the caliber of research performed for the sponsor. Accordingly, although the institute encourages publication as a part of the scientist's professional development, it may require prepublication clearance of scientific articles if contractual or other obligations dictate. Indeed, confidential reports to industrial sponsors are the rule rather than the exception. Because the stress is on applied rather than theoretical research, a small cash honorarium is awarded to inventors upon the filing of patent applications.

Typically, the kind of invention arising out of government-sponsored research of most interest to research institutions involves a new material on which they can obtain rights and which will attract contracts for applied research. One of the inventions in the sample, a patent on a method of making fine grain chromium, for example, arose out of a contract to develop an improved rocket nozzle.

The institute has been concerned over the opinion held by some agencies that nonprofit organizations are less entitled to patent rights than are industrial organizations because of the "established nongovernmental commercial position" criterion of the Kennedy Memorandum. The institute argues that the distinction inhibits utilization. In the institute's view, the nonprofit organization often has a stronger incentive to license than a manufacturer, since licensing is the only way in which it can profit from its proprietary position.

The institute is disappointed that government agencies are sometimes obliged to act contrary to their best interest in applying their patent policies. In a recent experience, a government agency took title to an invention under the public health and welfare criterion of the Kennedy Memorandum with intent to seek an industrial manufacturer, maintaining that a nonexclusive royalty-free license would be sufficient to secure a manufacturer. The institute, in fact, had already contacted a number of companies, who had declined to enter the field without an exclusive license because of the requirement for a relatively large capital investment in a limited market. If the agency can now induce a manufacturer to supply its demand, it will be only at a premium price for a device which might well have been marketed already, if, by owning patent rights, a manufacturer could anticipate a reasonable return on his investment.

Inventions in the Sample

The institute developed four inventions in the sample:

(i) A telemetering depth-sensing device which transmits sub-surface information to the surface of the ocean acoustically;

(ii) A mechanical vibrator for producing sound waves;

(iii) An impact-energized sound source;

(iv) A sonic surveyor instrument and sonic method of surveying water-covered areas.

Only the last invention has been used commercially.

Developed under a Navy contract, the sonic surveyor is operable from a boat; hence, it has civil engineering applications in the study of deep-sea structures for foundations and tunnels, channel dredging, and oil prospecting. The institute owns the invention and has received gross royalties of nearly $9,000 over the past three years, which are equally divided between the institution and the inventor in accordance with a recently adopted policy. The invention is being marketed under an exclusive contract between the institute and a small technical concern. Licenses have been issued to some of the large oil companies, and the equipment is available on a rental basis.

A second invention which may have commercial application is currently being evaluated at the institute. If it is licensed, it will be the second royalty-bearing patent in the institute portfolio.

Patent Policy and Utilization Philosophy

The basic research orientation of the institute has traditionally precluded patentable inventions, excepting the instrumentation work of a small group of institute scientists and engineers. Some personnel predict, however, that since recent government contracts have been more oriented toward engineering tasks, the patent program will increase if this trend continues. Regardless of these commercial possibilities, far more recognition is accorded a published paper at the institute than a patent relating to the same subject.

The patent committee has been unsuccessful in persuading inventors to reduce their ideas to practice. The inventors lack the time and money, and the institute does not have the funds to support development. The institute does not normally seek the kind of engineering development work required to reduce inventions to practice, but it has discussed establishing a small general fund for such a purpose with the Office of Naval Research. Thus far, no action has been taken regarding the proposal.

The notion of a patent endowment fund to finance prototypes of promising inventions arising out of research contracts is attractive, even though it is beyond the province of a research contract to reduce inventions to practice. Essentially, such a fund would be a government counterpart to royalty funds earmarked for the same purpose by institutions with successful patent promotion programs, such as the university in Case 1.

A number of industrial concerns have moved into the area adjacent to the institute to capitalize on the practical aspects of its research. Two companies have been formed by former employees and, as in Case 10, the transfer of technology from the institute to industry is, in general, achieved more through personal contacts than through licensing.

Management of Patents Within the Institution

Until a few years ago, the patent program at the institute extended only to meeting government contract reporting requirements. Several members of the scientific staff, however, initiated a committee to study the program over a three-year period. Its conclusion was that the institute should have a patent program which could be profitable to both the inventor and the institution. It also recommended that a patent development firm be engaged to manage the institution's portfolio. However, members of the study committee with academic backgrounds were far less interested in establishing such a program than those who had come to the institute from industry. One of the acknowledged reasons for the patent program, which was adopted in 1964, is simply that other institutions have patent programs, and the administration feels that patents are a fringe benefit to the professional staff, much like insurance coverage and retirement benefits.

The institute's contract with the patent development firm gives the institute an option to transmit or withhold disclosures at its discretion. Review of disclosures at the institute involves a technical evaluation by the patent committee to determine proprietary rights in the invention and to elect a mode of exploitation. To date, no patent applications have been filed on disclosures forwarded to the patent development firm. In some instances, when the patent development firm has rejected a disclosure, the institute may still elect to file at its own expense.

An unusual feature of the institute's patent program, shared only with the university in Case 1, is that it divides the net royalty income equally with the inventor. One effect of this generous policy is to discourage submission of disclosures to the patent development promotion at the request of a faculty member but it has no formal program for doing so.

The school of engineering has a rather extensive industrial affiliates program to which companies subscribe. The school regards it as an important means of transferring technology to industry and consequently for promoting utilization of government-sponsored inventions. In the industrial affiliates program, professors consult with subscribing companies, and the school presents symposia to which companies send their scientists to hear the current research of the faculty discussed. The school has stressed the immediate transfer of technology between academic inventors and industry through personal contacts of this sort, without relying on patents. It points with pride to the utilization of patented power tubes and traveling wave tubes which have achieved a high degree of industrial utilization in the adjacent electronics community because of the relationship between the academic and industrial communities, rather than the patents themselves. It believes that the flow of new technology is so rapid and emanates from so many diverse sources that patents play an increasingly smaller role in the development of new products. In this regard, some faculty members argue strongly that the interest and effort of academic inventors are the most important factors in invention utilization. They point out that licensing of patents cannot ensure use of inventions since it may be to a licensee's advantage to delay their development.

University researchers expressed concern over certain government requirements which inhibit communications with industry. One university laboratory which frequently hosts visiting industrial scientists is required to request them to sign government patent agreements. It often encounters refusals because the firms will not release them from existing company agreements. This limits the scope of their technical collaboration and the free exchange of ideas.

Management of Patents Within the Institution

In 1959 the office of the research administrator was established to administer contracts and grants between the government and the various activities of the university. Today there are six professional administrators in the office. Among its duties, the office processes invention disclosures from all departments, except those from the nuclear reactor facility which are processed by the AEC.

CASE 11
AN IVY LEAGUE SCHOOL

The Institution

This ivy league school has a student body of approximately 4,500 and a faculty of 900. The university is considered a liberal arts college although the school awards graduate degrees in all branches of the arts and sciences and conducts substantial research programs in several disciplines.

Government-Sponsored Research

The federal government financed 88 percent of the $31.9 million of sponsored research and development during the fiscal year 1966—somewhat less than the national average for academic institutions with programs of similar size and scope. By the same token, the $5.3 million of internally financed research is somewhat greater than the average.

The federal funds were distributed among the various source agencies as follows:

TABLE 1
DISTRIBUTION OF FEDERAL R&D FUNDS
Fiscal Year 1966

Agency	Dollars (in millions)	Percent
AEC	16.7	60
Navy	2.1	7.5
Air Force	1.5	5.4
Army	.5	1.8
NASA	3.1	11
NSF	2.8	10
NIH	1.2	4.0
Others	.1	.3
	28.0	100.0

Although government-sponsored research has increased by 400 percent in the last decade, it leveled off in 1963 with relatively little change, except in the case of NASA-sponsored research which has only had a

1966 research funds by government agencies appears in Table 1 below.

TABLE 1
DISTRIBUTION OF FEDERAL R&D FUNDS BY AGENCY
(1966)

Agency	Amount ($ in millions)
National Institutes of Health	$ 6.2
Atomic Energy Commission (Medical & Physics)	4.5
Department of Defense	1.5
NASA	0.5
National Science Foundation	1.0
TOTAL	$13.7

Inventions In the Sample

The college's sole invention, a chemical process to convert nitriles to aldehydes, was conceived under a Navy contract shortly after the college established its first formal patent policy in 1949. The invention has never been commercially utilized.

Patent Policy and Utilization Philosophy

There has been enough interest in invention utilization over the years to justify a patent program of sorts—but scarcely enough to sustain a viable program. In 1935 a member of the medical school staff invented a special last for the manufacture of orthopedic shoes. In order to develop the invention, the college created an independent foundation with a broad charter in non-educational matters, including patent management. The independently incorporated foundation issued an exclusive license for a period of seven years to a major shoe company. After the exclusive license expired, additional nonexclusive licenses were granted, some of which were to foreign firms on foreign patents for the same invention. Subsequent modifications of the original invention have, in effect, extended the patent and it is currently used around the world by 14 licensees. In the past 30 years, the family of patents on the orthopedic shoe last has yielded $300,000 in royalties. Royalty income, net of the inventor's share and the expenses of patent administration, is given to the medical school by the foundation to finance research in orthopedics. Two or three additional inventions have been assigned to the foundation in the past 30 years, but none has been licensed.

The publication of the formal patent policy in 1949 was responsive to the increase in the patent and data requirements of government contracts rather than the activities of the foundation. The policy states that "inventions arising out of programs financed by the university are the property of the university, to be disposed of according to its best judgment. . ." ". . .In some instances, in order to encourage the utilization of a discovery which has resulted in a college-held patent, we have granted an exclusive period of use. In general, this is not considered desirable and every effort is made to avoid exclusivity." In addition, the policy acknowledges government requirements by stating that the standard patent provisions of sponsor agencies will supersede any institutional requirements and that the college policy will apply primarily to commercial rights.

There is currently some interest on the part of the administration itself and a few faculty members to revise the patent policy to permit the inventor rather than the university to acquire title to the inventions subject to the patent restrictions of sponsoring government agencies. The institution would retain a nonexclusive license with a right to sublicense others if the governing body felt that the public interest had been adversely affected by the inventor's monopoly. Although this new policy has been formally recommended, it has not been adopted because of insufficient interest among faculty members.

Management of Patents Within the Institution

In 1953, the college established a contractual arrangement with a patent development firm to assist it in evaluating invention disclosures and to promote commercially useful patents. The criterion for assigning an invention to the institution's own patent foundation or to the patent development firm is its commercial potential. Those inventions with a clear potential are assigned to the foundation for direct licensing, and those with a questionable or marginal potential are assigned to the patent development firm. In the past decade, patent applications have been filed on roughly a dozen inventions. One-third of these are in the field of health and medicine; the balance are related to scientific instrumentation, optical, and electronic devices. None has achieved commercial utilization because of unfavorable market conditions and the high development costs of commercialization.

Few of the 1,500 faculty members have expressed any interest in patents which may have been obtained through their research. The college tends to discourage patent development firm to handle its patent portfolio.

Aware that patentable inventions are closer to the practicing arts than to theoretical studies, the university administration has begun to consider the implications of its medical research, a great deal of which is funded by HEW who normally acquires title to inventions developed under its programs. The university is also concerned about the inhibiting effect of the NIH title policy on relations between the pharmaceutical firms and the academic staff. The university has found that the drug firms are reluctant to retain members of the academic staff on a consultant basis if they are also working under NIH grants.

Management of Patents Within the Institution

The university's formal procedure for processing disclosures requires faculty and staff members to disclose inventions to their department chairman. He then forwards the disclosure to the dean of the appropriate school who, in turn, refers it to the office of the vice president for academic affairs. That office is responsible for patent management at the university, and has contracted with a patent development firm to promote university patents.

Under the terms of the agreement between the university and the patent development firm, the inventor receives the first 15 percent of gross royalties and the development firm and the university evenly divide the balance remaining after expenses. This agreement is nonexclusive: The university may, if it chooses to do so, withhold inventions from the firm, and the patent development firm is not obligated to market all the inventions the university submits to it. This arrangement pertains only to faculty members—there is no established policy or procedure governing inventions disclosed by staff or graduate students at any of the university's many research laboratories.

CASE 8
LARGE EASTERN PRIVATE UNIVERSITY

The Institution

The large, eastern private university has a student body of almost 14,000 and a faculty of 4,600. It is a leading institution in both the arts and sciences. Administratively, particularly in relation to invention utilization, the various colleges, divisions, laboratories, and institutes which engage in sponsored research, function as a community of independent activities.

Government-Sponsored Research

In fiscal year 1965, the university received $47 million in government contracts and grants; roughly 36 percent of the $129 million total funds from all sources to all departments. Two-thirds of this federal support went to the faculty of arts and sciences (division of engineering and applied physics) and the schools of medicine and public health. The following table indicates the source (by department or agency) and dollar amount of government-funded research for fiscal year 1965.

GOVERNMENT CONTRACT AND GRANT EXPENDITURES
($ in thousands)

Department of Health, Education, and Welfare	
Public Health Service	$23,344.6
Office of Education	2,523.4
Social Security Administration (Welfare Administration)	325.0
Vocational Rehabilitation Administration	4.5
Atomic Energy Commission	7,145.0
National Science Foundation	6,138.4
Department of the Navy	1,670.9
Department of the Air Force	795.5
National Aeronautics and Space Administration (NASA)	2,411.5
Department of the Army	769.3
Advanced Research Projects Agency	843.2
Department of State	841.8
Peace Corps	8.2
Department of Labor	52.6
U.S. Arms Control and Disarmament Agency	88.3
Other	84.7
	$47,046.9
Expenditures for construction and alterations of buildings financed by government funds but not included above are:	
Public Health Service	$1,818.9
National Science Foundation	232.2
Advanced Research Projects Agency	$2,052.8

Inventions in the Sample

The university had no inventions resulting from government-sponsored research during the sample years. In fact, the director of laboratories, division of

CASE 6
A WESTERN TECHNICAL INSTITUTE

The Institution

This western technical institute with fewer than 2,000 students and a faculty of slightly over 500, is one of the leading technical schools in the country. Its college of engineering and departments of astronomy, physics, and astrophysics are world famous. The school awards undergraduate and graduate degrees in most subjects, but specializes in the physical sciences and related technology. The institute operates a major laboratory for the U.S. Government.

Government-Sponsored Research

Excluding funds for the major government laboratory, the government funded approximately $12 million (90 percent of the total research funds received by the institute) in research in all scientific departments at the institute in 1966. Table 1 breaks down this amount by source and by percent of total.

TABLE 1

Agency	Percent of Total Funds
Department of Defense	26.5
Atomic Energy Commission	23.9
Health, Education, and Welfare (Public Health Service)	20.0
National Science Foundation	17.2
National Aeronautics and Space Administration	11.2

Table 2 indicates the total amount of government funding to the institute (including the government laboratory) for the 12 years from 1954 to 1966 as well as the patent activity at both the institute and its government laboratory during this period.

Inventions in the Sample

The institute had five inventions in the sample, all attributable to on-campus government-sponsored research. Two of the five patents have been licensed to commercial firms and have returned a modest royalty.

The first patent—covering a paper tape recorder which can record information on ten channels simultaneously and can make 20 measurements per second per channel—arose from an Air Force contract. A commercial licensee was willing to invest funds in further development of the invention and paid a nominal royalty for an exclusive license. The product was not well accepted commercially, however, and royalty returns have been negligible.

A second patent, which made special use of a new porous material, was one of three conceived under an Army contract. The basic patent (not covered in the sample) is a method of manufacturing a porous wall filter, and the sample patent, an application of the basic patent to the construction of turbine blades, represents a significant advance in technology. The three patents were licensed as a group and yielded royalties of $3,100 in fiscal year 1966, $6,100 in fiscal year 1967, and $2,200 in the first quarter of fiscal year 1968. The full dollar value return on utilization of the inventions is not known since the government is the largest customer for these blades and it has a royalty-free license to the patent.

TABLE 2

	Total Government R & D Funds	Patent Applications	Patents Issued with Title at Institute	Patent Applications Licensed	Patents Licensed
1954	$ 12,385,000	1	3	1	1
1958	36,911,000	3	4	1	1
1963	182,322,000	3	2	0	0
1964	250,615,000	3	1	2	1
1965	245,843,000	11	2	1	0
1966	255,657,000	10	5	2	2

government itself might have filed suit on the invention with the same outcome, the institute stresses that the patent owner with a commercial position at stake is likely to fight hardest to protect his interest, protecting, in turn, his licensees.

The institute's principal objection to acquisition of title by the government is that it discourages the pursuit of worthwhile projects. Commercial application of government-sponsored inventions will not be pursued unless an individual is financially interested in doing so. Institute personnel remarked that even their own licensing agent was not fully convinced of the inherent potential of the computer memory invention. They assert that the motivation to promote new technology decreases rapidly as one gets further from the inventor himself, and that commercial utilization is best motivated by allowing the inventor or his organization to hold title to his inventions.

Management of Patents Within the Institution

The institute regards itself as rather low-keyed in encouraging invention, notwithstanding its success in generating royalty income. It has no program to encourage disclosures within the institute or in any of its affiliated research laboratories. As elsewhere in the academic world, publishing of results is more important than acquiring a patent and, except as may otherwise be required by contractual obligations, there is no policy to urge inventors to file applications within one year after publication. The staff members who work most closely on government contracts are the most patent-conscious, apparently stimulated by the disclosure obligations of the contracts.

CASE 4
A SMALL EASTERN TECHNICAL INSTITUTE

The Institution

This eastern technical institute enrolls about 5,000 students and has a faculty of 500. The faculty is more oriented toward applied technology than are other institutes studied. Institute graduates are frequently the main line engineers and technicians employed by industrial firms.

Government-Sponsored Research

All of the $4.5 million of sponsored research at the institute in 1966 was financed by the federal government. The Department of Defense was the institute's principal customer. No further information on the volume or distribution of sponsored research funds was available.

Inventions in the Sample

The institute has four inventions in the sample, all arising from DOD-sponsored research. Three of the inventions are electronic and the fourth, a material used as a separator in dry cell batteries, is chemical. Two of these discoveries have been utilized: a dielectric coating for single wire transmission lines, and a process for measuring electric characteristics by using an oscilloscope in connection with special transmission line junctions. Both of these inventions, derived from research during World War II, were originally assigned to the PRD Corporation, which was established as a fully owned subsidiary of the institute to manufacture and sell precision measuring instruments. It is no longer possible to ascertain whether the utilized inventions produced any royalty income.

Patent Policy and Utilization Philosophy

The patent policy of the institute requires full disclosure of any invention conceived or reduced to practice by an employee unless, in the case of faculty members, the invention is not made in connection with assigned duties or is made using facilities outside the institute. In practice, the institute feels that little is to be gained financially from patents and that prosecution of patents is hardly worth the effort. At one time, the institute held a number of foreign patents, which it has since abandoned to avoid annual maintenance fees.

The lively interest in invention utilization which existed after World War II appeared to have all but vanished when the institute sold its subsidiary, the PRD Corporation, to a large lithographic company in 1957. The principal reason for the sale was to acquire cash for expansion. In the decade since, institute interest in patents has dwindled. As one administrator put it, "The current academic approach is to publish."

The institute has standard agreements with the two leading patent development firms, and has submitted one or two disclosures a year for the past few years, with no results to date. One invention, however, is believed by the development firm to have licensing potential.

With the exception of the patent development firm discussed in Case 16, below, this institute is the only nonprofit organization interviewed which formed a profit-making company to utilize its inventions; in this respect, it is unique among the academic institutions we studied. It was not possible, however, to explore the commercially, to the knowledge of the vice president for academic affairs.

Patent Policy and Utilization Philosophy

The university's published patent policy, last revised in 1950, is incorporated by reference in a general clause in faculty contracts. Faculty and staff do not sign any form of patent agreement.

The university has standard agreements with two patent development firms. Under these agreements, the inventor is entitled to 15 percent of the net royalty of any licensed patent. The university's share of income derived from patents is to be used to further the research functions of the university. In accordance with its published policy, university employees are encouraged to disclose discoveries which could lead to patentable and valuable inventions and which are the result of research work involving university time, laboratories, or other facilities.

The vice president felt that there is no incentive to file patent disclosures or otherwise to identify inventions if the government takes title. Under those circumstances, it is easier to report findings to the sponsoring agency and leave it to the agency to determine if anything in the report constitutes invention. There was no evidence of any university policy or practice, however, which provides any greater incentive to report disclosures in the case of nongovernment-sponsored research.

Management of Patents Within the Institution

The dean of the graduate school is chairman of the patent committee, which meets irregularly. The committee stands ready to resolve any conflicts that may arise from the consulting which the faculty are allowed to do. Except for occasional instances, however, when it has reviewed an agreement between a faculty member and a commercial chemical or pharmaceutical firm, the committee has not been active. The vice president regards this inactivity as regrettable and feels that the failure to invent is due, to a large extent, to lack of awareness in faculty members of the possibilities for invention in their research work. A few faculty members are believed to have left the university to join a commercial firm in order to exploit inventions inherent in a course of research, but none of these instances has involved government research.

The dean's office is also responsible for the administration of sponsored research through an office of research services. The dean is to report to the vice president on matters pertaining to government-sponsored research, and is to disclose any inventions that may arise from it.

The vice president does not think that public and private universities should have any differences in policy with respect to utilization of inventions. The policy for both should be maximum exploitation, with the encouragement of such federal laws and university regulations as will achieve it. It does not appear, however, that the university is about to undertake any program to increase its invention activity or utilization.

CASE 3
A LARGE EASTERN TECHNICAL INSTITUTION

The Institution

This private eastern technical institution has 7,500 students and a faculty of approximately 1,500. In recent years, it has strengthened its liberal arts program in an effort to train well-rounded scientists. It operates several scientific laboratories for the government and is a principal government contractor in its own right.

Government-Sponsored Research

In its 1967 fiscal year, the institute received approximately \$50,600,000 in total sponsored research funds. A major part of this total—\$45,300,000—came from various departments of government and was distributed among the several schools and institute laboratories, as set forth in Table 1, below.

Inventions in the Sample

The institute had 63 patents in the sample, 53 of which were issued in 1957 and 10 in 1962. All arose out of Department of Defense contracts. The institute retained title to 10 of the inventions and waived its title rights to the balance, which it felt had no commercial significance. Seven of the patents which the institute retained concerned electronic devices; the others covered chemical processes. To date, these inventions have not been licensed. However, the institute's patent administration office is optimistic about eventually licensing at least six of the ten patents.

All of the inventions were advances in the state of the art far beyond any current industrial utilization. In one instance—a process for making new alloys for high-temperature applications—the institute noted that licensing is imminent; however, the patent has fewer than five years to run. In another case, involving a guidance system for supersonic aircraft, a literature

Efforts to license were made for only four inventions in the university sample: a sophisticated electronic device which could be used to detect the direction of underwater sounds, two discoveries concerning sewage treatment, and a method for making a derivative of morphine. The research in the first case was funded by the Department of the Navy; the research for the other three inventions was funded by the United States Public Health Service. In each of these cases, the patent administrator stated that, although he was making an effort to license the inventions, he did not expect any commercial utilization of them.

Patent Policy and Utilization Philosophy

The university patent policy was originally adopted in 1943. Its history is marked by two significant milestones. In 1952, a patent fund was created to invest accumulated earnings of university-owned inventions to provide an income for financing patent expenses and research activities; and, in 1963, a program of mandatory assignment of all inventions to the university was adopted, in consideration of a liberal division of royalties with the inventor.

Prior to 1963, the assignment of patent rights to the university was optional. The inventor could, in many instances, retain his own invention and finance its patent application, or even abandon the invention to the public domain. Royalty distribution from patents was then based on a sliding scale. Under the 1963 policy, however, 50 percent of the net royalty received by the university was to be awarded to the inventor. Since the adoption of this policy, disclosures have increased by 600 percent.

At this time, the university has approximately 50 active licenses outstanding which yield an average net royalty of approximately $130,000 per year. Although the university has the power to waive its rights to title to an inventor, a waiver is never granted if the university elects to file patent application. Even if the university does not elect to file, a waiver will ordinarily be granted only when there is clear evidence that the invention was conceived and reduced to practice outside of the inventor's scope of work and without university funds or facilities.

As a matter of policy, the board of patents will file a patent application only if it is likely that the costs of prosecution will be recovered through utilization and there is a reasonably foreseeable market for the invention. Prior to the 1963 policy change, the university followed a broader filing policy.

This institution has one of the most active patent utilization programs in the study. It relies largely on the professional contacts of the patent staff and the relationships of the inventors to the commercial community. The staff sends occasional mailings to manufacturers regarding inventions that may be of interest to them. In fact, the disclosure form used by the patent staff asks the inventor to suggest manufacturers in the technical field of his invention. Lists of inventions are made available to interested segments of industry. Publications by the inventor are often solicited by industry and accommodated by the university patent office.

The licensing policy of the university is as aggressive as its prosecution policy. The executive staff of the patent board actively solicits industrial interest in university activities, keeps abreast of technical developments in industry, attends trade meetings, and engages in a variety of promotional activities. When a license is negotiated, the agreement invariably contains a due diligence clause, which obliges a licensee to work the patent or risk the loss of the license. In addition, the university demands a payment of "earnest money" upon execution of a licensing agreement. This amount may range from $500 to $10,000 and is not regarded as an advance against royalties. Most of the license agreements contain a minimum royalty clause.

As a public institution, the university feels that it has a primary obligation to the public to maximize utilization of its inventions. In licensing matters, the university will refuse to issue exclusive licenses for the entire life of a patent and their licensing standards are based upon maximum utilization rather than maximum royalties to the licensor.

The university cites two examples of their policy in action. In one case, a multivibrator circuit, conceived and reduced to practice under an Atomic Energy Commission project, has been licensed on a nonexclusive basis to a small company since 1959 and has paid over $2,000 in royalties to the university. Another invention, a mechanized tomato harvester, developed without federal funds, is credited with saving the tomato industry in the state. The university solicited bids for an exclusive license from several companies and awarded the license to a small concern, which successfully engineered and marketed the machine.

The university contrasts success of the tomato harvester with their lack of success in licensing a peach harvester. A peach harvester was co-invented by the university and an employee of the Department of Agriculture, and the Department of Agriculture acquired title to the invention. Many industry inquiries have been received by the patent board, but when the inquiring firms learn that the government owns the patent to the harvester, they lose interest. Further investment is required to perfect the apparatus and the patent board has not been able to find companies willing to make that indication of unworthy commercial motives. All but one of the educational institutions interviewed declared that publication of research results is preferred even if, by doing so, patentability of an invention is endangered.[4] Thus, we found that perhaps the single most difficult task of a university patent administrator was the solicitation of invention disclosures. Even if the inventor was willing to cooperate in the utilization process, it was a familiar story that the university patent office only learned of the invention eight months after publication in a scientific or technical journal.

Since, under the present law, patent applications must be filed within one year of public disclosure of the invention or the patent will be banned, patentable ideas are frequently lost to an institution's portfolio. The universities, however, have never considered the industrial alternative of delaying publication until a patent is filed, resting on the comfort of one year within which to file an application. Should the Patent Reform Act of 1967 become law, this grace period will be eliminated and first filing will be conclusive evidence of first invention. The conflict between publishing and patenting will then become critical. If government regulations require disclosure to the government prior to the publication of findings, a serious question of academic freedom may arise.

The college officials in Case 10, below, proposed that the government agencies retain an option to prohibit publication during a contractual evaluation period rather than require clearance prior to publication. This proposal is particularly timely since, if prior clearance by the government is delayed, patent rights may be forfeit under the Patent Reform Act of 1967. A subsequent inventor who is first to file would preempt the university invention.

While nonprofit institutions actively disseminate technology through publication, promoting utilization of a specific invention is another matter. Given the academic preference for publication of research results over patenting them, a major problem exists in mounting an effective patent promotion program. As the cases illustrate, except for a few universities and technical schools, there is today little active promotion of patents by academic institutions.

Notwithstanding the low-key promotion of inventions by academic institutions, the critical question concerning utilization is whether patents would be promoted more effectively through government ownership, given their speculative utility. Research indicates that the mission-oriented government agencies–DOD, NASA, and AEC–would promote patents largely through publicity. These agencies would not, as a rule, develop inventions beyond the agency mission expressed in the contract. Chance, then, determines the utility in the commercial market of inventions that are in that state. In most cases, substantial private development is required to commercialize patents, and the nonexclusive license the above agencies would offer may not compensate for the development risks involved. Allowing academic and nonprofit institutions to keep title, under these circumstances, offers greater flexibility in providing patent protection to interested developers, when that is necessary to achieve utilization. Title also motivates the inventor to assist in developing the invention for commercial use, because of its potential rewards to him.

Inventions of public service agencies–such as TVA, HEW, and the Departments of Agriculture and the Interior–may differ from the inventions discussed above in two important respects: their close alignment with commercial needs, and their greater agency development and promotion for public use. Appraisal of public service agencies[5] and their promotional programs suggests that TVA and Department of Agriculture inventions have a good chance of utilization if these agencies retain title, and invest in invention development and promotion. HEW and Department of the Interior inventions, on the other hand, require strong patent incentives for industry because of high product development costs and minimum agency development and promotion. For these inventions, commercial utilization would appear to be better promoted by allowing academic and nonprofit institutions to retain title.

CASE 1
A LARGE WESTERN STATE UNIVERSITY

The Institution

This western state university is among the largest in the country. It awards graduate degrees in almost every subject in which a graduate degree may be earned, and operates several scientific laboratories for various agencies of the government.

Government-Sponsored Research

In 1966, the university received almost $78 million in grants and contracts from a multitude of government agencies, a sum which does not include the operating expenses of laboratories administered for the Atomic

[4] Case 1, below, is a qualified exception to this rule.

[5] See Volume III, on government efforts to promote utilization.

Expectation of large returns, which appears to be a principal motivation behind the upsurge in patent interest among nonprofit organizations, is not likely to be fulfilled for many of them. At best, a well-organized patent program, using the personnel required to meet reporting commitments under government contracts, may expect to reap a modest return for a nonprofit organization.

2. Transfer of Technology in the Nonprofit Environment

Inventions arising out of nonprofit research do not travel the same route to commercial utilization as inventions arising out of industrial research. While there is much variation in the policies and practices of educational and nonprofit research institutions, we found more similarities than differences among them when contrasted with industrial commercialization practices. The nonprofit institutions do not make or sell the products and processes embodying their inventions and must license these inventions in order to have them used. Therefore, these institutions have evolved a variety of licensing techniques to transfer technology from nonprofit research programs to the marketplace.

Some colleges and universities, such as those discussed in Cases 1, 3, and 6, below, have their own licensing programs. These programs call for processing patents through special administrative units that are responsible directly to the administration of the senior policy-making group in the institution.

Other colleges and universities administer patents as a part of the routine duties of established offices and faculty committees. At the state university discussed in Case 2, below, for example, the dean of the graduate school is chairman of the patent committee. An office of research services, which is responsible for administration of sponsored research, provides the necessary administrative support. Here, as in other institutions which lack formal licensing programs, the administrative arm of the school ensures that pertinent institutional regulations are observed, that there is compliance with invention-reporting requirements of government contracts, and that the rights of the parties involved are guarded in the rare case of a decision to patent an invention.

Many educational institutions administer patent programs through independent foundations, for various legal, financial, and policy reasons that are only occasionally related to invention utilization. In these instances, the invention is assigned to the foundation either by the institution or by the inventor himself. The technical institute in Case 6 and the liberal arts college in Case 9 administer their patent programs in this way. The reasons for establishing such foundations include:

- Insulating patent funds from use by the state agency, or even by the university itself, for purposes other than financing scientific research;
- Creating a buffer between the nonprofit institution and industrial licensees in the event of litigation;
- Limiting contractual and tax liabilities;
- Providing a degree of flexibility in relationships between the nonprofits and industry not possible with the nonprofit institution alone;
- Facilitating a continuing relationship between the inventor and the licensee in order to develop the invention.

In many instances, a patent administration foundation was created to relieve the institutional administrative staff of the complicated and time-consuming technical and commercial problems of patent management. However, as additional duties were delegated, a number of the 50 to 60 such foundations retained patent development firms like those discussed in Cases 15 and 16, below, to manage their patent portfolios.

The principal agent for the transfer of the patentable products of nonprofit research to industry is the patent development firm. Of the 349 institutions described by Palmer,[3] 212 have contracts with patent development firms; in our investigation, all but three of the institutions having patent programs were also found to have contracts with such firms. Some patent development firms serve a restricted clientele or a limited technological market. Only three firms offer their services in invention marketing to all educational institutions, foundations, and nonprofit research corporations. The services of patent development firms include:

- Evaluation of disclosures.
- Assistance in preparation of patent applications.
- Promotion of inventions.
- Negotiation of licenses.
- Distribution of royalties.
- Policing the patent.

The firms act as a clearinghouse for the nonprofits and as a marketplace for industry. Patents are typically assigned to the patent development firm on a royalty-sharing basis. Patent applications are filed on approximately 10 to 15 percent of the disclosures submitted and, if present circumstances continue, only one-quarter of these patents will ever be licensed.

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[3] See footnote 1, page IV-6, above.

FIGURE IV - 1
INSTITUTIONS AND AGENCIES
THEIR INVENTIONS, UTILIZATION, AND GOVERNMENT FUNDS

Case Number	Institution	Number of Inventions in Sample	Number of Utilized Inventions	Government-Sponsored R&D Funds–1966 ($ in millions)
1	A Large Western State University	53	4	$77.8
2	A Smaller Western State University	1	0	4.2
3	A Large Eastern Technical Institution	63	6	45.3 (1967)
4	A Small Eastern Technical Institution	4	2	4.5
5	A Midwestern Technical Institute	1	0	2.7
6	A Western Technical Institute	5	2	12.0
7	A Big-City University	1	0	12.5
8	A Large Eastern Private University	0	0	47.0
9	A Smaller Eastern Liberal Arts College	1	0	14.5
10	A Large Western Private University	10	0	33.0
11	An Ivy League School	2	0	28.0
12	An Eastern Research Institute	4	1	8.4
13	A Midwestern Research Institute	19	1	21.4
14	A Western Research Institute	1	0	44.2
15	An Eastern Patent Development Foundation	8	2	N/A
16	A Western Patent Development Firm	11	1	24.0
	TOTAL	184	19	$379.5

of inventions each institution or agency held in the sample, the number of inventions licensed by the institution or agency, and the amount of government funds made available to these organizations for research and development activities.

1. Selection of Institutions

a. *Colleges and Universities.* A representative of virtually every type of accredited educational institution was included in the study, as noted in Figure IV-1, above. Some characterization of the organization is suggested by descriptive case titles, although all remain anonymous in the report. Specifically, our sample, derived from every part of the United States, included large and small state universities, large and small private colleges and universities, institutions with a mainly technical orientation, institutions with a mainly liberal arts orientation, and city colleges. In the selection of individual institutions for detailed investigation, we attempted to preserve the diversity of the total sample.

b. *Nonprofit Research Organizations.* The nonprofit research organizations in the sample shared the characteristic of being assignees of government-sponsored inventions. Those organizations selected for in-depth investigation—including the patent development firms—shared the additional distinction of conducting or being intimate with scientific research. The case studies include university-affiliated foundations; foundations created by industrial associations to conduct product research (on such subjects as meat, paper, and gas); single-purpose research corporations investigating a portion of the human anatomy, a specific field of technology, or a disease cure; and charitable trusts with broad charters. While some of the organizations are very small, others are among the largest research institutions in the world.

c. *Institutions Not Covered in the Sample.* In selecting cases for investigation, care was taken not to include those institutions involved in health research which might have been reported under an earlier study task (see Volume II, Parts II and III). We have also tried to avoid duplicating research conducted by Donald S. Watson and Mary A. Holman in "An Evaluation of NASA's Patent Policies at George Washington University," 1966. Finally, because of their independent character, the large mission-oriented laboratories operated by universities for the government, such as

PART IV: Patent Utilization by Universities and Nonprofit Organizations

LIST OF FIGURES

feasible for household use in areas having water with high alkali content.

After 1960, the AB Company made no further attempts to commercialize the invention, after a decision to devote itself full-time to engineering construction. When the company sold its manufacturing division, about five years later, the rights to the invention reverted to the inventor.

Comment

The failure of this invention to achieve greater commercialization must, in large measure, be attributed to its failure to live up to technical expectations. Patent rights do not appear to have played any significant role in the technical and management decisions preceding the demise of the invention. Although one may speculate about the influence of patent rights in marginal cases, this case illustrates that rights in an invention are never more highly regarded than the invention itself. Without an acceptable level of commercial potential, a patent generally holds little interest for the prospective user.

CASE 24
SOLAR STILL

Background of the Invention

This invention is a novel and inexpensive method of building collapsible solar energy-powered distillation units (stills) for use in desalinating water. The stills are made of a single, transparent plastic sheet, supported by wire or plastic structural members, and containing a saltwater tray and a freshwater reservoir, or well, placed inside. Suitable inlet and outlet piping is provided for saline and distilled water. This invention represents a real improvement in the state of the art of solar stills, because those that had been developed previously had been built of such expensive materials that the cost of large-scale use was prohibitive.

The still was developed by the ABC Company in 1957 under contract to the Office of Saline Water (OSW) as a result of OSW-sponsored research and development efforts to find an inexpensive means of desalinating water in substantial quantities. The patent was applied for in 1957 and issued in 1961, when title to the patent was assigned to the ABC Company, and a royalty-free license was issued to the Department of the Interior.

Private Development and Commercial Utilization

There has been no commercial utilization of the invention disclosed in this patent, and there has been no further research and development beyond the initial OSW development contract. ABC has, however, sought further support to pursue commercial utilization from the Departments of the Interior and Agriculture.

The ABC Company feels that in an application such as farming, where an overwhelming percentage of water supplied to the crop is lost in evaporation, this invention has merit. If crops could be grown in the well or reservoir of the still, there would be little or no evaporation, and such efficient use of the water would make the stills cost competitive with other methods of water production.

Accordingly, ABC has sought further government funding for development and a pilot installation, since it does not, as a matter of policy, engage in manufacture on its own account. The Department of the Interior expressed the belief that the still process would be uneconomic, and that this application was, in fact, a "greenhouse" effort and, therefore, its funding should come from the Department of Agriculture.

ABC Company feels that since the Department of the Interior has been granted a license, it should be willing to participate in the development that would be necessary for commercialization. The effort would cost approximately $1 million. As yet, no other license applications have been received, but the company would handle such requests on a royalty or fee basis.

Comment

This is a case where the government has developed an invention only to the point of demonstrating technical feasibility. The contractor, with the idea and the rights, does not have the type or size of organization necessary to pursue development, production, and marketing. Commercial utilization, in this case, is effectively blocked for two reasons: First, the developing firm is unable or unwilling to continue engineering development and, second, the invention falls between the responsibilities of two government agencies, and is not clearly applicable to the mission of either. OSW has, however, continued to sponsor other research on solar stills.

CASE 25
SHALE OIL PROCESSING

Background of the Invention

The invention is a method for the destructive distillation of oil shale which involves decomposing organic matter in the shale by means of heat, vaporizing the oil components in this matter, and condensing these components into marketable crude oil. Of four potential commercial processes for shale oil production, this process, known as the gas combustion process, requires royalties) reimbursed OP for its investment. The government was also granted a free license for a demonstration plant and royalty-free licenses under any foreground patents with OP obligated to grant licenses to all qualified applicants who wanted to employ the process under the background patents.

OP Company continued its work under the agreement outlined above. Although distillation appeared to be outstripping the hydrate-forming process as a purification technique, the government also continued development of the hydrate process; to advance this program, the government financed a pilot plant, which OP Company built and operated.

A problem arose when the OSW, negotiating a contract for operation of the plant decided not to reimburse OP for some costs which the government considered disallowable. The government also requested a royalty-free license under two background patents, which the company refused to grant.

The OP Company position was that the Saline Water Conversion Act does not require a government contractor, regardless of whether he is investing his own funds or not, to grant a royalty-free license under a background patent. The firm believes that improvements resulting from government-sponsored work should be freely available to the public, but if these improvements are dominated by or require a license under the contractor's background patents, such a license *can* bear a reasonable royalty. OP Company felt that it should continue research work at the pilot plant on the basis of the patent clause agreed to in 1963, with full reimbursement for the work done.

The OSW contract expired in 1965, but OP personnel stayed on at the pilot plant until mid-1966. The final breach between the government and OP came later in that year, when the government stated that since it had not been given a royalty-free license under the background patents, it would seek another contractor for the work.

OP Company negotiated for a year on the fee for the pilot plant staff. The final decision resulted in a loss for OP. The cost to the government for the total effort exceeded $1 million, while OP had invested about half that sum. The government has contracted with two companies to jointly run the pilot plant that OP Company built. Under another contract, a small firm holding a similar patent has built another pilot plant next to the original one. OP Company is watching carefully for any infringement of its patent rights, but no infringement claim is possible unless the process is commercially utilized, which OP does not expect until after its background patent expires, in 1976.

The hydrate process is still not competitive with the distillation process. The OP Company had no basis on which to project costs for commercial purification of water by the hydrate process because it has not tested the process on a large enough scale. However, an estimate of this cost does not compare favorably with the cost of water purified by distillation.

Comment

The OP firm feels that the hydrate process has significant commercial potential, but without a large-scale plant it cannot develop the process further toward commercial utilization. OP is also very patent conscious and appears ready to defend its inventions against unauthorized use by anyone attempting commercial utilization of the process.

Public Law 87-295 states that the Department of the Interior must "conduct, encourage, and promote fundamental scientific research and basic studies to develop the best and most economical processes and methods for converting saline water into water suitable for beneficial consumptive purposes." To carry out its mission, OSW has actively solicited the ideas of men professionally qualified to contribute to the development of desalination technology. However, the Department's patent policy has caused a number of contractors who are capable of major contributions to the field to withdraw because of its attempts to secure rights in background patents. Volume II of the study provides further discussion of this program.

CASE 22
ELECTROLYTIC PROCESS FOR DESALINATION OF WATER

Background of the Invention

This invention is an electrically driven desalination process utilizing charged membranes for demineralization of water. The concept underlying this invention came from the SR Company, a nonprofit research institute, which invested a small amount in the project in 1963. During this period, the Office of Saline Water (OSW) of the Department of the Interior was solicited for funds, and in late 1963 OSW awarded SR a small research contract to develop the process.

Basing its decision on the promising results of this initial development contract, OSW awarded experimental development contracts totaling approximately

DEPARTMENT OF THE INTERIOR
NONUTILIZED INVENTIONS

Case 20: The Mechanical Crabpicker
Case 21: Hydrate Process for Desalination of Water
Case 22: Electrolytic Process for Desalination of Water
Case 23: Centrifugal Compression Distillation
Case 24: Solar Still
Case 25: Shale Oil Processing

CASE 20
THE MECHANICAL CRABPICKER

Background of the Invention

These inventions involve mechanical devices which punch the core out of the body of the Atlantic blue crab and pluck the meat from the core. The devices were developed by the Department of the Interior and were intended as part of a series of machines to automate the crabmeat processing industry.

The production models incorporating these inventions have experienced mechanical problems. Government and industry technical personnel involved in the development do not agree on the reason that the machines do not work, and the problem has been under study for the past two years. Lack of agreement between the government and the industry with respect to who should assume the cost of further development has contributed to the stalemate, and there has been no commercial utilization of the inventions.

A Department of the Interior study conducted in 1963 indicated that there had been virtually no technological change in processing crabmeat since the industry was founded 75 years ago. Crabpicking is largely a family business; many of the pickers are a two- or three-person operation. In the off-seasons, about 40 percent of the crab plants shuck oysters or handle shrimp or fish. There is a minimum of cooperation and communication among the pickers. The industry does not support a research operation or have the facilities for research.

Although competition from Alaska, Japan, and other seafood producers was becoming acute, the situation did not reach a crisis until Congress removed the exemption from the Fair Labor Standards Act that had been enjoyed by the shellfish industries. Faced with rising labor costs, the processors appealed to Congress to assist them to automate, and a special appropriation was made to the Fish and Wildlife Service. The mandate was unique in the agency, which had no previous experience in automation in this area. An extensive survey by the agency concluded that mechanization should be accomplished through the development of four machines to separate and process the crabmeat. It solicited industry for prototype models of two of the machines, a punch which dismembers the crab, and a lump meat picker, which extracts the most valuable meat. A contract was awarded to the BX Corporation to design and fabricate working models of these machines.

Private Development and Commercial Utilization

Subsequently, for reasons apparently unrelated to the contract, the BX Corporation went into bankruptcy, and the contract was terminated. The government awarded a contract on a competitive bid to the CQ Company to manufacture production prototypes in accordance with specifications drafted by the inventor and the Fish and Wildlife Service laboratories. The company compiled with the specifications, but the machines do not work satisfactorily. The government has been trying to interest engineering firms in further private development of the machines. The only firm interested to date, however, has been the CQ Company, which insists that it be given a free hand to pursue a fresh approach with at least some government investment in the project. Its management believes that the failure of the prototype machines is a direct consequence of trying to develop universal components to serve all segments of the industry. Although the company has already invested some private funds in the crabpicking machines, it will not allocate additional capital for development because it has more profitable opportunities in related businesses. Neither the CQ Company nor any of the other companies approached by the government is interested in receiving licenses under the two patent applications filed by the Department of the Interior and currently pending. Thus, there has been no commercial utilization of the inventions to date.

Comment

This case marks an effort by the government to give a small industry a technological boost into automation, an advancement critical to its survival. The average direct cost of production of one pound of crabmeat in 1964 was 84 cents, of which the average picking cost was 27 cents per pound. The minimum wage during the year in

DEPARTMENT OF THE INTERIOR
UTILIZED INVENTIONS

Case 18: Synthetic Mica
Case 19: Low-Temperature Phase Equilibria Cell

CASE 18
SYNTHETIC MICA

Background of the Invention

The patent discussed in this case covers a method of synthesizing crystalline mica. Mica is essential to the electrical and electronic industries where it is used in capacitors, paper, and tubes as a superinsulator, primarily in the form of "glass-bonded mica," a combination of high-quality glass and powdered mica. The product has a wide range of important uses—from improving the safety of electric power distribution in aircraft to improving microwave transmission.

Synthetic mica has advantages as well as disadvantages over natural mica. Although it is chemically more pure, is more efficient as an insulator, withstands higher temperatures (over 700°), and has dimensional stability, synthetic mica costs four times more than natural mica and, thus far, it is not possible to produce crystals larger than 2 sq. in.

Prior to the development of synthetic mica, the United States produced only about 5 percent of its natural mica requirements and depended for the remainder upon India, for the most part, and upon Brazil, whose product is inferior. Because mica is classified as a strategic and critical material—it has many important military applications—and to avoid the possibility of being cut off from its supply in time of national emergency, in July 1947 the Office of Naval Research contracted with the Bureau of Mines, assisted by the Bureau of Ships and the Army Signal Corps, for joint sponsorship and financing of a synthetic mica development program. By June 1953, development had reached the stage where project personnel felt that synthetic mica could be used for glass-bonded ceramics and for fabrication of mica sheet and paper products by a modified process.

At this point in development it was obvious that if synthetic mica were to be substituted for natural mica or were to be used as a new material, it would have to be accepted and manufactured by industry. Consequently, the government, who then held title to all synthetic mica processes, issued licenses to many companies. It continues, however, to conduct limited research in this area at the Bureau of Mines Electrotechnical Laboratory and in cooperation with industry. Among these companies is the AA Corporation, with whom the government drew up a cooperative agreement. In part, this agreement between the Bureau of Mines and AA Corporation stated:

> The Bureau and the corporation will cooperate as hereinafter provided to the end that synthetic mica shall be produced on a pilot-plant scale for the purpose of perfecting operating techniques, evaluating cost of production, and supplying the required quantities of a suitable micaceous material for the corporation's test application.

Under this agreement, the AA Corporation funded the salaries for research personnel and supplied the raw materials while the Bureau of Mines supplied the laboratory facilities for one year.

Private Development and Commercial Utilization

AA Corporation

At the expiration of its agreement with the Bureau of Mines, the AA Corporation decided to set up its own synthetic mica plant. Although the corporation's executives did not make any projections or analyses of the size of the market for synthetic mica at this time, they felt there was very little risk involved in undertaking commercial developments since there was a market for natural mica.

The company developed an improved process for making synthetic mica and subsequently established manufacturing facilities for its commercial production. The AA Corporation applied for the patent rights to the improved process and was issued the patent with a nonexclusive, royalty-free license going to the government. Over the past fifteen years, the AA Corporation has invested substantial sums in the development of synthetic mica—a major part of this in trying to increase the yield of the synthetic product. Although synthetic mica has twice the thermal capacity of natural mica, processing problems limit the size of the synthetic crystal. The company does not license this patent to others in the industry.

U.S. COMMERCIAL FERTILIZER CONSUMPTION
1954 - 1965
(in million tons)

	1954	1957	1959	1961	1963	1964	1965
All Types	22.2	21.8	23.1	24.4	27.4	29.2	30.3
Total Liquid Fertilizer	.56	1.27	2.10	2.76	4.09	4.74	5.35
Liquid Mixed Fertilizer	.03	.24	.46	.58	.78	.88	1.03
% of All Types	0.1	1.1	2.0	2.4	2.8	3.0	3.4
% of Total Liquid Fertilizer	5.4	18.9	21.9	21.0	19.1	18.6	19.3

fertilizers, sales from which account for one-third of total sales. For the ZBQ Company, the sales pattern of the liquid mixed fertilizer, using the first TVA invention, is one of a decreasing annual volume which the company attributes to four factors:

(i) The product's price is not competitive with dry fertilizers;

(ii) The product does not have any better performance characteristics than dry fertilizers;

(iii) The product must be applied with special aerial or ground equipment which many farmers do not have; and

(iv) The product's weight grades are limited as compared to commercially produced high-analysis dry fertilizers.

The effective cost of the dry fertilizer is about 4 percent less than the liquid produced by this process. One other factor which makes this liquid fertilizer less desirable than the dry is that it cannot be enriched with significant amounts of the micronutrients or trace elements such as manganese, iron, copper, zinc, boron, molybdenum, which are essential, although in small quantities, to plant growth. These trace elements can be blended into the present commercial dry mixed fertilizers.

For these reasons, ZBQ sees no significant future market for this production process for liquid N-P-K fertilizers.

ABC Company

The ABC Company is a small firm involved in the manufacture and sale of liquid fertilizer. As a result of publicizing on government work in fertilizers, the president of the firm became interested in liquid fertilizers in 1954, and he began part-time research to develop a liquid N-P-K fertilizer. A patent search was initiated, and a number of TVA patents relating to liquid fertilizer were identified. The two sample patents and an earlier TVA patent provided him with technical information which, combined with his own ingenuity, brought about a significant technological breakthrough in the state of the art. This firm claims it has invented a process, at minimal cost, to produce liquid N-P-K fertilizer of 9-18-9 or 10-20-10 grades which contains not only the primary nutrients (N-P-K) but the secondary elements (calcium, magnesium, and sulphur) and the trace elements as well. This has been accomplished by combining the critical aspects of each of the three TVA processes in such a way that each element will remain in solution.

To carry development further, this firm found that applying this fertilizer directly to the plant foliage, at the right time and in the right quantity, was more successful than applying it to the soil. Field test results indicate that a soybean crop will yield 47 bushels per acre with the application of one half-gallon of this product per acre as compared to a 32-bushel per acre yield with dry fertilizer.

This firm feels it faces only the limitations of its ability to market this product and to generate resources to expand. Even though this firm is sure that it possesses a patentable process, it refuses to apply for a patent, its principal reason being that it feels that chemical patents disclose more than they protect, and the resources required to protect itself against larger firms who might infringe are not at its disposal.

The R Association

In 1959, a TVA representative came to the R Association with the process for manufacturing liquid fertilizer from materials comprising ammonia and wet process phosphoric acid. The R Association, a cooperative whose fertilizer sales comprise about 5 percent of total sales, considered the process worth investigating so it requested a license under the TVA patent. Two subsequent low-cost studies undertaken two years after, grades of fertilizer manufactured within the existing cost framework of the industry.

In addition to these economic factors, until the mid-1950's considerable surpluses and lack of former education in use of fertilizer tended to retard the use of fertilizers in agriculture. As a result, the industry stagnated—with low profits, low return on investment, and little interest in risking capital. The only serious research and development of fertilizer technology was done at the TVA Development Center at levels of about $2 million per year for basic R&D and additional expenditures for experimental production of fertilizers for educational programs.

Demand shifted, however, and the TVA announcement of its invention came at a time when world food shortages were beginning to be sensed. Also, rising labor costs caused the farmer to try to increase crop yields—for which he needed more efficient fertilizers. As a result, fertilizer companies gradually converted to continuous production, with mixed fertilizers predominating. The impact of the TVA inventions on this situation is described below in brief reviews of its effects on several fertilizer producers and equipment suppliers who typify the industry.

The LM Company

This small company, a leader in innovative equipment for the fertilizer processing industry, was attracted to the TVA invention when it was demonstrated at the TVA Development Center. The company applied for a license to build and sell the equipment, although no marketing analysis was done. The firm installed the first TVA ammoniator in a plant operated by a local farmers' cooperative, without any additional engineering development.

The ABC Fertilizer Company

This medium-sized company was faced with bankruptcy in 1955 because of its inability to meet customer demand for higher analysis fertilizer products that did not cake. As a result, the firm installed the ammoniator-granulator process, without further engineering development. ABC fertilizer became the first supplier to the South of a granulated, homogeneous, mixed fertilizer product. The material won immediate acceptance, and the firm continues in business as a major supplier of mixed fertilizers.

The P Organization

P Organization, another medium-sized producer, experienced the usual problem of caking when it tried to produce higher analysis fertilizers in response to the demand in the early 1950's. P Organization began using the TVA ammoniator process with no additional development effort. Two P Organization process plants at the same site are now successfully producing high-quality granulated materials, using the TVA process.

The Q Chemical Company

The Q Chemical Company did no further development work on the TVA process, but simply determined capacity requirements and ordered equipment from suppliers to the industry. Ammoniators are currently in use in all its mixed fertilizer plants.

Comment

This case represents a situation in which the government agency developing the invention takes an active role in promoting utilization far beyond simple announcement of its availability. The agency's charter and its basic goals and objectives provide active motivation not only to support technical research and development in fertilizer technology, but also to promote the use of fertilizers and improved agricultural techniques among the farmers.

The fertilizer industry, by its own admission, has been behind in technology, inflexible, and unwilling to adjust to change. The low intrinsic value of the product, high transportation costs, social pressure against the use of the material, and general conservatism among the ultimate users of the products caused the industry to stagnate to a point at which investment capital was withdrawn to more fruitful areas. TVA's entry on the scene in 1933, with its businesslike approach to product requirements and practical promotion of technical developments and inventions, helped break down this negative pattern and pave the way for the advancing technology and production capacity that is available today.

Government R&D in this industry was essential because industry R&D did not exist. Government promotion of new ideas was also essential because industry was reluctant to accept innovation and invest in new plant equipment. The transfer of technology involved in the inventions described above was direct and immediate because their development occurred at a time when market demand for a high-analysis fertilizer material was beginning to swell, and existing technology could not cope with production problems. The invention had dramatic impact, changing the entire industry from one of batch processing to more efficient continuous production. All aspects of the process were developed

Private Development and Commercial Utilization

As far as either the USDA or the inventor knows, the invention has not been commercially utilized. The USDA cannot be certain that the invention is not being utilized, however, since often it is not informed by industrial firms when they are working on something that it has patented.

An executive of EURDD indicated that the reason that licenses are not taken out on the USDA inventions is that companies do not want their competitors to know what they are doing. For example, an epoxidized oil invention, patented 10 years ago by the USDA, had no known utilizer until a large company filed an infringement suit against a company that had developed an improvement to the process. When news of the infringement suit became public, eight other companies applied for licenses.

Comment

In this case, the USDA apparently patented one result of a basic research program which, although not commercially significent, had the effect of disclosing, and, perhaps encouraging, similar chemical research efforts at two industrial laboratories. Whether this particular invention is being used cannot be verified. It is interesting to note in connection with this case that government-owned patents may frequently be used without a license from the sponsor agency. Thus the full use of such inventions cannot be documented through government records alone.

TVA
UTILIZED INVENTIONS

Case 15: Mixed Fertilizer Process
Case 16: Liquid Fertilizer Processes
Case 17: Superphosphoric Acid

CASE 15
MIXED FERTILIZER PROCESS

Background of the Invention

This invention involves a chemical process and the associated processing equipment for the production of high-quality dry fertilizers. The invention improves the process of manufacturing mixed fertilizers by providing for continuous ammoniation and granulation of various fertilizer materials. When potash is added, a honogeneously mixed, granulated particle containing nitrogen, phosphorus, and potassium (N-P-K) is produced.

The invention was developed in the early 1950's as part of an in-house TVA effort to improve procedural steps in processing chemical fertilizers and to upgrade the quality of the product. Heretofore, ammoniation had generally been done on a batch basis, resulting in loss of ammonia material, inadequate ammoniation, high production costs, and poor quality control. Although granulation techniques had been developed by the Department of Agriculture and TVA as early as 1935 and were in use in a number of fertilizer plants in the United States, these techniques required special equipment and numerous processing steps. Continuous ammoniation was also being done in some of the newer plants as early as 1948, but this process, too, required special equipment and careful control. The extreme simplicity of the TVA concept, plus the combination of continuous process flow with simultaneous ammoniation and granulation, made the invention a significant technological breakthrough.

TVA applied for two patents, which were issued in 1956. One patent covers the principles of the continuous ammoniation process, and the other covers basic design features of the ammoniator-granulator equipment. Under TVA's active promotion policy for inventions developed under its program, with procedures for establishing licensees among industry users, the Authority announced its invention in the trade press and through technical papers presented at the American Chemical Society and other organizations. In 1953, industry representatives were invited to a demonstration meeting and technical presentation to see the pilot plant in operation and review the technology and processing procedures involved. Licenses were offered to fertilizer producers and to firms manufacturing fertilizer production equipment under the usual nonexclusive, royalty-free agreement.

CASE 11
HONEYCOMB UNCAPPING APPARATUS

Background of the Invention

This invention is an apparatus for uncapping honeycombs that involves passing the honeycomb between a pair of heated rollers and then scraping the surface of the comb. This mechanized procedure is intended as a substitute for the usual procedure of uncapping honeycombs by slicing off the caps with heated knives.

Equipment to be used by beekeepers must be inexpensive, reliable, and operable by unskilled workers. Compared to other honeycomb uncapping procedures, this invention offers no advantages. The roller concept is poor in that it tends to scrap and break the surface of the honeycomb in the process of uncapping it. In addition, the unit cost of production models of the invention would be quite high. The Department of Agriculture has constructed a working prototype, but the model is too fragile for commercial use.

The invention arose out of a USDA research program investigating reduction of labor requirements in bee culture and honey production. Intended to replace the hand knife, the invention is not the first attempt to mechanize honeycomb uncapping. However, beekeepers tend to be individualistic in their approach to their craft, and while hives are standard sizes, allowing some mechanization, no two beekeepers follow exactly the same approach and procedures. Nearly all beekeepers custom-build some of their equipment, or introduce modifications around expensive equipment, making mechanization difficult.

Applied for in 1960, a patent on this invention was issued in 1962. There are now 25 licenses under the patent.

Private Development and Commercial Utilization

In the judgment of many of the licensees, who are beekeepers themselves, another few thousand dollars is needed to make this invention reliable and efficient enough to be a useful piece of equipment for the nation's beekeepers. One beekeeper estimated that to break even on the purchase of this equipment a beekeeper would have to have 640 hives, and only a few of the largest producers have that many.

Comment

The beekeeping industry is interested in reducing labor requirements, but commercial utilization of this mechanism has not been achieved. The principal obstacle to commercialization appears to be reconciliation of the cost involved with the economics of an industry containing many family producers which lack the capital and technical sophistication needed for mechanization.

CASE 12
COUMARONE DERIVATIVES

Background of the Invention

This invention yields new derivatives of coumarone (a compound normally found in coal tar but in this case discovered in alfalfa); a process for synthesizing them; and methods for using them in animal feeds and other compositions. When fed to animals, these derivatives accelerate weight gain as well as increase the proportion of flesh produced per pound of feed. They may be fed to any livestock–chickens, turkeys, geese, ducks, swine, sheep, cattle, or horses–but they provide the greatest economic benefit when given to large meat-producing animals such as steers.

The Department of Agriculture developed this invention at the Western Utilization Research and Development Division (WURD). The invention grew out of a research program that was begun in 1955 to investigate various chemical properties of alfalfa as a livestock feed. Coumestrol and coumarone derivatives were found in certain diseased alfalfa and thought to be potentially useful in this form as feed. The application of this invention, however, has been hampered by problems attributable to the disease, and no known commercial development has taken place. The WURD program was terminated in 1965. A nonexclusive license was issued to one firm which has made no use of it commercially.

Comment

This is a case of government development of an invention which encountered serious technical problems and never progressed beyond the experimental stage. Although one firm requested a license, it does not plan any additional development of the invention. The case illustrates one of the characteristics of public-service oriented research by the government. Agencies such as USDA are willing and able to explore new avenues of research which private firms may consider too risky an investment. The result may be important breakthroughs with solid commercial success like potato flakes (described in Case 5) or, as here, individual failure. In both cases, the cumulative knowledge gained from research may be a truer measure of value than either success or failure of a specific invention.

CASE 8
A CALCIUM CARRYING AGENT FOR MEDICINAL APPLICATIONS

Background of the Invention

This patent describes a product condensed from citric and gluconic acids, potentially an improved method for correcting calcium deficiencies in animals by increasing the calcium content of liquid solutions administered to them. Developed by the Department of Agriculture at the Northern Regional Research Laboratory (NRRL), the invention has not been commercially utilized, although it sparked HK Company to conduct R&D that is still under way.

Although there is an available market for products which will carry metal ions for medical and other uses, this invention was neither better nor cheaper than those presently on the market. Ordinary calcium gluconate, for example, one of the most commonly used products for calcium enrichment, will function as well as the sample invention.

Private Development and Commercial Utilization

HJ Company engages in heavy chemical production, with internal research and development related to the product areas in its current market—it is a major producer of antacids and antiperspirants.

The invention appealed to the company because it looked like it could be easily produced using existing equipment and experience. Soon after R&D was begun, however, the firm discovered that the patent claims were not sufficiently broad. Better compounds had subsequently been discovered and patented. Apparently the inventor, working in a government laboratory, had not investigated the many alternative compounds that could be employed to carry metals ions into living systems. When the firm's research and development team took this approach, it discovered a number of superior compounds.

The company is not exactly sure how much it invested in the research and development work stemming from this patent, but the estimate is well into five figures, for small-scale laboratory research, even though the program itself has never been one of major importance in the company's overall R&D picture. If present research and development results in some marketable products, executives in the firm think that they would produce themselves, rather than issue nonexclusive licenses to the industry.

Comment

In this case, the USDA invention has seen no tangible commercial utilization, but it has stimulated research which may lead to a number of new products. Government research in this instance was a catalyst not a producer of commercial products.

CASE 9
GELSOY

Background of the Invention

This patent, used in the manufacture of emulsion-type sausages, such as frankfurters and bologna, is based upon "Gelsoy," a protein-like material obtained from soybeans. The substance is capable of stabilizing the emulsion character of the water and meat, permitting the meat to absorb and hold more water during the processing operation. It also gives a finished sausage a firmer texture.

The Northern Regional Research Laboratory (NRRL) of the Department of Agriculture (USDA) began research on the material on a small scale. Subsequently, the NRRL, to ascertain the commercial uses of Gelsoy, awarded a research contract to the TWX Company to perform application studies and, a year later, follow-on research contract. Both contracts contained a clause assigning patent rights for any applications of the Gelsoy invention to the USDA. Four commercial applications were found, one of which was in the manufacture of sausages.

The government has done no further work on the material, and the invention has not been commercially utilized in the United States. There is a Japanese firm which is using the process commercially; no foreign applications were filed. Another company, the AZ Company took out a license, which it has not used to date.

Private Development and Utilization Philosophy

The TWX Company

The TWX Company performs research on food products and processes. About 60 percent of its sales are from food products, such as dehydrated honey, and about 40 percent, from contracts for research and development work.

personnel, after the inventions were developed, undertook to determine through press releases, letters, and personal visits in the chemical industry what sources, if any, existed for the phosphorous compound. Only one company, XX Company, was willing to manufacture the required compounds–the dangerous, colorless, and poisonous gas (THPC) basic to the manufacture of the phosphor–from the by-products of another chemical process. In addition to XX Company, three other firms (AA Company, GG Company, and KK Company) have utilized the inventions to a limited degree. A fifth company has licensed the invention, but was unavailable for comment,and still others may be using the inventions without a formal license.

Private Development and Commercial Utilization

XX Company

Based on the work accomplished by USDA, the XX Company proved the feasibility of using THPC for developing textile flame retardant finishes which were subsequently patented and marketed under a trade name.[2] When the company was licensed under the patent over a decade ago, the potential market for the product was, according to the firms's marketing personnel, extremely limited. Today the market is still limited to military and industrial uses where the fire hazard is high, but pending federal and state flammability laws could cause a tremendous market boom. Based on its past and continuing R&D in this area, XX Company anticipates a significant competitive edge in any future market.

AA Company

AA Company, a chemical firm working in areas related to the patents, secured a license to the inventions but abandoned any plans to develop the product commercially after a series of unrelated setbacks. One employee indicated, however, that it is questionable whether AA Company would have utilized the patents anyway because of the difficulty in obtaining THPC and because of serious misgivings concerning the chemical stability of the process involved in the manufacture of the product.

KK Company

The KK Company, a textile finishing firm, took out licenses for two of the five USDA patents and has tested and evaluated both with the help of USDA personnel from SRRL. Using these preliminary evaluations, KK Company has stated that it is not likely to use this particular invention because the water-dispersible composition has become obsolete by superior new finishes now on the market. The company feels that the second patent, the process patent may well, in the future, find some general application. Until it can make such an evaluation, the KK Company does have fireproofing treating techniques which it believes produce a more acceptable end result and which are more amenable to its bulk processing operation.

The KK Company, like the XX Company, foresees a substantially greater market for fire-retardant treating agents than currently exists and it, too, has been following closely the pending federal and state legislation with respect to flammability.

Comment

The failure to achieve significant commercial utilization of these inventions appears to result from the combination of the controlling position established by the XX Company and a traditionally limited market for the product. Since the XX Company is the sole United States manufacturer of the THPC which is required in order to utilize these inventions, and since the company has developed and is marketing its own patented product, the economic disadvantages for potential competitors are obvious. They were quickly recognized by those firms which took out licenses.

The work done by USDA in establishing the basic feasibility of using phosphorous compounds in fire-retardant textile-treating compositions was, in fact, a primary stimulus for the XX Company's extensive research program which resulted in their own product development. It must also be noted that the XX Company has demonstrated a high degree of perseverance in the face of a prolonged limited market condition which only now appears to be on the verge of a highly significant increase. It appears that the complete history on the commercial utilization of these inventions is yet to be written.

CASE 7
TEXTILE FIBER CLEANING MACHINE

Background of the Invention

The invention discussed in this case is a modification of a conventional textile fiber cleaning machine that recovers portions of the fibrous material discarded with the trash, thereby increasing the cleaned fiber yield. The invention is one in a series of textile fiber cleaning

[2] The THPC compounds were not covered by the USDA patents.

CASE 5
POTATO FLAKES

Background of the Invention

This invention involves four patents for processing raw potatoes into dehydrated potato flakes which can easily be reconstituted into a commercially acceptable mashed potato. The techniques was developed in a USDA laboratory by Department of Agriculture food technologists. From 1954 to 1959 the inventors filed a series of patent applications, covering various processing aspects of their discovery which, taken together, comprise an efficient and practical processing method for the production of potato flakes.

Work on potato dehydration had been under way within the Department of Agriculture since the early 1950's as part of an overall program on food processing and dehydration. The State of Maine co-sponsored the potato flake research as the potential use for low-density potatoes was of particular interest to them because the high water content of the Maine white potato makes it less useful for diced or shredded forms than the high-density Idaho or midwestern vegetable.

After patent applications were filed, the Department of Agriculture took title in accordance with prevailing agency policy. It promoted the inventions through its normal media—news bulletins by the individual laboratories, Department press releases, technical papers at scientific meetings, and direct contact with industry representatives. In this case, however, the department not only perfected the product, but the agricultural marketing service of the Department performed consumer studies. Sample stores were stocked with a specially designed box during a five-week test period. The product was mentioned in newspapers, reported on radio and television, and demonstrated in the stores. Sales of other potato products were audited, and promotional variations programmed in different localities. The test data showed potential consumer sales for the product as significant. A "Market Position and Consumer Acceptance" report was distributed to the food processing industry and published by the Government Printing Office.

Private Development and Commercial Utilization

Packaged potato flakes, processed under license from the Department of Agriculture patents, are sold throughout the United States and several foreign countries under the brand names of the licensees and local retailers. The market is estimated at $40 million to $50 million per year in retail sales.

From 1961 through 1964, Departmental promotion resulted in 17 nonexclusive licenses being granted under the four potato flake patents. It is possible that additional unlicensed firms are utilizing the potato flake process, since it is not uncommon among food processors to use government technology without requesting licenses.

This study examined the utilization pattern of two licensees—the DD Company, the largest licensee in total volume of sales, and the EE Company, a small licensee at whose plant the pilot study on potato flake processing was conducted.

The DD Company has been associated with the development of the process since its inception, and emphasizes that it is a "conservative company—one which does not readily enter into new markets." The company also points out that much of its own research and development, as in the rest of the industry, is inclined toward quality control and troubleshooting on the production line. Part of the DD Company's program for keeping abreast of new technology is regular visits to USDA regional laboratories.

Although it had examined the potato granule process, a dehydration technique which produces a somewhat inferior product, DD Company had performed no R&D in potato flakes or granules before USDA developments in 1954. Potato flake work observed earlier, however, although not a fully developed commercial process, had interested DD Company for two reasons: The marketing potential for the product was considered substantial, and entry into this product line would require only minimum investment in processing equipment. In the interest of gaining as rapid an entry into the market as possible, DD Company bypassed market testing of potato flakes. The company knew of the market survey work done by the USDA, but stated it had not relied on the data. The DD Company declared that it had put a "substantial effort" into the technical problems of preparing potatoes for dehydration, and indicated that at all times its investment was covered by the profit of current sales of the flakes.

Like the DD Company and the industry at large, the EE Company regularly monitors food technology developments at government laboratories. It learned of the potato flake developments in this way, and requested a license several years ago. Processed potato flakes accounted for about 10 percent of the company's gross sales in 1966.

The firm had attempted to develop a similar process in-house to make fullest use of raw materials. The taste and texture of its product were not acceptable, however, and the project was abandoned. The flake process

Agriculture at the Western Regional Research Laboratory (WRRL) as an outgrowth of a research program begun in 1950 to improve the value of sugar beets to the farmer. WRRL scientists worked closely with personnel of the Beet Sugar Development Foundation, a trade research organization. Had the Department of Agriculture never worked in the counter-current extraction area, an industry chemist and a government administrator contend, the processes would have been discovered in concurrent private research.

Both patents are licensed to the SS Company, but only the patent covering counter-current extraction and the recirculation technique has been utilized. The other has not been utilized because the process it covers is so complex as to outweigh the benefits it describes. It is suspected, however, that unlicensed firms may be using the counter-current extraction and the recirculation process patent.[1]

Private Development and Commercial Utilization

Fifteen companies comprise the sugar beet extraction industry. Because the industry is stable—the extraction process is essentially the same as that used 100 years ago, and equipment is standard—its only concern with patents is as they relate to slight modifications to improve the quality of the process.

The Sugar Act of 1966 sets the annual quota for sugar producers at 300,000 tons. Given these allocations, the strategy of sugar producers is to sell as much as possible in areas geographically near the factory, thereby minimizing transportation costs. The main target of research work is reduction of manufacturing costs.

Comments

One of the inventions developed and patented by the Department of Agriculture has contributed significantly to the processing technology of the sugar beet extraction industry, although, since it is a process, there is no measurable market for it. Whether the process might have been developed by private capital without the expenditure of public funds is a moot point. The only expense to the user was studies related to a modest investment in plant equipment and layout.

[1] An executive of the SS Company thought that most of the 52 processing factories in the industry were using the invention.

CASE 4
FOAM-MAT PROCESS FOR DRYING FOODS

Background of the Invention

This invention involves three patents which make use of a foam-mat process of reducing food products, by drying, to a readily dispensable form. The process can be applied to any food which can be converted to a pulp or liquid. It has the following advantages:

(i) Products are quickly and easily prepared for packaging and distribution in a form that also allows for reconstitution for consumption.
(ii) It is one of the most inexpensive ways of dehydrating foods—less expensive than freeze drying while yielding comparable material.

Developed at the Department of Agriculture Western Research and Development Division (WRRD) at sizable cost, the inventions have a long history of research. Through 1958, the USDA worked on development of the foam-mat process, although it was carried only to the point of laboratory demonstration. To solicit industry support and promote the process, one of the inventors published articles and visited companies around the U.S. The first attempt at commercial application failed, but modifications corrected the problem and today there is believed to be commercial potential for the process in preparation of foods such as coffee and fruit drinks.

USDA believes that the patented process is used more abroad than within the United States. Overseas, where exclusive rights have been granted by the inventor, who held all foreign rights under the then applicable USDA policy, Japan and Germany are the main users of the process. In Germany, a company has exclusive rights to the machine fabrication for the process, and it is sublicensing other concerns. An American firm was given the foreign rights to a number of patents on the process and associated inventions on a two-year option, which it let expire.

In addition to the licensed firms, at least one company, not licensed by USDA, has a patented foam-mat process which is believed by Department personnel to be derived directly from the USDA process. Four of the many U.S. licensees are discussed below.

Private Development and Commercial Utilization

The GN Company

In 1962 the GN Company, consulting engineering firm in the food industry, made a substantial private thereby increasing demand and return to the farmer on corn products. MM Company was looking for ways to exploit its chemical knowledge in various selected fields.

Because MM Company believed it had a technical headstart over competition in the chemical process and had confidence in its ability to remain ahead of competition, it was willing to undertake without exclusive rights the expensive R&D work necessary to commercialize the inventions stemming from the USDA patents. Significantly, MM Company did further development work on its own, and in the course of the work developed its own patents which protect it in marketing its product. It concentrated on the basic process, leaving USDA to work on product applications. The company has had some commercial success with the product, but marketing (rather than product development problems) appears to be limiting further commercial use of dialdehyde starch.

CASE 2
COTTON OPENER

Background of the Invention

This invention is a machine for processing staple fibers, such as cotton or other natural or synthetic fibers, having a staple length of about one-half to two and one-half inches. The machine has commercial application as an opener, cleaner, and blender of cotton. It untangles or opens tangled masses of fibers and at the same time removes a large proportion of any nonfibrous particles that are mixed with them. It is the most efficient cleaner yet devised since it removes more trash, leaves more fiber, and provides cleaner cotton from low grade stock than other methods.

The Department of Agriculture (USDA) began work on the cotton opener in 1943, and during the war, emphasized developing a machine for processing lintless cotton. In the early 1950's, a cotton opener was developed by the Southern Regional Research laboratory (SRRL) of the USDA.

The current invention to open and clean cotton was developed several years after the SRRL had initiated a research effort to develop equipment for textile mills that would efficiently clean hand-harvested cotton. SRRL actively advertised its invention and furnished drawings and a description of the process to firms in the industry. Thirteen firms in the period of 1957 to 1962 received licenses to produce the machine. Of the number of firms undertaking its commercial development, firms AC, XYZ, BT, and TF will be discussed.

Private Development and Commercial Utilization

The AC Company

The SRRL made a presentation of the invention to the AC Company in 1956. Since the machine was replacing four to five other processing operations, the risk of commercialization versus potential return looked good to the company, and it requested a license the following year, underwriting a nominal development cost to adapt the invention for commercial use. The company lost money on the first few machines produced because they had been assembled in such a way that the whole machine had to be completely disassembled for any repairs.

A few years later, a new machine was developed, with improved mechanical parts, at a cost of several thousand dollars. Although the original Department of Agriculture patent still covered some parts of the basic machine as well as the concept, the company applied for and was issued a patent for its cotton opener. Since this patent resulted from private development work, no rights were requested by or given to the government.

Sales were healthy for the first few months after the improved model was marketed, but they began to decline steadily when competition arose soon after. After about five years of sporadic production, the cotton opener was dropped from existing product lines, and the company does not plan to exploit it further.

An executive of the AC Company said that product development is usually undertaken only when potential return looks good. The promotional and marketing costs incurred by new products, he noted, usually equal development expenses, as evidenced by the original cotton opener, where the same amount was spent for development as for promotion and marketing.

The XYZ Company

As a result of the SRRL presentation also, the XYZ Company took out a license to the cotton opener patent, mainly for protection though, as the machine proved to be too elaborate for the company's market. The company wanted to be assured entry if a market materialized and it decided to get into commercial development quickly. The president felt that the potential return as currently envisioned was not great enough to undertake the risk of developing a new opener, particularly since he was satisfied with the sales of two other XYZ machines and did not want to expand. In XYZ's president's view, the SRRL original cotton opener is not in the mills today because it was not marketable.

has not been used because alternative preservation methods were developed at approximately the same time that this invention was made: nevertheless, the invention is technically sound and could be used if the industry adopted different methods of packaging and preservation.

(ix) *Vinyl 9, 10-Epoxystearate Compounds (Agriculture).* The vinyl 9, 10-epoxystearate compounds have an interesting history: Private industry was apparently working in this area when the initial Department of Agriculture patents were filed and as a result two firms iniated interference proceedings. One of these firms pursued the interference proceedings at some length, and, although the Department of Agriculture won the case, this firm is believed to be using the invention without an Agriculture license.

(x) *Honeycomb Uncapping Apparatus and Deamidized Gliadin (Agriculture).* The honeycomb uncapping apparatus and deamidized gliadin are examples of patents which have come from government-sponsored inventions for which there is little market need. The honeycomb uncapping apparatus is undoubtedly too elaborate for use by the average honey producer and deamidized gliadin, a derivative of wheat which has some potential uses in food preparation, apparently has to compete with a number of other natural products such as egg whites and gelatin which are cheap and widely available.

(xi) *Mechanical Crabpicker (Interior).* With the mechanical crabpicker, the developing agency, Interior, encountered technical difficulty and has not been able to entice new approaches from industry.

Fuller presentation of the cases summarized above is set forth in the remainder of Part III.

one company, having developed improved models of the machine, has exploited the market successfully, whereas the other three companies who obtained licenses on the invention have not been able to develop a marketable product out of the invention.

(v) *Superphosphoric Acid (TVA).* Although market statistics on the manufacture of superphosphoric acid were not available, this TVA invention might be the most significant one involved in the study. The product is used in a number of applications described in the case, including fertilizer and explosives; the significant reduction in cost for high-quality acid brought about by this invention has opened a large new market for the chemical. In this case, as in the liquid fertilizer process case, TVA demonstrated the production of the commodity and permitted licensees to copy the production facilities and set up production themselves. Unfortunately, statistics on market growth resulting from the invention covered in this case were unavailable because of the involvement of a number of other inventions with it and the difficulty of segregating the market for superphosphoric acid from that for other related chemical compounds.

(vi) *Sugar Beet Extraction (Agriculture).* Another process invention which contributed significantly to a large industry is that for extracting sugar from beets. Although it is difficult here to attribute specific value in sales to the invention because the processor did not keep detailed records on investment and cost savings resulting from the installation of the process, the company has had $40 million in sales and has indicated that other firms not licensed by USDA are using the invention. The annual contribution of the invention, therefore, is probably quite high.

(vii) *Foam-mat Process for Drying Foods (Agriculture).* The foam-mat process for drying foods currently is being utilized by several food processing machinery manufacturers who are installing pilot drying lines for food processing companies. The value of these sales were not made known to us, but it appears that if the process is successful, the potential annual market is substantial. As Figure 1 indicates, one equipment manufacturer invested $300,000 to test and improve the process in order to gain a leading position in equipment and system design.

(viii) *Potato Flakes (Agriculture).* The potato flake patents, which sustain a $40 million market, are a classic example of commercial utilization success that can be achieved under nonexclusive licenses, if the developing agency extensively develops and then actively promotes its invention.

(ix) *Low-Temperature Phase Equilibria (Interior).* The low-temperature phase equilibria cell is an instrument developed during research in the properties of gases. A number of petroleum and natural gas companies evinced considerable interest in the invention; one firm has a license under the invention and several others are believed to be using it without license. Unfortunately, the company that is licensed declined to discuss its use of the invention.

2. Nonutilized Inventions

Of the 23 nonutilized inventions, 13 came from the Department of Agriculture and 10 from the Department of the Interior. (Figure 2 lists these inventions in the order of their utilization potential.) Four of the six Interior inventions related to water desalination and, therefore, came under the direction of the Office of Saline Water (OSW). Although OSW's development activities are not affected by government patent policy to the extent that commercial utilization is crippled, industry appears reluctant to participate in the desalination program. A similar situation exists with Interior's shale oil program. Agriculture's licensing policies, on the other hand, appear to have encouraged industrial research in the fields of the inventions—particularly with fabric flameproofing, the calcium carrying agents for medicinal applications, and with the walnut preservation process—even though the inventions themselves were not utilized.

Following are summaries of the 23 nonutilized inventions:

(i) *Water Desalination Inventions (Interior).* Interior has sponsored research on several water desalination processes: among these are the hydrate process, the electrolytic process, the centrifugal compression distillation process, and the solar still process. The technical feasibility of these processes has been established and currently the government is funding development of plants based on the electrolytic and hydrate processes. Work on the solar still and compression distillation has stopped for the time being—in the first case, pending demonstration of economic feasibility, food processors picked up the invention. TVA had a similar experience with fertilizers it developed. Both agencies employ a variety of techniques to promote the use of new products.

That TVA and Agriculture are able to achieve utilization without granting exclusive rights is attributable to the fact that, due to their missions, both agencies tend to carry consumer products and processes with good demand through full development *and* then actively promote their use by industries which do little research on their own.

The Department of the Interior experience varies somewhat from that of Agriculture and TVA. Much of its research—particularly in water desalination, coal, and oil—is basic in nature and parallels work being performed by research and development-oriented firms that are sensitive to patent rights. Although its research has great commercial potential, the technology involved is speculative and commercially feasible inventions are still in the development stage. To undertake commercial development involves a risk that industry is not willing to assume without patent protection. Therefore, nonexclusive rights are not as effective as with Agriculture and TVA inventions. When research is performed under contracts, patent rights are often an issue (see Volume II, Part IV, as well as the following cases), and resulting inventions, because they are not yet economically feasible, do not spark wide interest in industry. It is not clear whether the use of these inventions would be increased if exclusive rights were granted, but such a policy would probably attract more private funds to the underlying research tasks which would speed development of products useful to the consumer.

C. Conclusions

- Exclusive patent rights were not a major factor in invention utilization in most of the cases in Part III. Although the cases involved both utilized and nonutilized patents and varying degrees of financial risk and market potential, all of the rights granted on the utilized patents were nonexclusive. The TVA inventions typified those having low financial risk—this because the agency had previously demonstrated market acceptance of the product. Cases 1, 6, 8, and 14, the semideveloped chemical compound formulations, represent high-risk situations. In all but Case 14, "Vinyl 9, 10-Epoxystearate," however, the risk was undertaken by the company which carried the original government invention to more advanced stages of development and which provided the company with proprietary protection.

- *Public Service agency inventions which found utilization achieved broader use in several cases than those of the mission-oriented agencies.* Because these agencies perform research in areas with a demonstrated public need and because they engage in extensive development and promotion of the products they develop—thus eliminating much of the risk involved in undertaking commercial development—their successful inventions tend to find broader use than do the mission-oriented agencies. Both TVA and Agriculture—the former with its fertilizer program and the latter with such inventions as dialdehyde starch and potato flakes—exhibit good records of utilization.

- *Despite the commercial orientation of their inventions, public-service oriented agencies may have to undertake additional development and promotion of the inventions they sponsor in order to achieve utilization.* TVA, which has carried a number of inventions to the point of production and sale, carries this policy the farthest. Agriculture, which normally does not go quite so far, does, however, conduct market studies and send out technical teams to promote commercialization of its inventions; it has had modest success in achieving utilization.

- *Companies with a history of large-scale development of proprietary products are more sensitive to patent protection than those who do not have such a history.* Such companies either negotiate for title or exclusive license to patents and, when these two avenues are not open, may refuse to participate in government research. For example, two large chemical and commodity suppliers refused to participate in this study because the information sought was proprietary—even though the government, in each case, had either a license or title to the invention.

- *There is opportunity to exploit licensed government-sponsored inventions with some proprietary protection through improvements developed at private expenses.* For example, in Cases 1, 6, and 8 ("Dialdehyde Starch," "Flameproofing of Fabrics," and Preservation of Walnuts") commercial firms picked up incomplete government research projects and went on to develop new products. In such situations, the commercializing firm gains protection through patented improvements to the original invention or through trade and processing secrets growing out of its own research. Here government patents, although they have not been utilized, have stimulated private research which led to commercial products. This is a mode of utilization of government-sponsored inventions which is not readily measurable but is significant.

- *Small firms more often than large firms seek nonexclusive licenses to government-developed inventions.* Case 25 ("Shale Oil Processing"), Case 4

FIGURE 1
UTILIZED INVENTIONS
(PUBLIC-SERVICE AGENCIES)

	Case	Sponsor Agency	Number of Government Patents Involved	Additional Inventions (Trade Secrets/Patents)	Licensees/ Utilizers	Investment[4]	Annual Market[5]
1.	Dialdehyde Starch	Agriculture	8	Secrets and patents	1/1	About $2.5 million	About $750,00
2.	Synthetic Mica	Interior	1	Secrets	2[1]/2	About $2 million	About $600,000
3 & 4.	Liquid and Mixed Fertilizer Process	TVA	4	None	130/many[1]	About $40,000	About $3 million
5.	Cotton Opener	Agriculture	1	Secrets and patents	13/3[1]	About $40,000	About $140,000
6.	Superphosphoric Acid	TVA	1	None	3/1	N/A[8]	N/A[8]
7.	Sugar Beet Extraction	Agriculture	2	None	1/more than 1[2]	N/A[6]	N/A[6]
8.	Foam-mat Process for Drying Foods	Agriculture	3	Patents	4/1	About $300,000	N/A[7]
9.	Low-Temperature Phase Equilibria Cell[3]	Interior	1	Unknown	1/more than 1[2]	N/A[9]	N/A[9]
10.	Potato Flakes	Agriculture	3	Patents	6 or more	Unknown	$8 million

[1] Case research on all licensees was not performed for the study. Number of licensees reflects licensees under most "popular" of patents involved in the product.
[2] Firms other than those licensed are believed to practice the invention.
[3] Government sources believe this invention to be in use although single licensee declined to be interviewed.
[4] Investment of "most successful" utilizers in case where more than one attempt took place.
[5] Current annual market of "most successful" utilizer.
[6] A process improvement invention used by a company with $40 million sales. No breakout of investment or contribution of invention available.
[7] Current market is only in pilot plant design and installation.
[8] A process for turning out an existing product--acid manufactured by new process probably amounts to several million dollars; investment estimates were not available.
[9] Only known utilizer declined to be interviewed.

PART III. Commercial Utilization of Public Service-Oriented Agency Inventions

LIST OF FIGURES

technical development and production facilities to bring the invention into commercial use. A second patent, in which Company N invested $200,000 for commercialization, has been responsible for approximately $1.2 million in sales since 1959. Still another patent, in which the firm invested $50,000, has generated domestic sales of $6 million.

It appears that the company's high rate of patent utilization can be attributed to two factors: the parallel applications for the company's products in government and commercial markets and its practice of patenting only those inventions which appear to have good application to its product lines. A broader government acquisition of title to inventions would probably cause the company to reevaluate its participation in government programs because of its interest in maintaining proprietary positions in commercial markets and would greatly inhibit its commercial use of government-sponsored inventions.

A second company in the first pattern, *Company M's* major orientation is toward commercial and industrial markets, and the firm will participate in government R&D work only if there are follow-on opportunities for items directly connected with its commercial product lines. Company M maintains a small in-house research laboratory to undertake government R&D in new technologies that are related to major corporate objectives of the firm.

Company M reported commercial utilization on three of the total of eight patents arising from government contract work in the sample years, which it owns. This high utilization rate results from Company M's selective participation in government R&D with the clear-cut objective of applying the results of this work to existing products or to new product areas. Company M's ability to select the appropriate government programs is aided by the firm's well-established position in industrial markets which makes it perceptive of commercial opportunities.

Company M considers patent rights essential to maintaining product superiority in traditional lines and also to establishing proprietary positions in new technologies. The firm is very sensitive about its proprietary position in new or anticipated commercial markets, and is generally reluctant to undertake government contract work unless the patent position is favorable. Contract proposals are evaluated individually with regard to patent considerations, and the decision to undertake government work is based on top management's assessment of the technical value of the work and its commercial potential.

A shift in government policy toward greater ownership of patents would probably greatly inhibit Company M's participation in government R&D programs and its commercial utilization of resulting inventions.

Representing the second pattern, *Company D* is a leader in an industry where innovations and patent rights are critical to continued growth. Company D attributes only a small percentage of total annual sales to government work, viewing it mainly as a public service. It acquired title to 13 and license to 9 government-sponsored inventions in the sample years.

The company's policy and operating practice reflect strong sensitivity to commercial markets and a preoccupation with company-funded rather than government-sponsored research. Company D has little interest in undertaking government work or in developing inventions arising from it. It maintains separate government facilities—both R&D and production—because the technology involved is distinct and requires a greater degree of sophistication. There is no exchange of personnel and no expectation of technological transfer to commercial applications. The company has found that a great many more new product ideas arise from its commercial operations than from the government work it undertakes.

Having utilized 14 percent of the sample inventions, (3 of 22), Company D would, at first glance, seem to be a high utilizer. Further analysis, however, reveals that the company was, in fact, a low utilizer since the utilization achieved in the sample represents the company's only attempt to transfer technology developed under government R&D to commercial application.

The company invested $300,000 in commercial development and sales to date in three related inventions have amounted to more than $800,000. More recently, however, sales in this market have declined, and the company has decided to drop the effort. It is now licensing the patents to three other companies who will carry on business in this area.

Because Company D has completely separated its government and commercial work and has no expectation of commercial spillover from government programs, greater ownership of patents by the government would have little effect on either its participation in government programs or utilization of resulting inventions.

f. *Patent Rights in Commercial Activities and in Government Activities Are Judged By Different Standards*

Many diversified companies follow different patent policies in their commercial and government markets. These firms place a strong emphasis on maintaining proprietary positions in commercial markets and express contract or decline so as to avoid compromising a proprietary position. While Company T could conceivably refuse to accept a contract for patent reasons, such a decision is influenced by many other factors—potential profitability, market size, development costs, and company resources.

The primary criteria for judging disclosures are foreseeable commercial and economic opportunity. Since the firm has a broad range of product lines, it is interested in applying new technology to domestic markets. Military- and space-oriented patents are also of economic value for their sales and royalty fees resulting from utilization by foreign governments. A second criterion is enhancement of the Company T image. If patenting will link the firm to advanced technology, the tendency is to patent even though there is no apparent direct economic advantage.

Company L's primary business objective is to identify new processes and products through research, secure patent protection when possible, and develop markets for the products—or negotiate for market development by a licenses. The company is a low utilizer. It acquired title to 26 survey inventions none of which it has been able to use commercially.

Company L undertakes government contract work primarily because of the availability of contractor patent rights which may eventually be used in commercial exploitation of inventions developed during the research. The company views financial returns based on a proprietary market position or derived from licensing agreements as the major source of its growth. Therefore, retaining patent rights is essential in any work performed by the firm under government contract. Normally, the firm accepts government contracts only when patent title can be obtained. An exception is sometimes made, however, for study contracts by which Company L could enlarge its background knowledge in new fields with commercial potential. A shift in government policy toward greater ownership of inventions would greatly inhibit the company's participation in government programs and its efforts to utilize resulting inventions.

A high utilizer, *Company J,* during the sample years, was an independent company operating as an applied research laboratory specifically to generate and develop new ideas into commercial products, spinning-off the successful product lines to new subsidiaries or by sale to other companies. From 1957 to 1962, as much as half of annual company sales were to the government.

Company J views patent rights as important, specifically as they establish privileged positions in the marketplace. The license policy of its government customers permitted pursuit of Company J's original objective of using government R&D to develop new product lines which it would spin off to form subsidiary companies or sell to interested firms.

The commercial potential beyond the immediate contract was the principal consideration in Company J's decision to undertake government work. The firm viewed government contracting as a way of establishing competence in a new technology or pushing the state of the art in areas within the company's scope of interest. Under this policy, when a commercially promising item was disclosed through government work, it was designated for further in-house research upon completion of the government contract. But the firm did not delay commercial utilization of an idea if patents could not be obtained; the importance of being first to market a new product with strong commercial potential was often given greater weight.

The firm's transfer of technology, however, was not dynamic enough to be successful. Its extensive development activity created a constant shortage of investment capital and its mission changed when it merged with a manufacturing company. Both then and now a shift in government policy toward greater ownership of patents would probably cause Company J to become more selective in its government programs and greatly inhibit its commercial use of resulting inventions.

Company C's work for the government accounts for an insignificant percentage of total annual sales, and the importance of patents resulting from government contracts is almost negligible. Patents resulting from company-sponsored research are highly valued at Company C, however. In fact, concern for preserving its patent position has led the company to avoid participation in government work in fields where it has an established technical capability. In the several instances when the company has undertaken large-scale government contracts, the tendency has been to separate the effort entirely from its commercial endeavors. The company is a low utilizer.

In effect, Company C is reluctant to engage in government-sponsored research. The amount of patent protection available under such agreements is a primary concern to protect already established patent positions and a strong technical capability. With high development and production costs and relatively low cost-per-unit return on its products, Company C requires a high volume of sales to recoup its investment and feels it cannot risk involvement in programs where patent protection is questionable. A shift in government policy toward greater ownership of patents would probably cause Company C to be even more selective in its government programs, but would probably not affect its utilization of resulting inventions since, even now, it has no expectation of commercial applications from its government work.

Since Company O's market position is based on technology, integration, design, and overall systems management, patents are valued largely for their defensive potential but hold a secondary position to technical capability. They are not critical to the firm's market position. The company is a low utilizer, with only incidental use of four of its 30 survey inventions.

Company U, a large corporation with a low rate of utilization, utilized three of its 42 survey inventions in which it held title to 39 and license to three. It views title rights primarily as secondary to technical knowhow. But, at the same time, the company upholds a variety of patent objectives, corresponding to product lines and markets. As a supplier of parts to manufacturers, Company U continually files improvement patents and considers them an important contribution to product development and marketing success. Another area where title rights are important is in foreign markets. By retaining title, Company U can compete favorably by obtaining foreign patents, or can receive royalties through licensing items for sale in the foreign markets. However, government programs sometimes precede commercial work in overlapping markets of the company. When this occurs, the company may give higher priority to full participation in the government program than to acquisition of a proprietary commercial position in inventions resulting from the work.

It would seem that, given Company U's variety of patent objectives, a shift in government policy toward greater ownership of patents would vary according to market.

Company Q, dependent on government contracts for most of its business, regards patent rights as of little value in achieving the commercial utilization of its products, despite its high utilization rate. The company used 13 of its 56 survey inventions, in which it held title to 52 and license to four. An idea generated in government product areas, for example, would probably be utilized whether or not it could be patented, although filing is encouraged for the sake of protection. And Company Q's products are sufficiently complicated and require an accumulation of technology and manufacturing capability such that inventions generally represent only incremental additions to the basic product that are unimportant when compared to the investment of production and engineering skills.

Business reputation and technology seem to be far more important in generating sales than any single patent or group of inventions developed while under contract to the government. When the company patents in the face of no commercial utilization, it does so (i) to publish its name as the inventor, and (ii) to recognize the competence of technical personnel. A shift in government policy toward greater ownership of inventions would probably have little effect on Company Q's participation in government programs or on its commercial utilization of resulting inventions.

Sales to the government of *Company R* products are a small percentage of the aggregate and represent the output of a single division of a large, multidivisional, consumer-oriented company. The company was classified as a high utilizer and acquired title to 110 survey inventions of which it used thirteen.

Company R, as a matter of corporate policy, seeks government contracts where there is an opportunity for market overlap between government and commercial products. The company is careful to integrate the results of government- and company-sponsored R&D to use in demonstrating an established commercial position when negotiating patent clauses with government agencies. While patent rights are not directly essential to the marketing of products in this field, they are valuable for cross-licensing which can lead to improvements in overall product performance.

According to corporate policy, whenever possible, the inventing division retains title to inventions generated from government R&D. The firm believes that the company's contribution of technical experience, equipment, and personnel is as much responsible for the invention as is the government's purchase of particular contract objectives. They contend that since the government receives royalty-free use of an invention, its commercial exploitation is a fair return for the firm's commitment of resources.

Although the firm also takes contracts in which the government retains title, they are generally in areas where little or no commercial potential is expected. As a rule, Company R would not invest additional corporate funds if it held only a license for an invention, nor would it accept contracts with a title clause if it envisioned potential commercial applications for the work involved.

c. *Patents Are Valuable for Defensive Purposes*

Some firms believe that corporate ownership of patents offers flexibility in design, both in the United States and abroad (through ownership of corresponding foreign patent rights), and provides trading material for cross-licenses with competitive firms. Ownership of a patent, however, as a prerequisite for new product development is a relatively minor factor compared with market considerations and investment requirements associated with commercialization of the invention. A change in government patent policy may affect firms in this category by causing them to choose more carefully

FIGURE 7
DOMINANT INDUSTRIAL ATTITUDES TOWARD PATENTS
AMONG TEN HIGH AND ELEVEN LOW UTILIZERS
(CONTRACTOR INVENTIONS)

1. **Patents have no importance**

   Company F
   Company K
   Company A

2. **Patents are of little value, compared with technical know-how**

   Company E
   Company B
   Company O
   Company P
   Company Q
   Company U
   Company R

3. **Patents are valuable for defensive purposes**

   Company B
   Company G
   Company H
   Company I
   Company O
   Company P

4. **Patents are important in establishing proprietary positions**

   Company C
   Company J
   Company L
   Company T

5. **Patents are essential to business activities**

   Company L, Company M, Company N — Pattern 1

   Company C, Company D — Pattern 2

6. **Patents are judged differently in commercial and government work**

   Company C
   Company D
   Company S

either a preponderance or a large percentage of their business in the government aerospace and defense markets. No desire to expand into commercial markets and no mechanism for the commercialization of inventions were noted. When these firms obtain patents, their sole purpose is recognition of technical competence within the company. A change in government policy with respect to ownership of patents would have little effect on the business activities of firms in this category because of their underlying lack of interest in patents.

One of the smaller companies in the study with no commercial utilization of the 11 survey inventions which it owned, Company F maintains an essentially defense marketing posture, regarding itself as an R&D contractor for the government. Since its product lines are almost wholly government- or military-oriented, they are not suited for the commercial environment, nor is the company interested in transferring technology through the medium of commercial utilization. Patents, when they have been obtained, serve the purpose of commending the inventor.

Company K, another firm with no utilization, owns eight patents and one license to survey inventions. It views itself primarily as a government contractor and makes no attempt to retain proprietary rights on discoveries. A nominal number of patents are obtained each year, primarily to honor the inventor and support the company's reputation for creativity. Company management has shown little interest in seeking out and developing the commercial applications of patents obtained as a result of its government work.

Company A's attitude toward patents varies depending upon whether they arise from commercial or government work. The company has essentially no interest in patents arising from government-sponsored work because they have proved a less fertile source of commercial utilization than was originally expected. For example, despite Company A's high utilization rate,—applying seven of 20 survey patents it owns—only one of the 20 patents achieved sales as great as $1 million. The company has made significant efforts to establish commercial spin-offs from government work. One such

FIGURE 4
INVENTION UTILIZATION
ELEVEN LOW UTILIZERS
(CONTRACTOR INVENTIONS)

Company	Rank in Patent Holdings	Patent Holdings				Number Utilized	Number Utilized With Commercial Sales Over $1 Million	Total Commercial Sales Million-Dollar Inventions
		Title	License	Number	% of Sample			
Company I	2	84	47	131	6.5	5	0	0.0
Company B	4	118	1	119	5.8	5	1	22.0
Company T	5	67	50	117	5.7	3	0	0.0
Company P	7	75	7	82	4.0	5	0	0.0
Company C	9	57	5	62	3.0	0	0	0.0
Company U	12	39	3	42	2.0	3	2	50.0
Company O	16	30	0	30	1.4	4	0	0.0
Company L	19	26	0	26	1.2	0	0	0.0
Company D	21	13	9	22	1.0	3	0	0.0
Company F	35	11	0	11	.5	0	0	0.0
Company K	39	8	1	9	.4	0	0	0.0
TOTAL				651	31.5	28	3	72.0

B. Findings

Figures 3 and 4 summarize relevant data on the 21 companies comprising Part II research. They account for 53 percent of the sample inventions, 130 of the 210 utilized inventions, and at least $179 million of the $405 million in sales reported for contractor inventions.

1. Barriers to Utilization

- *Low Commercial Potential*

Research indicated that a number of barriers to commercial utilization exist quite apart from government patent policy. The low commercial potential of the great majority of sample inventions is perhaps the most fundamental. Derived mainly from defense programs, they are too far removed from consumer needs to be truly useful. Developed under hardware programs in many instances, they represent applied engineering to meet a specific requirement which tends to limit their applicability to other products. Inventions developed by electronic firms like Company I typify this problem. Developed under more basic research in other cases, they are still too speculative to find quick commercial application. The experience of Company J which tried to found a business on investing in new technology to develop new products with high spin-off possibilities, illustrates this situation well. There are notable exceptions with high potential among the sample inventions, however, in the case of transistors, vacuum tubes, numerical control devices, computers, and gas turbine engines. But the exceptions prove the rule, since these inventions have commercial applications closely parallel to their government applications. The consensus of the 21 firms on the commercial potential of government inventions is perhaps best shown by Figures 5 and 6. Both high and low utilizers alike filed the greatest number of patent applications by far on company-sponsored inventions.

- *Company Market Orientation*

The market orientation of the company owning the invention is a second major barrier to utilization. Firms like Companies F and K are almost wholly keyed to government work and do not seek commercial markets. They acquire patents to meet their contractual obligations, to honor their inventors, and to help them market their skills to the government, but not to develop commercial products.

Firms like Companies O and P develop large systems and rely on broad management and engineering skills rather than patent position to increase their markets. Firms like these acquire patents more to ensure design flexibility and to protect against infringement suits rather than to exploit the inventions commercially.

Firms like Companies C and D are almost wholly in commercial markets and separate their government and commercial work. They discount rather completely the commercial spillover of government inventions they develop, and make little or no attempt to use them.

- *Inadequate Internal Communications*

Inadequate communications within a company are a third barrier to utilization, particularly within large, multidivision corporations. In several firms, the decision to patent government inventions and the decision to use them commercially are completely separated.

- *Degree of Market Competition*

The competitive characteristics of the market are a fourth major barrier to utilization. Companies B, G, H, N and others emphasized the greater importance of being first in the market with an innovation than having patent protection at the time the product is introduced. In rapidly changing markets, too, the value of a patent is short-lived as technology quickly bypasses current applications and designs.

In this respect, the environment in which the 21 high and low utilizers live is very different from the more slow-moving technologies and more conservative industries which relate to inventions developed by public service agencies like Agriculture and TVA (reported in Part III, below). The high and low utilizers as a group necessarily place far greater stress on their research programs as a factor in company growth than firms reported in Part III. This has a great effect on the varying role of patent incentives in promoting commercial utilization in the two environments. The firms reported here expressed six dominant attitudes toward the role of patents in their business activities. Figure 7, which follows, displays the sample companies according to the dominant industrial attitude of each. These attitudes, described in Section 2 below, condition their reaction to government patent policy and govern their actions in participating in, and using the fruits of, government programs.

2. Six Dominant Industrial Attitudes

a. *Patents Have No Importance to the Firm's Business Activities*

A lack of interest in patents was characteristic of both research-oriented and manufacturing firms that do

PART II. Commercial Utilization of Government-Sponsored Inventions by Industry

A. Background of the Task

As part of the initial study effort, Harbridge House conducted pilot study case analyses between January and April, 1967, to determine what could be learned about the effect of government patent policy on invention utilization. Through these cases and the drug study,[1] we were able to define several major factors affecting utilization and to develop a preliminary concept of the role patent policy was playing in the utilization process.

The cases showed that industrial organizations focus their interest on marketable *products;* exploitation of *inventions, per se,* is not usually a business objective. Moreover, they normally seek products that they are confident they can develop and market. Thus, the development risk in commercializing an invention in relation to its expected commercial potential influences a company's policy regarding patent rights. In a high-risk, low-potential situation, lack of exclusive rights often precludes commercial development; in a low-risk, high-potential situation a company may move into commercial markets without them.

Nonetheless, companies and industries varied widely in their willingness to undertake development risks. In this respect, *the greater a company's investment in research and development of new commercial products, the greater its sensitivity to patent protection. Accordingly, the government's patent policy appeared to be a critical issue when the R&D interests of the government and industry overlapped.* The drug study provides a striking illustration of this: the drug industry, with heavy investment in its own R&D programs, has refused to participate in government programs in which the government takes title to inventions. To eliminate any claim that their work is based on government-sponsored ideas, drug firms avoid contact with researchers working under government funds and avoid participation in conferences and symposia at which government representatives appear or government-sponsored work is discussed. The industry reaction is severe enough to have caused a significant breakdown in communication and collaboration among the government, academic researchers, and the drug industry. This breakdown in communication and collaboration has inhibited the effectiveness of government-sponsored research in medicinal chemistry and has been an equally potent limitation on commercial utilization of research results.

The pilot studies also suggested that many inventions developed under DOD programs are more sophisticated in concept and more costly to product than the commercial market requires. Even with patent title or an exclusive license, the high business risk involved in adapting these inventions to commercial development limits their appeal. Other DOD inventions are so specifically oriented to the defense mission that they have no commercial application now or in the foreseeable future.

Lastly, the cases indicated that patents developed by agencies whose R&D programs are public service-oriented either in whole or in part—such as AEC, TVA, and the Department of Agriculture—tend to find greater commercialization even without exclusive rights than those developed by agencies whose R&D programs are oriented toward direct use by the government itself—such as DOD. This appeared to be due to two factors. First, inventions developed by public service agencies are normally more closely related to identifiable needs of the public. Second, the public service agencies frequently go further in perfecting an invention for its commercial application and in promoting its utilization. The research results on this question are reported in Part I, above, and Part III below.

The findings from the pilot cases were tested on a broader scale through an analysis of the utilization questionnaires and additional case studies, comprising most of this volume and spanning a cross-section of industry; government agencies, like the Department of Agriculture and the Interior and the TVA; and various universities and other nonprofit organizations.

For this part of the study, the questionnaires showed that commercial utilization of government-sponsored inventions was low—about 13 percent of the sample if both supportive and critical inventions are considered, and about 2.1 percent for critical inventions alone.[2] Commercial utilization of these inventions is normally only a by-product of their original function since few were intended for civilian use. They differ from most privately-sponsored inventions in this respect and do not, as a group, provide comparable commercial opportunities. However, this does not mean they are less

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[1] The drug study is reported in Volume II of this report.

[2] Of the 200 industrial contractor inventions utilized in the sample, 49 played a critical role in the products in which they were utilized (see Part I above).

TABLE 44
PATENTS IN COMMERCIAL USE THROUGH LICENSEES
(INSTITUTIONAL INVENTIONS)

Frequency
(Percent)

Field of Technology	Total	Process	Material	Component	End Product	Other
Total	11 (100.0)	2 (18.2)	1 (9.1)	3 (27.2)	5 (45.5)	0 (0.0)
Electronic	4 (36.4)	1 (9.1)	0 (0.0)	2 (18.2)	1 (9.1)	0 (0.0)
Electric	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chemical	2 (18.2)	1 (9.1)	1 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)
Mechanical	1 (9.1)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)
Hydraulic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nuclear	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Optics	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Life Science	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	4 (36.4)	0 (0.0)	0 (0.0)	0 (0.0)	4 (36.4)	0 (0.0)

TABLE 42
EFFECT OF PRIOR EXPERIENCE ON REASONS FOR NONUTILIZATION
(GOVERNMENT-OWNED INVENTIONS)

	Technical Reasons (percent)	Marketing Reasons (percent)	Number of Observations
Prior Experience	76.4	23.6	17
No Prior Experience	50.0	50.0	44

10. Utilization by Educational and Nonprofit Institutions

a. *Introduction.* Four hundred fifteen sample inventions resulted from research at 67 educational and nonprofit institutions. One hundred twenty-five responses were to the same type of questionnaires sent to commercial firms. Since many of these organizations did not answer questions aimed more directly at industry, only limited information can be obtained from the statistical data. Interviews were conducted at 16 organizations, however, to determine the factors affecting utilization in the institutional environment. These interviews, reported in Part IV below, provide the major portion of the analysis of these institutions. Because educational and nonprofit institutions neither manufacture, use, nor sell products based on their inventions, utilization must be achieved, if at all, through licensing. The data here and in Part IV reflect that fact.

b. *Concentration of Inventions.* Table 43 displays the concentration of institutional inventions by field of technology and form of invention.[52] There is heavy concentration in the chemical, electronic, and mechanical fields, with the chemical group showing the highest share (24.8 percent), and electronic and mechanical inventions close behind with 16.8 percent and 12 percent respectively.

If Table 43 is compared to Table 12 (contractor inventions), institutional inventions have less than half the concentration in the field of electronics (34 percent for contractors), 68 percent greater concentration in the chemical group (14.7 percent for contractors), and 58 percent smaller concentration in the mechanical group (20.2 percent for contractors). The decline in concentration in the electronic and mechanical fields is attributable largely to the more basic nature of the research performed by institutions. In chemistry more than in the other two fields, however, invention is more likely to occur from basic research (see Table 43). Similarly, inventions in life sciences account for 10 percent of the institutional response compared to .7 percent for contractors, reflecting basic research performed by institutions in medical chemistry and allied fields.

Influenced by the chemical and life science fields, process and material inventions account for 35.2 percent of the response. As was the case with contractor inventions, however, component and end-product inventions still predominate (64.5 percent).

c. *Concentration of Utilization.* Table 44 shows the concentration of utilization of institutional inventions. Eleven inventions (8.8 percent) were reported in use[53]—four electronic, two chemical, one mechanical, and four involving a combination of fields (the "Other" category). The number utilized is to small to perform any meaningful statistical analysis, but utilization, royalty income, and reasons for nonutilization of institutional inventions are discussed in more detail in Part IV.

[52] Categorization of concentration by size of firm and percent government business was found to be inappropriate with regard to institutions.

[53] Nonresponders interviewed in connection with Part IV reported utilizing an additional eight inventions which do not appear in Table 44 but which do appear in Figure IV-1 of Part IV. As noted in Part IV, these eight additional inventions increase the rate of utilization of the institutional inventions to 10 percent.

TABLE 39

SALES AND PRIVATE DEVELOPMENT COSTS ASSOCIATED WITH COMMERCIAL UTILIZATION (GOVERNMENT -OWNED PATENTS)

	Amount[1] of Actual Domestic Sales From:		Amount[1] of Actual Foreign Sales From:		Development Costs[2]			
	Critically Important Inventions	Inventions with a Supporting Role	Critically Important Inventions	Inventions with a Supporting Role	Amount[1]	Average Percent in Technical Development	Average Percent in Production Facilities	Average Percent in Marketing
Total Sample	201.12	6.945	2.2	.085	5.389	21.1	52.2	26.7
DOD	.02	.055	0	0	.040	70	30	0
AEC	.40	0	0	0	.020	50	25	25
Agriculture	196.5	.025	2.2	.085	3.118	17.1	47.9	35
TVA	4.20	5.34	0	0	2.211	16.9	58.9	24.2
Other Agencies	0	1.525	0	0	0	0	0	0

[1] Millions of dollars to date of response to questionnaire.
[2] Average only for those responding to this question.

TABLE 40

EFFECT OF PRIOR EXPERIENCE ON UTILIZATION (GOVERNMENT -OWNED PATENTS)

	Percent of Licensees Using Invention	Number of Observations
Prior Experience	62.0	36/58
No Prior Experience	19.6	11/56

As noted in Section B.9.d above, a high correlation also exists between utilization and size of firm. This is caused, however, more by the size structure of industries using the inventions of public service agencies like TVA and Agriculture—these agencies tend to service small firms who do limited R&D of their own—than any necessary requirement for utilization. (See Part III.)

g. *Reasons for Nonutilization.* Table 41, which presents the reasons for nonutilization of government-owned inventions, shows some important differences from the reasons for nonutilization of contractor inventions (Table 29). Here, development costs and development flaws were much more important to licensees of government-owned patents (35.3 percent of reasons ranked first) than they were to contractors (2.8 percent). Lack of commercial potential was much less important to licensees (2.9 percent) than to contractors (28.9 percent). And the fact that the invention fell outside company product lines was more important to licensees (27.6 percent) than to contractors (16.1 percent).

Table 42 defines the effect of prior experience on the reasons for nonutilization of inventions.

Both with and without prior experience technical reasons are more important to licensees than to contractors—39.7 percent with experience and 31.9 percent without (see Table 30). Where prior experience is present, however, the importance to licensees of technical reasons increases. Interviews indicate that licensees without prior experience often inquire about an invention to determine if it is of commercial interest to them and normally receive a license in response to their inquiry. Upon closer examination of the invention they often conclude they do not wish to pursue it. Licensees with prior experience, on the other hand, tend to screen inventions in their field more carefully before inquiring about them, resulting in a higher proportion of marketing reasons for licensees who have no prior experience than for those who do have it.

TABLE 37
TOTAL PATENTS IN COMMERCIAL USE
(LICENSEES OF GOVERNMENT-OWNED PATENTS)
(1957 AND 1962)

Frequency
(Percent)

Field of Technology	Type of Invention					
	Total	Process	Material	Component	End Product	Other
Total	52 (100.0)	21 (40.4)	20 (38.5)	4 (7.7)	7 (13.5)	0 (0.0)
Electronic	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.8)	0 (0.0)
Electric	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chemical	40 (76.9)	16 (30.8)	20 (38.5)	3 (5.8)	1 (1.9)	0 (0.0)
Mechanical	6 (11.5)	2 (3.8)	0 (0.0)	1 (1.9)	3 (5.8)	0 (0.0)
Hydraulic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nuclear	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Optics	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Life Science	2 (3.8)	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	2 (3.8)	1 (1.9)	0 (0.0)	0 (0.0)	1 (1.9)	0 (0.0)

was the case with contractor inventions. The shift in emphasis is due, we believe, to the fact that the public service agencies sponsor inventions with greater commercial orientation and, in addition, carry development of their inventions further toward a commercially useful form. Table 39 shows the high percentage of costs going to technical development for DOD and AEC inventions (matching the pattern of contractor inventions in Table 22) as compared to the same costs for Agriculture and TVA patents. (Utilization studies of Agriculture and TVA inventions are reported in Part III.)

f. *Factors Affecting Utilization.* The small number of patents and licensees of government-owned inventions makes a statistical analysis of the factors affecting utilization difficult. The case studies in Part III provide most of the findings in this respect. From the statistics that are available, however, it appears that prior experience is the most important factor affecting utilization. As shown in Table 40, utilization drops from 62 percent to 19 percent when the licensee has no prior experience in the field of the invention.

TABLE 33
TOTAL RESPONSE LICENSEES OF GOVERNMENT -OWNED PATENTS
(1957 AND 1962)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	5 - 0	5 - 50	50 - 200	Over 200
Total	115 (100.0)	62 (53.0)	27 (23.0)	14 (12.0)	12 (10.0)
0 - 20	92 (80.0)	45 (39.0)	21 (18.0)	14 (12.0)	12 (10.0)
20 - 50	8 (6.0)	2 (1.0)	6 (5.0)	0 (0.0)	0 (0.0)
50 - 80	4 (3.0)	4 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)
80 - 100	11 (9.0)	11 (9.0)	0 (0.0)	0 (0.0)	0 (0.0)

TABLE 34
NUMBER OF LICENSES IN COMMERCIAL USE
(GOVERNMENT -OWNED PATENTS)

Frequency
(Percent)

Percent Government Business	Size of Firm ($ in millions)				
	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	41 (100.0)	29 (70.0)	5 (12.0)	2 (4.0)	5 (12.0)
0 - 20	40 (97.0)	28 (68.0)	5 (12.0)	2 (4.0)	5 (12.0)
20 - 50	1 (2.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)
50 - 80	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
80 - 100	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

If such is the case, one should find inventions with good commercial potential being utilized even in the absence of exclusive rights, particularly with the inventions of public service agencies such as Agriculture and TVA who have civilian oriented R&D programs. This section and the case studies in Part III below report on this aspect of the study.

b. *The License Subsample.* The license subsample consists of 126 inventions patented by the government in 1957 and 1962 and licensed to 342 organizations. Table 31 shows the distribution of these inventions among the sponsoring government agencies. In contrast to contractor inventions, this subsample is concentrated in agencies other than the Department of Defense. AEC and Agriculture own the largest number, accounting for 65 percent of the patents and 55 percent of the licenses. TVA has the largest number of licenses per invention, reporting 106 licenses under three patents.

c. *The Response.* Utilization questionnaires were distributed to all licensees (see Appendix A) and 149 licensees—or 43 percent—replied. Ten inventions were used by some 50 licensees (Table 32), the widest utilization being achieved by a TVA invention reported in use by 32 licensees. Only two DOD inventions in the response were utilized.

d. *Connection of Licenses and Utilization.* Table 33 shows the concentration of licenses by size of firm and percent government business.[50] Eighty percent of the licenses are held by firms doing 20 percent or less of their business with the government, 39 percent are held by firms with $5 million or less in sales, and an additional 18 percent are held by firms with from $5 to $50 million in sales. Thus it is evident that the greatest interest in nonexclusive licenses is by small-to medium-sized firms operating almost wholly within commercial markets.[51]

Table 34 shows that the licenses in commercial use are even more concentrated in the small and commercially oriented firms that were the licenses of government-owned patents described in Table 33. Ninety-seven percent of the utilization is by firms with 20 percent or less government business, and 68 percent is by firms with $5 million or less in sales.

Table 35 shows the number of licenses in use where the invention played a critical role. Twenty-two, or more than half of all commercially used where the invention played a critical role. Twenty-two, or more than half of all commercially used licenses, fall within this category. Small firms ($5 million or less in sales) again account for much of the utilization, reporting 11 of the 22 licenses with a critical role.

Table 36, which distributes the response by field of technology and by form of invention, indicates a heavy concentration of licenses in the chemical field—reflecting the high utilization of TVA fertilizer inventions. Chemical inventions account for 53 percent of the total in contrast to 15 percent for contractor inventions. The process and material forms of inventions, accounting for 61.7 percent of the response compared to 20 percent for contractor inventions, also exhibit a heavy concentration of licenses.

Commercial utilization by field of technology and form of invention is indicated in Table 37. Here, the concentration in the chemical field is even higher than with license holdings. Utilization in this field accounts for 76.9 percent of the total (53 percent for holdings), about evenly divided between process (30.8 percent) and material (38.5 percent) inventions. Substantially the same pattern occurs for licenses in which the invention played a critical role in commercial use (see Table 38).

e. *Sales and Private Development Costs.* Sales and private development costs associated with utilization of government-owned patents are included in Table 39. (Sales data represent respondents' estimates of cumulative sales through 1966). Domestic and foreign sales to the date of the survey were $210.3 million, compared to $405 million for contractor inventions (see Section B.5) All but $7.03 million of this is attributable to inventions which play a critical role in their commercial use.

Unlike contractor inventions where sales were related primarily to DOD inventions, government-owned patents arising from this source account for only .4 percent ($75,000) of the total. Agriculture and TVA are the largest contributors of commercial inventions, and, here again, the extreme variability in commercial potential of government patents, seen first in connection with contractor inventions, is evident. Three patents involved in the manufacture of potato flakes account for about half the sales from Agriculature inventions.

As with contractor inventions, reports on private development costs were sketchy. Licensees reported $5.389 million in development expense, with a much smaller share—21.1 percent—going toward technical development of the invention and a much larger share—52.2 percent—going toward production facilities than

[50] Only 115 licensees are reported by size of firm and percent government business because some organizations were nonprofit cooperatives which could not respond to the size of firm and percent government business question.

[51] However, it is general knowledge that the government does not enforce its patent rights and many firms may be using government patents without obtaining a license.

TABLE 29

REASONS FOR NONUTILIZATION OF INVENTIONS

(CONTRACTOR INVENTIONS, 1957 AND 1962)

Frequency
Percent

Rank of Reason	Reason for No. Commercial Utilization	No Reason Given	Development Costs Too High	Development Revealed Serious Flaws	Development Personnel Not Available	Invention Became Obsolete	Expected Market Failed to Materialize	Technology too Sophisticated	Too Much Competition	Channels of Distribution Lacking	Invention Falls Outside of Company Product Line	No Commercial Potential Seen	All Other	Total Reasons Given
	1	244	20 (1.4)*	21 (1.4)	6 (.4)	236 (16.2)	208 (14.3)	171 (11.7)	10 (.7)	26 (1.8)	234 (16.1)	420 (28.9)	102 (7.0)	1,454
	2	1,116	80 (13.7	23 (4.0)	4 (.7)	76 (13.1)	78 (13.4)	62 (10.7)	26 (4.5)	43 (7.4)	67 (11.5)	86 (14.8)	37 (6.3)	582
	3	1,470	22 (9.6)	15 (6.6)	5 (2.2)	22 (9.6)	34 (14.9)	17 (7.5)	28 (12.3)	17 (7.5)	48 (21.0)	10 (4.4)	10 (4.4)	228
	4	1,611	3 (3.4)	7 (8.1)	3 (3.4)	35 (40.3)	6 (6.9)	5 (5.8)	8 (9.2)	6 (6.9)	12 (12.7)	1 (1.5)	1 (1.5)	87
	5	1,635	1 (1.6)	1 (1.6)	7 (11.1)	10 (15.9)	34 (54.0)	3 (4.8)	1 (1.6)	3 (4.8)	2 (3.2)	0 (0)	1 (1.6)	63

*Percentage is the total responses for a reason, divided by the total reasons given for that row.

This pattern is particularly pronounced for large firms doing 20 percent or less of their business with the government. This group accounts for 31.4 percent of the patents available for license[25] but received only 5.7 percent of the license requests,[26] and entered 3.6 percent of the licenses agreements.[27] All that they did license, however, were used.[28] Large firms doing 80 to 100 percent of their business with the government show a contrasting pattern: Accounting for 18.5 percent of the inventions available for license,[29] they received 26.9 percent of the license requests,[30] entered into 30.4 percent of the licenses,[31] but accounted for only 14.3 percent of the licenses in use.[32] Note, however, as Tables 26 and 27 show, 10 of the 11 licenses in use covered inventions which licensor was also using—a degree of common use of inventions not exhibited by other groups of firms.

By far the strongest license utilization record is held by firms with sales of from $5 to $50 million doing 50 to 80 percent of their business with the government. They account for only 1.5 percent of the inventions available for license,[33] but received 19.4 percent of the license request,[34] entered into 23.2 percent of the licenses,[35] account for 33.8[36] percent of the licenses in use, and utilized directly five of the 26 inventions used by licensees. This group—which itself uses only 4.3 percent of the patents in commercial use[37]—made its greatest contribution to utilization through licensing.

A consistent record of utilization both directly and through licenses is shown by large firms doing 20 to 50 percent of their business with the government: Accounting for 20.9 percent of the inventions available for license,[38] they received 20 percent of the license requests,[39] entered into 15.9 percent of the licensing agreements,[40] and accounted for 22.1 percent of the licenses in use.[41] This matches closely its *direct* utilization of inventions (27.5 percent).[42] This same group, however, used only two of the 17 inventions which were utilized by licensees,[43] illustrating the influence of a company's basic orientation on commercial use of an invention (see Part II).

Table 28 compares the concentration of firms achieving utilization through licensing with that of firms holding patent rights and firms using the inventions directly.[44] Only 23 firms reported licenses in use, compared with 65 who used inventions themselves.[45] The top five licensors accounted for 70.7 percent of the licenses in use, achieving a much higher concentration than the top five contractor responders who accounted for 27.2 percent of the contractor uses.[46] This is consistent with the finding in Section B5 above that a few inventions with high potential account for the major share of commercial sales. In addition, company interviews[47] indicate that few have an active program to promote licenses. These two factors—low commercial potential and little promotional activity—screen out all but inventions with high importance to prospective licenses.

Table 28 shows that the top five licensors rank 25th in terms of patent rights holdings and 14th as direct utilizers, suggesting that direct use by licensors and utilization through licensing may be more closely linked characteristics of sample firms than are large patent holdings and licensing.

Licensing time lags in connection with the effect of patent policy on business competition are discussed in Part V, Section B.2.

8. Reasons for Nonutilization of Inventions

The utilization questionnaire included 10 reasons for nonutilization of an invention. In each case, responders were asked to rank 10 different reasons for nonutilization according to the importance of the reason in the decision not to utilize. Table 29 presents the response to this question. The first row indicates the number of times a reason was ranked first, the second row, the number of times a reason was ranked second, and so forth. Table 30 groups the reasons and responses in two categories—technical and marketing—and relates the effect of prior experience, patent rights, percent government business, and size of firm to them.

[25] Table 23.
[26] Table 24.
[27] Table 25.
[28] Tables 25 and 26.
[29] Table 23.
[30] Table 24.
[31] Table 25.
[32] Table 26.
[33] Table 23.
[34] Table 24.
[35] Table 25.
[36] Table 26.
[37] Table 11.
[38] Table 23.
[39] Table 24.
[40] Table 25.
[41] Table 26.
[42] Table 11.

[43] Tables 26 and 27.
[44] Table 28 includes nonprofit organizations as well as contractors.
[45] Table 3.
[46] Table 3.
[47] Part II.

TABLE 23
PATENTS AVAILABLE FOR LICENSING
(CONTRACTOR INVENTIONS)

Frequency
(Percent)

	Size of Firm ($ in millions)				
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	1,539 (100.0)	55 (3.6)	116 (7.5)	139 (9.0)	1,229 (79.9)
0 - 20	555 (36.1)	11 (.7)	15 (1.0)	46 (3.0)	483 (31.4)
20 - 50	366 (23.8)	1 (.1)	28 (1.8)	15 (1.0)	322 (20.9)
50 - 80	198 (12.8)	4 (.3)	24 (1.5)	31 (2.0)	139 (9.0)
80 - 100	420 (27.3)	39 (2.5)	49 (3.2)	49 (3.1)	285 (18.5)

TABLE 24
REQUESTS FOR LICENSES
(CONTRACTOR INVENTIONS)

Frequency
(Percent)

	Size of Firm ($ in millions)				
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	175 (100.0)	5 (2.9)	63 (36.0)	9 (5.1)	98 (56.0)
0 - 20	15 (8.6)	1 (.6)	1 (.6)	3 (1.7)	10 (5.7)
20 - 50	63 (36.0)	0 (0.0)	27 (15.4)	1 (.6)	35 (20.0)
50 - 80	42 (24.0)	0 (0.0)	34 (19.4)	2 (1.1)	6 (3.4)
80 - 100	55 (31.4)	4 (2.3)	1 (.6)	3 (1.7)	47 (26.9)

TABLE 21

SALES AND DEVELOPMENT COSTS ASSOCIATED WITH COMMERCIAL UTILIZATION
SAMPLE YEARS 1957 AND 1962
(CONTRACTOR INVENTIONS)

	Amount[1] of Actual Domestic Sales From:		Amount[1] of Actual Foreign Sales From:		Development Costs:				Number of Licenses in Use for Inventions With:	
	Critically Important Inventions	Inventions With a Supporting Role	Critically Important Inventions	Inventions With a Supporting Role	Amount[1] ($)	Average[2] Percent in Technical Development	Average[2] Percent in Production Facilities	Average[2] Percent in Marketing	Critical Role	Supporting Role
Total Sample	193.63	117.07	47.28	47.65	26.33	56.8	22.7	20.5	31	40
DOD	193.48	117.05	47.18	47.65	25.88	56.8	21.9	21.3	29	38
AEC	0	.021	0	0	.201	52.5	45	2.5	1	2
Other Agencies	.15	0	.10	0	.25	70	20	10	1	0
1957 DOD	100.85	103.37	45.80	40.32	3.59	58.3	20	21.7	12	13
1962 DOD	92.63	13.68	1.38	7.33	22.29	56.2	22.7	21.1	17	25

[1] To date of response to questionnaire.
[2] Average for those responding to this question only.

ratio of 77 rapid to 15 slow utilizations. In contrast, firms without prior commercial experience had a ratio of only 31 to 22. Thus, the value of prior experience in achieving commercial utilization reappears in the data. A second relationship of statistical significance is that it takes longer to achieve utilization of end products than other forms of inventions such as materials, components, or processes.

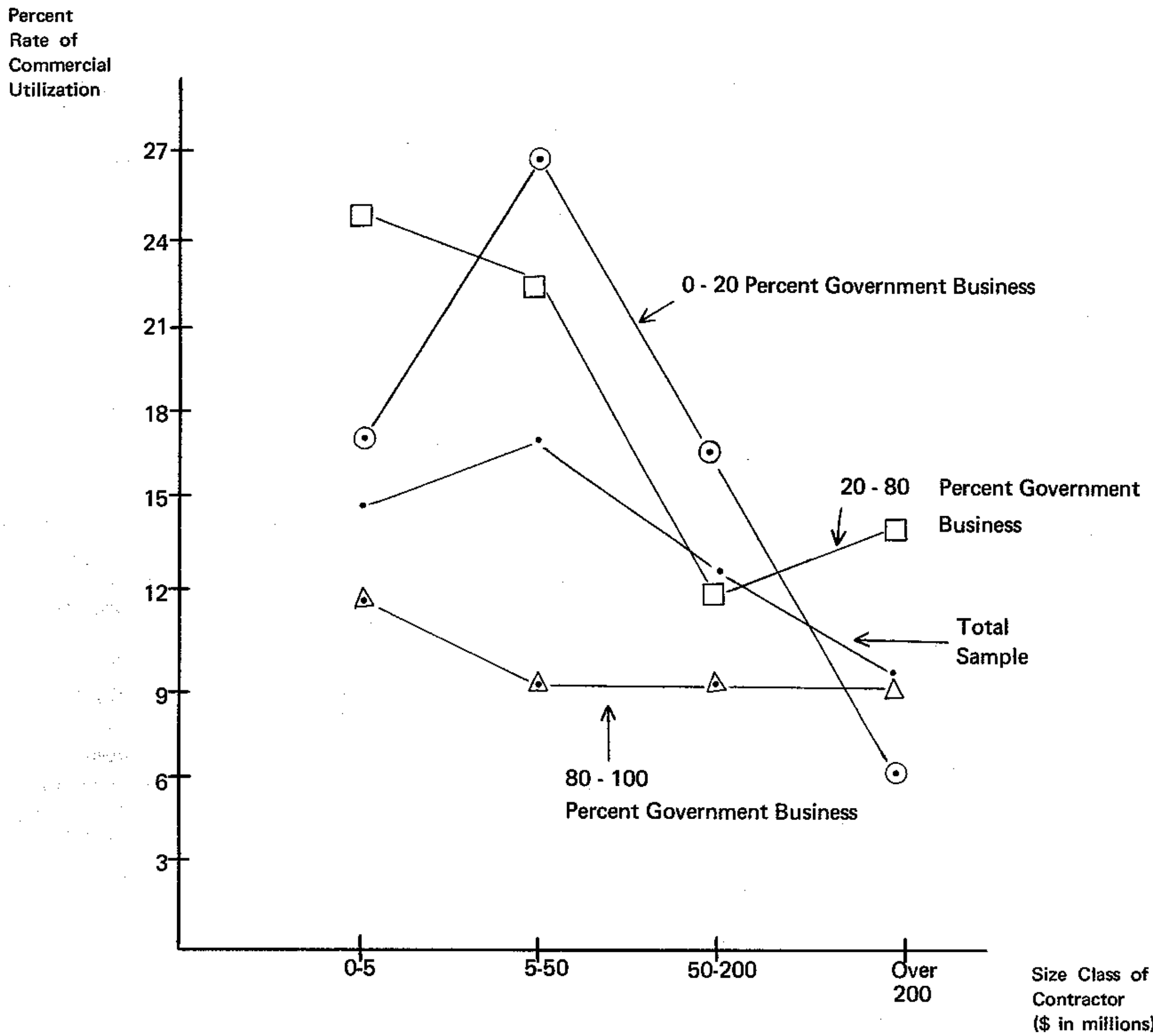
It was expected that mechanical inventions might achieve commercial utilization faster than inventions based upon other technologies, but this is not the case. Nor did firms with low levels of government business achieve commercial utilization faster than firms with high levels of government business, notwithstanding their proximity to commercial markets. The statistics show high percent government firms outperforming low percent firms in this respect (a ratio of 30 to 22 for 0 to 20xpercent government and 31 to 11 for 80 to 100 percent government business). There is a statistically significant relationship indicating that firms in the medium range of government activity (20 to 80 percent) have the fastest rate of commercial utilization (a ratio of 47 rapid to 4 slow utilizations). This may be due to the fact that firms with both low and high proportions of government activity separate their government and commercial work to a greater extent that the firms in the medium range of government activity (see Part II).

7. Licensing of Contractor Inventions

The utilization survey asked questions on licensing of sample inventions to determine the extent to which government-sponsored patents (i) are available for licensing to others and (ii) actually result in license agreements and commercial application. The responses to these questions are discussed here and in Part V.

The responses show that almost all the contractor inventions are available for license. Contractors reported 1,539, or 95 percent, of the 1,618 inventions in which they held title as available for license. The distribution of these inventions by size of firm and percent government business is shown in Table 23. The great majority--almost 80 percent--are held by firms with sales over $200 million. Verification of information on the remaining inventions established that only 15--less than 1 percent--involved refusals to license and these were held by only five companies. (Part V, Section B3, discusses these inventions in more detail.) Contractors received 175 requests for license of sample inventions (Table 24), resulting in 138 agreements (Table 25), of which 77 were reported in use (Table 26)--thus 79 percent of the license request resulted in agreements. Table 27 shows the number of licensed inventions used by licensors.

FIGURE I - 1
RELATIONSHIP AMONG SIZE OF FIRM, PERCENT GOVERNMENT BUSINESS, AND THE RATE OF COMMERCIAL UTILIZATION[1]



[1] Defined as patents in commercial use/patents in response.

TABLE 15
CORRELATION OF PATENT RIGHTS, PRIOR EXPERIENCE, YEAR OF PATENT, AND COMMERCIAL UTILIZATION

Characteristics of Invention	Rate of Commercial Utilization (percent[1])	Observations (No. Utilized/ Total No. Observations)
Year of Patent		
1. 1962 patent, contractor has title and prior experience	22.8	78/341
2. 1957 patent, contractor has title and prior experience	25.6	50/195
Title (both years)		
1. Contractor has title and prior experience	23.8	128/536
2. Contractor has no title, but has prior experience	13.3	8/60
Prior Experience (both years)		
1. Contractor has prior experience, but no title	13.3	8/60
2. Contractor has no prior experience, but has title	6.6	63/948
3. Contractor has no prior experience and no title	2.2	4/176

[1] Computed by dividing the number utilized by the total number of observations.

TABLE 16
PERCENT OF INVENTIONS USED OR EXPECTED TO BE USED
(Total Observations equal 1,740)

	Prior Commercial Experience		No Commercial Experience	
	Percent	Observations	Percent	Observations
Exclusive Rights	29.7	(165/554)	10.0	(96/956)
Nonexclusive Rights	12.5	(7/56)	4.6	(8/174)

TABLE 17
PERCENT OF INVENTIONS WITH CRITICAL ROLE IN COMMERCIAL USE
(Total Observations equal 1,740)

	Prior Commercial Experience		No Commercial Experience	
	Percent	Observations	Percent	Observations
Exclusive Rights	4.7	(26/554)	3.6	(34/956)
Nonexclusive Rights	1.8	(1/56)	0.6	(1/174)

patent position and frequently without prior consultation with company personnel responsible for patents.

b. *Other Factors.* Three other factors—the field of technology, the size of the firm, and the percent government business—were found to affect the rate of commercial utilization statistically.

Table 20 shows that mechanical inventions have a higher rate of utilization than inventions in other fields of technology. Prior experience again strongly influences utilization, but apparently less for mechanical inventions than for those in other fields of technology.

The combined effect of size of firm and percent government business on utilization [14] is shown in Figure I-1. As we have already discussed, large firms in government markets tend to patent government inventions for reasons other than planned use of the invention, resulting in their lower rates of utilizations shown in Figure I-1. Many firms who do most of their work for the government (see Part II) do not try to apply the inventions commercially and, therefore, have low rates of utilization. Smaller firms and those more oriented to commercial markets achieve higher utilization because they patent more selectively and have the necessary experience to develop market innovations in their product lines. Even for firms with the highest rates of utilization, however, the amount of utilization is very small when measured in sales. Thus the factors affecting utilization, described above, affect it only within a narrow range of performance. The most basic factor, as noted in Part II, is the commercial potential of the sample inventions and all other factors made a difference only when inventions reach a minimum threshold of

[14] The rate of commercial utilization is computed differently in Figure I-1 than in the Table 6 through 11 reported above. Utilization percentages in Tables 6 through 11 represent a group's share in all inventions used. Utilization rates in Figure I-1 represent the percent of a group's holdings that it hasbeen able to utilize.

TABLE 13

PATENTS IN COMMERCIAL USE: 1957, 1962, AND SUPPLEMENTARY INVENTIONS (UTILIZATION QUESTIONNAIRES)

Frequency (Percent)

Field of Technology	Type of Invention					
	Total	Process	Material	Component	End Product	Other
Total	215 (100.0)	36 (16.7)	5 (2.3)	68 (31.6)	106 (49.3)	0 (0.0)
Electronic	62 (28.8)	5 (2.3)	0 (0.0)	18 (8.4)	39 (18.1)	0 (0.0)
Electric	5 (2.3)	0 (0.0)	0 (0.0)	1 (.5)	4 (1.9)	0 (0.0)
Chemical	16 (7.4)	12 (5.6)	3 (1.4)	0 (0.0)	1 (.5)	0 (0.0)
Mechanical	69 (32.1)	11 (5.1)	0 (0.0)	31 (14.4)	27 (12.6)	0 (0.0)
Hydraulic	12 (5.6)	0 (0.0)	0 (0.0)	6 (2.8)	6 (2.8)	0 (0.0)
Nuclear	2 (.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (.9)	0 (0.0)
Optics	9 (4.2)	1 (.5)	1 (.5)	1 (.5)	6 (2.8)	0 (0.0)
Life Science	2 (.9)	1 (.5)	0 (0.0)	0 (0.0)	1 (.5)	0 (0.0)
Other	38 (17.7)	6 (2.8)	1 (.5)	11 (5.1)	20 (9.3)	0 (0.0)

which account for 90 percent of the total. Overall utilization is half the rate of the response (Table 13), but utilization of critically important inventions (Table 14) is the same rate as the response—all but one are process inventions.

4. Factors Affecting Utilization

Having identified the patterns of patent activity in the sample and the response, the data were analyzed as to the major factors affecting utilization. Contractor rights, prior experience, percent government business, size of firm, field of technology, form of invention, kind of agency, and year of patents were all tested for their effect on commercial use.

a. *Patent Rights, Prior Experience, and Year of Patent.* Of all the factors patent rights and prior experience show the strongest association with commercial utilization. Table 15 correlates these factors and the year of patent with the rate of utilization. The year of the patent issue appears to have little effect on utilization, but utilization drops from 23.8 to 13.3 percent when exclusive rights are not available and from 23.8 to 6.6 percent when prior experience is not present.

As shown in Table 16, when inventions with both actual and expected utilization are included, commercial utilization drops from 29.7 to 12.5 percent when contractors have no exclusive rights and from 29.7 to 10 percent when they have no prior experience in the field of invention.

TABLE 11A
PATENTS IN COMMERCIAL USE
(CONTRACTORS)

Frequency
(Percent)

	Size of Firm ($ in millions)				
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	200 (100.0)	9 (4.5)	26 (13.0)	20 (10.0)	145 (72.5)
0 - 20	58 (29.0)	2 (1.0)	9 (4.5)	9 (4.5)	38 (19.0)
20 - 50	64 (32.0)	0 (0.0)	4 (2.0)	5 (2.5)	55 (27.5)
50 - 80	36 (18.0)	2 (1.0)	8 (4.0)	1 (.5)	25 (12.5)
80 - 100	42 (21.0)	5 (2.5)	5 (2.5)	5 (2.5)	27 (13.5)

TABLE 11B
PATENTS IN COMMERCIAL USE WHERE INVENTION PLAYED A CRITICAL ROLE
(CONTRACTORS)

Frequency
(Percent)

	Size of Firm ($ in millions)				
Percent Government Business	Total	0 - 5	5 - 50	50 - 200	Over 200
Total	49 (100.0)	7 (14.3)	9 (18.4)	9 (18.4)	24 (49.0)
0 - 20	21 (42.9)	1 (2.0)	3 (6.1)	5 (10.2)	12 (24.5)
20 - 50	8 (16.3)	0 (0.0)	1 (2.0)	2 (4.1)	5 (10.2)
50 - 80	7 (14.3)	2 (4.1)	1 (2.0)	1 (2.0)	3 (6.1)
80 - 100	13 (26.5)	4 (8.2)	4 (8.2)	1 (2.0)	4 (8.2)

TABLE 8
NUMBER OF RESPONDING COMPANIES[1]

Frequency
(Percent)

1957

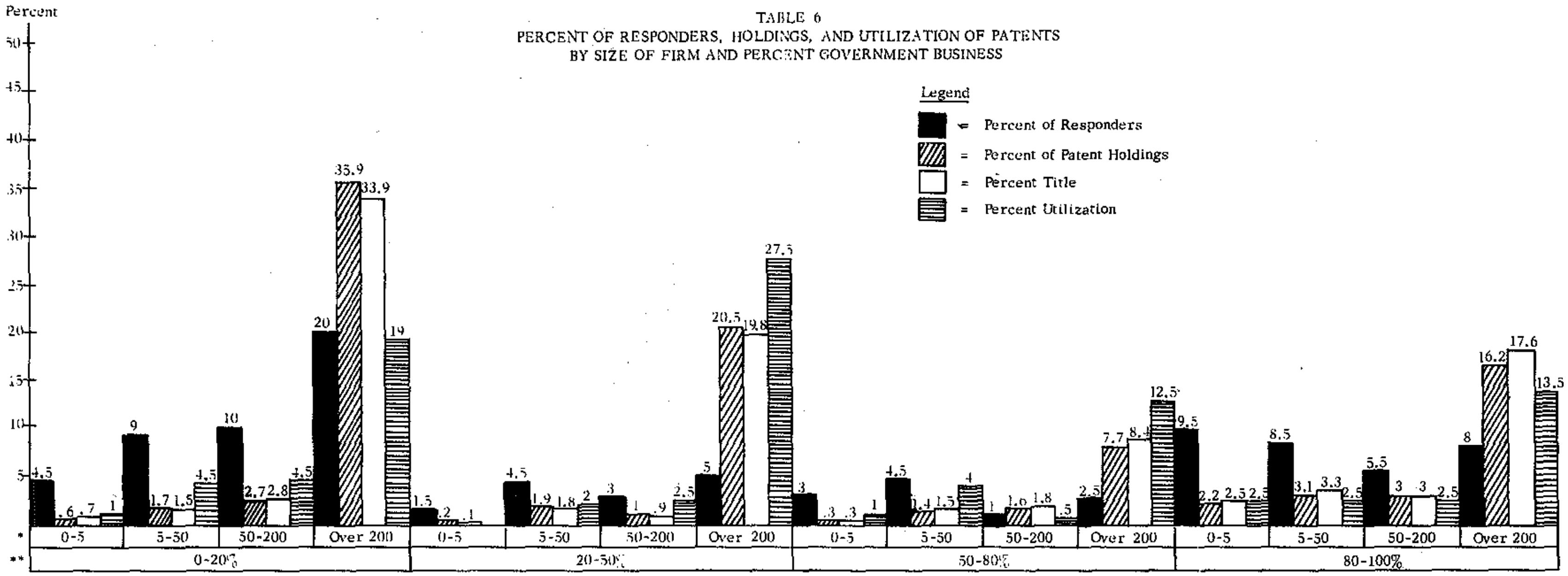
	Size of Firm ($ in millions)				
Percent Government Business	0 - 5	5 - 50	50 - 200	Over 200	Total
0 - 20	5 (4%)	8 (8%)	10 (10%)	18 (17%)	41 (40%)
20 - 50	3 (3%)	8 (8%)	5 (4%)	4 (4%)	20 (19%)
50 - 80	3 (3%)	6 (6%)	0 (0%)	3 (3%)	12 (12%)
80 - 100	10 (10%)	7 (7%)	4 (4%)	9 (9%)	30 (29%)
Total	21 (20%)	29 (28%)	19 (18%)	34 (33%)	103 (100%)

1962

	Size of Firm ($ in millions)				
Percent Government Business	0 - 5	5 - 50	50 - 200	Over 200	Total
0 - 20	6 (5%)	14 (11%)	13 (10%)	29 (22%)	62 (47%)
20 - 50	0 (0%)	5 (4%)	2 (2%)	8 (6%)	15 (11%)
50 - 80	4 (3%)	5 (4%)	2 (2%)	9 (6%)	19 (15%)
80 - 100	9 (7%)	11 (8%)	7 (5%)	8 (6%)	35 (27%)
Total	19 (15%)	35 (26%)	24 (19%)	53 (40%)	131 (100%)

[1] The two sample years (1957 and 1962) are shown separately because some firms fall into different categories in the two years as a result of changes in the size or business mix (commercial and government). The total number of responders for both years is 192.

TABLE 6
PERCENT OF RESPONDERS, HOLDINGS, AND UTILIZATION OF PATENTS
BY SIZE OF FIRM AND PERCENT GOVERNMENT BUSINESS



*Size of firm ($ in millions).
**Percent Government business.

responders, hold rights (title and license) in 80 percent of the inventions (see Table 7), and account for 72 percent of the utilization (see Table 9). Table 6 indicates that these same firms (annual sales over $200 million) have the following characteristics:

(i) Firms in the 0 to 20 percent government business category include 20 percent of the responders, have title in 33.9 percent of the inventions and account for 19 percent of the inventions utilized;

(ii) Firms in the 20 to 50 percent government business category comprise 5 percent of the responders, have title in 19.8 percent of the inventions, and account for 27.5 percent of the inventions utilized;

(iii) Firms in the 50 to 80 percent category include 2.5 percent of the responders, have title in 8.4 percent of the inventions, and account for 12.5 percent of the inventions utilized; and

(iv) Firms in the 80 to 100 percent government business category make up 8 percent of the responders, have title in 17.6 percent of the inventions, and account for 13.5 percent of the inventions utilized.

Highlighting the record of this group, as shown in Table 6, is the heavy concentration–20 percent of all responders– of firms doing 20 percent or less of their business with the government. These firms own a larger share of inventions (33.9 percent) than they have utilized (19 percent). In contrast, large firms in the 20 to

TABLE 3

CONCENTRATION OF CONTRACTOR PATENT HOLDINGS IN THE SAMPLE AND RESPONSE AND RATE OF COMMERCIAL UTILIZATION: ALL AGENCIES BOTH SAMPLE YEARS

Number of Firms		Number of Patents in			Percent[5] of Total Patents in			% Average Utilization Percent[6]
		Sample[2]	Response[3]	C. U.[4]	Sample	Response	C. U.	
Top Five[7]		721	662	57	31.2	32.6	27.2	8.6
10		1,150	1,047	92	49.7	51.6	43.8	8.8
25		1,635	1,479	142	70.7	73.0	67.6	9.6
50		1,919	1,735	170	82.9	85.6	81.0	9.8
Total		2,316	2,024	210	100.0	100.0	100.0	10.4
In Sample, No Response		1,082						
Number of Firms:								
(1) Responding	192							
(2) Not Responding	271							
(3) Total	463							
(4) With At Least One C.U.	65							

[1] Total sample includes all patents developed by contractors and issued in 1957 and 1962, except those developed under NASA contracts and 415 AEC inventions.
[2] "Sample" means the total population of patents as defined in footnote 1.
[3] "Response" indicates the number of patents for which questionnaires were returned.
[4] "C. U." indicates that commercial utilization has been achieved for this patent, by the inventing contractor.
[5] Percent in each case is the percent of the total patents of responding firms in the sample, the response, and in commercial utilization. For example, a total of 210 patents in C. U. and the top five firms held 57 or 27.2 percent of these patents in C. U.
[6] Calculated by taking the sum of patents in C. U. over the sum of patents in the response for each class.
[7] Ranking is by order of number of questionnaires in the response.

TABLE 2
SUMMARY OF STUDY PATENTS
PATENTS ISSUED IN 1957 AND 1962, "ALL RIGHTS IN AEC," AND SUPPLEMENTARY LIST

Sponsor Agency	Number of Contractor-Owned Patents		Number of Licenses		All Rights in AEC		Supplementary Patents[1]																	
	1957	1962	1957	1962	1957	1962	1956		1958		1959		1960		1961		1962		1964		1965		1966	
							T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L	T	L
Army	188	289	28	21																				
Navy	355	478	148	149																				
Air Force	415	734	17	40																				
AEC	33	98	210	180	51	95																		
NASA	4	7		4																				
HEW	1	2	2	4							2	2	1	2	1	1	4	2		2	1	1		1
Interior			1	1							1		1		1				5		4			
Agriculture		1	16	18						3		1		1										
GSA	1			1			3		11		7		4		2		1							
IRS			1																					
Commerce	2		8	7																				
Justice	4																							
FAA		8													1		5				2	1		
P.O.		4											1		8		3							
TVA				3																				
NSF											1		2											
TOTAL	1,003	1,621	419	411	51	95	3	0	11	3	11	3	9	3	13	1	13	2	5	2	7	2	0	1

[1] "T" and "L" designations for supplementary patents indicate title or license held by private organizations.

inventions is very low: Of all government-sponsored inventions patented in 1957 and 1962, only *251* or *12.4 percent* received any use at all and only *55* or *2.7 percent* played a critical role in the commercial products in which they were incorporated. Measured in sales, utilization amounted to $616 million through calendar year 1966–$406 million of this was attributable to contractors who made and owned the inventions and $210 million to licensees of the government who utilized inventions with nonexclusive rights. Prior experience in the field of technology of the invention was found to be the single most important factor affecting utilization; exclusive patent rights were second.

With both groups of users (contractors and licensees of government-owned inventions), a very few inventions account for the majority of the sales: Just five contractor inventions--in the fields of transistors, vacuum tubes, numerical control devices, computers, and gas turbine engines--account for 88 percent of the sales of critically important inventions. And just three patents on the manufacture of potato flakes account for about half the sales of licensees.

Significantly, the evidence does not indicate that either title or nonexclusive licensing is uniformly the best way to promote utilization. There are areas of technology where title is required for utilization; areas where title would inhibit it; and a large area–inventions with no commercial application–where neither title nor license will promote utilization. Licensing has been most effective with inventions of the Department of Agriculture and TVA (see Part III). Both agencies perform research in consumer products and develop inventions to the point where the financial risk to the private commercializer is often low. In addition, their inventions relate to industries that spend relatively littly on R&D and, as a result, are not overly concerned about patent protection.

The Departments of the Interior and Health, Education, and Welfare (HEW) perform research in more speculative areas such as water desalination and medicinal chemistry relating to industries that are highly sensitive to patents (see Volume II and Volume IV, Part III). Here, the question ofpatent protection is very much an issue.Some exclusivity may be required to promote utilization or at the very least to induce investment of private funds to carry forward promising lines of research begun by the agencies.

The Department of Defense has the largest number of inventions, most of which have very limited commercial application (see Section B below) For those that have no commercial application, patent policy is not really an issue in most cases so far as utilization is concerned. But patent policy can provide some incentive for other reasons since many DOD contractors acquire patents for their speculative value, as a means of insuring freedom of design, of protecting against infringement suits, of recognizing employee inventiveness, and of negotiating cross-licenses (see Part II). For inventions that have high commercial potential and that can be used largely as developed for the government, utilization may be promoted best by licensing all comers. But for inventions requiring substantial additional development or involving a small or uncertain market, some exclusivity may be a necessary incentive to attract investment of private funds. In many areas of the DOD program, such as development of complex systems and subsystems, contractors rely more on engineering and management capacilities than patent position to generate sales. And, firms doing most of their business with the government do not, in many instances, try to apply their inventions commercially. However, leaving title with the contractor even in these cases will still create a more favorable utilization environment than government ownership since the Department of Defense does not actually promote commercial use of its inventions.

Educational and nonprofit institutions play a different role in the utilization process than do other groups involved in government programs (see Part IV). Although these organizations develop many inventions under R&D projects, they cannot utilize them directly and must find a licensee to carry the invention through to commercial application. Although a few schools and nonprofit research organizations pursue this approach aggressively, most avoid any such involvement and rely instead on patent development firms to promote their patents for them. Even where no promotion is provided, allowing such organizations to retain title facilitates utilization when a licensee seeks them out. Since these inventions usually are very basic, the prospective user may need not only a license but also the assistance of the inventor, and such arrangements are made more easily in a single transaction with the inventor and his institution.

Part V shows that all but about 1 percent of the sample inventions are available for license from industrial owners and that license requests are being acted on promptly. In fact, an investigation of infringement suits involving sample inventions indicated that discovering users to negotiate licenses is a bigger problem than willingness to license in the orderly promotion of government-sponsored inventions.

More detailed findings on utlization and business competition are presented in the introductory portions of Parts II through V below.

Page

PART III. Programs Related to the Utilization of Inventions

As noted above, the SBA's activities in relation to the utilization of inventions are incidental to its primary mission. The agency has recently initiated an innovation loan program, in which the field office staff will actively seek out small businesses that have innovation plans but are impeded by lack of funds. The agency will solicit loan applications from these businesses and provide advice and assistance in developing and marketing new products.

Several activities of the SBA have a direct bearing on the utilization of patents and technology. Until October 1966 the SBA published a *Products List Circular* describing patents that were thought to be potentially usable by small business concerns. The patents were selected primarily from the *Official Gazette*, but also through the daily contacts of agency personnel with small business concerns. The patents included in the *Products List Circular* were selected on the basis of the judgement of SBA personnel as to the extent of investment required and the marketability of the product. The items described in the *Products List Circular* included both government-owned patents, available on a royalty-free, nonexclusive basis, and privately owned patents, available for purchase, licensing, or other arrangements.

Publication of the *Products List Circular* was dropped in November 1966 for budgetary reasons, the same information being available elsewhere in the government, though in a less convenient form. At the time of its final publication, the *Products List Circular* had a circulation of 7,000 to 8,000. The SBA business facilities inventory provided the basic mailing list, which was enlarged as additional requests for the circular came in. In a test of effectiveness of the circular conducted shortly before discontinuance, 3,713 questionnaires were forwarded to subscribers and 1,404 replies were received. These replies revealed that 218 subscribers acknowledged making 1,614 inquiries about patents and 390 patent owners admitted receiving 2,344 inquiries. The replies also indicated that 22 of the 1,012 patents publicized had changed ownership (title) or license in the seven months prior to the survey and more than 100 negotiations were in progress.

During the past year the SBA has initiated two programs in cooperation with the Atomic Energy Commission (AEC) and the National Aeronautics and Space Administration (NASA) to educate small businessmen in recent technological developments of these agencies. With AEC, the SBA has organized groups of small businessmen to be briefed by personnel of the Argonne National Laboratory on current technology. These briefings or seminars have been presented to between 100 and 150 small businessmen thus far; each one has taken two or three days. Participants are selected for invitation by SBA field office personnel from personal knowledge and from the business facilities inventory; the subjects of the seminars have been selected by AEC personnel. Although the seminars are not explicitly designed to promote patent utilization, this may be one of the results of the program. The initial seminars drew on a broad selection of companies. Future seminars, however, will be addressed to industry groupings—for example, to companies in a specified metropolitan area or to companies with a common technical interest, such as valve manufacturers. The SBA plans to extend these seminars to NASA installations and, if security considerations permit, to other AEC installations.

With NASA, the SBA has developed a pilot program to foster the use by small businesses of the NASA regional dissemination centers for the classification, storage, and retrieval of technical information generated by NASA programs. The pilot program involved 18 companies, selected to provide a representative group as to size (from 25 to 325 employees), type (from wholly R&D to wholly manufacturing), and product (mechanical, electrical, electronic, and so forth). The SBA referred the selected companies to the regional dissemination center at Wayne State University in Michigan—the Center for Application of Sciences and Technology (CAST)—for assistance in defining technical problems and finding relevant technology for solving them. The SBA has also assisted the participating businesses in the application of the NASA-generated technology.

A preliminary evaluation of the pilot program with Wayne State indicates that small businesses, particularly those with a relatively high level of technical capability,

Under the Test Demonstration Program, demonstrations of new fertilizers are generally limited to one acre or less and the necessary fertilizer is provided at no cost to the farmer. The farmer, on his part, accepts any risk involved in using the new fertilizer and agrees to maintain complete farm records as well as to make these records and his farm available for educational uses. Some 2,300 farms in 30 states are currently participating in this program.

An example of how effective the Test demonstration Program can be is provided by TVA's experience with diammonium-phosphate. When TVA began producing this unusually high-analysis fertilizer in 1955, it anticipated a first-year market of possibly 20,000 tons; however, because of the farmer's reluctance to try something new and the fact that relatively little was known about this product's performance, first-year use barely exceeded 5,000 tons. TVA thereupon began distributing up to 25,000 tons a year in an effort to encourage both dealers and farmers to try small quantities. As a result of this program, the market for diammonium-phosphate has risen to more than 2,000,000 tons annually with production in more than 40 states.

4. Arrangements for Commercial Access to an Invention

In keeping with TVA's policy of making an effort to secure wide use of TVA inventions,[5] current TVA practice is to grant a royalty-free nonexclusive license for the term of a patent to any responsible individual or organization. The only requirement is that each licensee submit a brief summary each year of the use being made of the invention.

The breadth of use of TVA's nonexclusive licenses [see Appendix I (TVA)] is impressive. One company, for example, operates the TVA continuous ammoniator in at least 22 of its plants—another company in at least 16 plants. Twenty-two firms hold rights to use both the continuous ammoniator and the TVA superphosphate mixer. Several licensees of TVA liquid fertilizer processes operate from six to twelve or more plants. Of the seven companies producing phosphorous in the United States, six have licenses covering TVA developments.

With regard to exclusive licenses, TVA grants them in essentially two types of situations—both very infrequent. As already mentioned in connection with employee inventors, one of these situations occurs when TVA decides not to seek a patent and authorizes the inventor to file a patent application in the government's behalf. In such a case—which has occurred only once in the past five years—an exchange is made: the inventor agrees to assign title to the patent to the government and receives in return an exclusive license for the term of the patent.

The second situation in which an exclusive license may be issued arises when such a license is needed to induce proper development and/or utilization of the invention in the interests of the agency program. Criteria for granting such a license include the prospective licensee's capability "to complete the development of the invention, to utilize it effectively in the interests of the TVA program, or to secure the widest public use of the invention."[6] In the past five years there has been no instance where an exclusive license was granted in this situation.

5. Review and Control of Commercial Utilization

Basically interested in maximizing access rather than in controlling it, TVA has no formal procedures for review and control of commercial utilization beyond the requirement, mentioned above, that licensees report annually on the use being made of the particular inventions. Apparently the agency does not use these reports for monitoring—no review is made for the purpose of terminating licenses.

[5]TVA Board of Directors' policy statement of December 12, 1963.

[6]TVA Board of Directors' policy statement of December 12, 1963.

inventions also have the least capability to produce them. However, TVA has already received a number of requests from foreign countries for licenses to use TVA inventions. A more likely explanation for the lack of foreign patents would seem to be that TVA has no particular incentive to obtain patents abroad.

3. Determination of Promotional Approaches

a. *Public Dissemination of Information*

The dissemination of information regarding a new fertilizer or fertilizer process generally begins as soon as a patent application has been filed. Responsibility for this dissemination lies primarily with the cognizant branch chief, who must provide the necessary funds.

The principal vehicles for dissemination of technical information regarding a new development are the professional chemical societies, the fertilizer trade associations, and oral briefings of technical visitors. For example, almost every significant TVA fertilizer development is the topic of a paper before the American Chemical Society or the American Institute of Chemical Engineers. These papers then serve as a basis for an article in one of the professional or fertilizer trade journals. In 1965, 41 scientific and technical papers and articles were so published, and more than 23,000 copies of technical material were sent in response to some 3,600 mail requests.

Even more important from a standpoint of disseminating information on new developments, according to TVA personnel, are personal visits made by technical personnel to TVA facilities—last year, some 2,000 technical personnel spent an average of somewhat more than two days each at the National Fertilizer Development Center. Approximately one-fourth of these visitors were from other countries,[4] while the remainder came primarily from chemical fertilizer manufacturers and trade associations in this country. While most technical visitors come to learn of new developments by TVA, it is perhaps significant that many come seeking TVA's assistance and advice on specific technical problems, tending to underscore TVA's technical reputation in the chemical fertilizer field.

TVA actively encourages technical visits by scheduling special events on subjects of particular interest. Perhaps most important is a biennial demonstration of TVA developments that last year drew 461 technical visitors from 211 companies; as part of this program, TVA set up and operated pilot plants do demonstrate the feasibility of various new developments.

b. *Fertilizer Demonstration Programs*

The fertilizer demonstration program is most certainly the single most effective promotional technique used by TVA according to TVA representatives, who generally agree that without this program their promotional efforts could not have been successful in the face of the conservatism traditionally displayed by both the farmer and the fertilizer industry. The fertilizer demonstration program is, in fact, a series of programs aimed at both the fertilizer industry as potential supplier and the farmer as potential user of new types of fertilizers. These programs may range from the construction of a pilot plant for proving out producibility to the actual use of newly developed fertilizers on selected farms throughout the country. Thus TVA, in its demonstration programs, goes considerably beyond the promotional efforts of most federal agencies, which limit their promotional efforts largely to the dissemination of information and publicity regarding new developments. In contrast, TVA will, if necessary, further develop, produce, distribute, and even generate demand for promising fertilizer discoveries.

Three major types of promotion programs included in the fertilizer demonstration program are the pilot-plant and limited production demonstration program, the distributor demonstration program, and the test demonstration program. These three programs can be described as follows:

(i) *The Pilot-Plant and Limited Production Demonstration Program.* Building a pilot plant is one of the first steps that TVA researchers may take after laboratory tests have indicated that a new development shows promise. The pilot plant serves both as a preliminary-test vehicle for determining if commercial production may be feasible and as a source for the larger quantities of the new product necessary for more extensive agricultural testing. These pilot plants often have served as the focal point for TVA-sponsored conferences, as already noted, and apparently have proven very effective in encouraging industry interest and acceptance of new products.

[4]The National Fertilizer Development Center is receiving an increasing number of requests for assistance to developing nations in solving their fertilizer problems. A 19-member fertilizer team from India spent seven weeks last year in training at Muscle Shoals. At the request of the Agency for International Development, Department of State, TVA made a survey of the fertilizer industry of North America, Europe, and Japan to determine the contributions that the industry might make in the less developed countries of the world. Also under AID sponsorship, TVA sent one technical team to Nigeria last year and one to Korea to study fertilizer needs and production and marketing problems.

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

TVA's sole objective in promotion of its inventions is to maximize their utilization by their target groups—principally fertilizer manufacturers, for the agency's patent promotion efforts have been restricted largely to the field of chemical fertilizers, where the great bulk of TVA's research efforts are concentrated. The ultimate objective, of course, is to aid the farmers and agriculture.

A few patents have been acquired in other than the fertilizer field—for example, power. Little has been done to exploit them. Also significant is the fact that although various TVA representatives concede that various chemical fertilizer patents held by the agency had actual or potential advantages in such fields as detergents, these nonfertilizer applications were never promoted. Undoubtedly, there are a number of reasons for this. Certainly import is the emphasis, in TVA's original mandate, on assisting agriculture and industry in the Tennessee Valley. In addition, the agency's reputation in fertilizer development—now national in character—built up over the past 30 years has undoubtedly served to attract personnel with primary interests in fertilizer research.

The Division of Law has the primary responsibility for the patent process. The Office of Agricultural and Chemical Development, which has the program responsibility for the development of fertilizers, has the primary responsibility for the implementation of promotional approaches and the granting of licenses for fertilizer patents. This office does not consider the utilization program to be a separate entity—rather, the utilization efforts are viewed as an integral part of TVA's normal operations in insuring that both the agency and the farmer receive the maximum benefit from TVA's R&D.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Inventions to Be Patented and Selection for Promotion

Both the decision to patent a new fertilizer invention and the decision to promote the invention are largely determined on the basis of the invention's potential payoff to the farmer. Because, in most instances, the two decisions become merged and treated as one,[1] they will be discussed together here.

Under TVA's detailed procedure for identifying and acquiring title to patentable in-house inventions, TVA personnel are required to record all potentially patentable inventions in the official laboratory notebook provided to them for this purpose. Usually, when the originator feels that a discovery or innovation is patentable he prepares a technical suggestion, often in the official notebook, for consideration by his branch chief and others, including the Patent Counsel.

Essentially three alternatives are generally open in the case of each invention—the branch chief may conclude that TVA should consider filing a patent application, that TVA should *not* consider filing a patent application, or that further investigation of the invention's practical applications is necessary. In making his decision, he evaluates the potential benefit of the suggestion to the ultimate user—the farmer in the case of fertilizer, since the principal objective of the TVA fertilizer research program is to provide the farmer with improved forms of fertilizer. Presumably the branch chief specifically considers such factors as the potential improvement of the invention over existing fertilizers or fertilizer processes; the potential drawbacks of the invention as a pollutant, fire hazard, and the like; and the additional investment needed to refine, produce, and promote the invention. In effect, a sort of cost/benefit analysis is made, although this is not a formalized procedure.

The cognizant branch chief orally reports his findings and recommendations to the Patent Committee, consisting of all branch chiefs at TVA's National Fertilizer Development Center, the Director of Research, and the Patent Counsel. In reviewing these findings and recommendations and making such modifications as it sees fit, the Patent Committee apparently places primary emphasis on essentially two criteria—feasibility and patentability.[2] Some members of the Patent Committee claim

[1] The only exception would be in the case of defensive patenting, where the invention is patented to insure public access and there are no immediate plans for promotion. Defensive patenting appears to be minimal at TVA.

[2] The Patent Counsel is generally responsible for determining the patentability of inventions. He takes into account the judgment of TVA's technical divisions as to whether an invention is actually new and can be patented.

APPENDIX I (HEW)
STATISTICAL SUMMARY
SOURCE AND DISPOSITION OF INVENTIONS
FY 1963-FY 1965

A. Sources	1963	1964	1965	Total
Employee disclosures	10	32	25	67
Contractor disclosures	228	292	221	741
Total	238	324	246	808

B. Disposition*	1963	1964	1965	Total
Patents filed with government taking title				
Employee inventions	1	5	9	15
Contractor inventions	5	6	11	22
Patents filed with government taking license				
Employee inventions	0	1	0	1
Contractor inventions	10	3	17	30
Determinations to dedicate by publication rather than to patent				
Employee inventions	6	0	10	16
Contractor inventions	74	185	163	422

*Disposition actions during one fiscal year may relate to disclosures entered during prior years. In addition, action may not be taken during any fiscal year on all disclosures submitted during the same fiscal year. Accordingly, Parts A and B cannot be interrelated.

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

The department's efforts to exploit inventions are part and parcel of its efforts to further its basic mission–to promote the general welfare. The department's primary concern is the promotion of its mission by maximizing the availability of its inventions to the public, not with the promotion of inventions *per se.* For this reason, HEW is not actively interested in applications of its inventions that fall outside the HEW community, nor in promoting its inventions for the purposes of remuneration or fostering competition *per se.*

In promoting its inventions within the HEW community, the department tries to interest both governmental and nongovernmental parties. Its promotional efforts directed to governmental parties are relatively more organized, systematic, and regular than those directed to nongovernmental parties–for example, the promotion of Dr. Robert Guthrie's inhibition assay method for detecting phenylketonuria (PKU) which was developed under an NIH grant and promoted by the Children's Bureau (Social and Rehabilitation Service), which sent copies of Dr. Guthrie's proposal for trial of the method he developed to state health department maternal and child health directors, along with invitations to participate in the program. However, since its programs are highly oriented towards basic research, few patentable inventions arise. Therefore, direct promotion of HEW patents has been limited.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Introduction

In many agencies of the government, commercial utilization of inventions can be considered in terms of government-owned technology that is consciously identified, promoted, and used by the public. In HEW, and particularly in NIH, the circumstances are somewhat different. Here, the agencies are continually engaged in evaluating for public use *all* kinds of technology, where the issue, or even recognition, of government ownership or control is only incidental. The number of government-owned patents selected, promoted, and licensed is small. Accordingly, this report is primarily concerned with general operations within HEW that cause new technology to be used, whether or not patents are involved.

2. Selection of Inventions to be Patented

a. *Objectives.* "The department's interest in inventions is almost the reverse of that which generally prompts a private patent application. Its concern is not to withhold the invention from the public or to charge royalties for its use but to assure the availability of the invention to all. This assurance may be lost if an individual claiming priority of invention files a patent application."[1]

b. *Criteria.* The criteria for selecting inventions to be patented are described in the agency regulations. In the main, they set forth the legal conditions governing patentability and provide that "no recommendation as to patenting should in any case be made unless it is first determined that the invention may be patentable."[2] Once this condition has been satisfied, patenting may be "... appropriately recommended when–

1. it is deemed advisable, in the case of an invention of high potential significance to the public health, safety, or welfare, to obtain maximum assurance against potential rival claims by establishing priority of invention and diligence in reducing to practice; or
2. it is deemed advisable, for reasons of health or safety, to retain control (beyond that afforded under the Federal Food, Drug, and Cosmetic Act, as amended, or the Public Health Service Act, as amended, or other Federal control legislation) of the invention itself, with legal authority to impose restrictive conditions on its use; or
3. other Federal agencies have such an interest in the invention that they would be prepared to prosecute the patent application."[3]

c. *Procedure.* As a general rule, a preliminary, and usually informal review of an invention is made by the HEW Inventions Office and the Office of General Counsel. If an invention is believed to be patentable *prima facie,* it is submitted for evaluation of scientific validity and interest to be carried out either by staff members or by outside independent consultants–usually university professors specializing in the field in which the invention was made. Upon receipt of the evaluation, the patent staff–with the advice of the constituent agency–make recommendations to the Assistant

[1] HEW Manual of General Administration, Part 6-30-10-A.
[2] HEW Manual of General Administration, Part 6-30-20-A.
[3] HEW Manual of General Administration, Part 6-30-40-B.

APPENDIX I (FAA)
STATISTICAL SUMMARY

EXHIBIT 1 Source and Disposition of Inventions, FY 1963-FY 1965

EXHIBIT 1
SOURCE AND DISPOSITION OF INVENTIONS
FY 1963-FY 1965

A. Sources	1963	1964	1965	Total
Employee disclosures	2	12	7	21
Contractor disclosure	4	20	101	125
Total	6	32	108	146
B. Disposition*				
Patent filed with government taking title				
Employee invention	1	0	3	4
Contractor inventions	0	2	0	2
Patents filed with government taking license				
Employee inventions	0	0	0	0
Contractor inventions	1	3	0	4

*Disposition actions during one fiscal year may relate to disclosures entered during prior years. In addition, action may not be taken during any fiscal year on all disclosures submitted during the same fiscal year. Accordingly, Parts A and B cannot be interrelated.

(ii) Benefits to be gained in terms of efficiency and safety.
(iii) Extent of application.
(iv) Investment and operating cost.
(v) Impact of known privately held patents.[6]

The selection process includes coordination among several specified agency components, including the affected Program Services.

Approval/disapproval of the selection of equipment recommended by the Development Services for the National Airspace System is vested in the head of the agency. If a device or system is approved for selection, a selection order is issued that specifies the actions that agency personnel must perform in order to bring about the incorporation of the device or system into the National Airspace System.

d. *Selection of Products or Systems for Promotion Through "Pushing" or "Pulling" Utilization*

This type of selection involves the identification by the Development Services of existing products or systems that, if adopted,[7] would improve the safety or efficiency of aviation operations. In this connection, sometimes industry groups will come to the Development Services with a specified need for which they have no answer. Unaware of the existing technology that might solve their problems, they will ask the Development Services for help in identifying this technology. After the identification is made, the Development Services may decide that the technology has enough value to the aviation industry to warrant its promotion. In other cases, the impetus will come from the agency itself, as it--particularly the Development Services component of it—will have or be aware of a system or device that it believes has value to the aviation industry but is not being exploited.

The classic utilization problem involved here is, broadly speaking, usually addressed in one of two ways. One is to attempt to "push" utilization by interesting potential manufacturers in both the need for and the market potential of devices that the manufacturers might further develop and market. The other approach is to promote user interest by "pulling" utilization (in other words, promoting demand directly through the user).

Promotion as described above seems to be considered on a case-by-case basis, with major guidance and control from the upper management levels of the Development Services. For example, the widespread use of air-crash recorders was viewed by management as highly desirable for analysis and prevention of future air crashes. After a detailed review of the matter, Development Services personnel decided to make an extensive promotional effort. A series of discussions and presentations with airline pilots succeeded in ultimately getting users (the airlines) to "pull" this piece of technology into general usage in the industry. The criteria for selection here were wholly judgmental,[8] involving the benefits that the agency felt the aviation industry would obtain from the use of this device.

A recent example of "pushing" utilization by getting a manufacturer interested concerns the all-weather landing system. After identifying a need for lower ceiling systems, the Development Services first sponsored a series of symposia on glide-slope techniques. Those invited to attend were users (such as airlines and air traffic controllers) and potential developers (equipment manufacturers). The Development Services also sponsored a series of flight tests to appraise various approaches. The result of this promotion was the involvement of an aircraft manufacturer and the development of 100' ceiling system.

e. *Selection of Subjects for Promotion Through Publicity*

The Office of Information Services, through its News Division and its Publications Division, selects *subjects* for promotion through publicity. Subjects are selected on the basis of two general criteria:

(i) They make interesting reading to the aviation public.
(ii) They make positive presentations of the agency's activities—acquainting the public with the agency's activities is the primary objective of this type of promotion.

Specialists in the News Division cover various areas of agency activity (such as the Bureau of National Airports) and draft releases that, in their opinion, meet these criteria. The editorial staff of the Publications Division, which publishes the *FAA News*, selects its subjects in much the same fashion as the News Division.

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[6] Both technical personnel and Patent Counsel screen proposed Selection Orders. Where it appears that a selection order may require use of a privately held patent, negotiations are undertaken with the patent holder to assure availability of the patented item at reasonable costs or patent licensing on reasonable terms.

[7] While the agency's regulatory authority enables it to command adoption in some cases, in many other situations it is not so empowered.

[8] It is important to realize that developing productive knowledge and judgement about what technology should be used, by whom, and when is the primary business of Development Services management.

(NASA), and the FAA. This exchange is carried out in several ways:

(i) Through military liaison officers within both the Office of the Administrator and the Systems Research and Development Service. These officers are responsible for insuring close cooperation between the DOD and the FAA, both administratively and technically.

(ii) Through continuous contact, in some technical area, between FAA technical staff and DOD development personnel.

(iii) Through wide circulation among FAA development personnel of such publications as the DOD technical abstracts and the NASA Scientific and Technical Aerospace Reports, as well as the publications of the American Institute of Avionics and Astronautics.

Also, there is some interaction among the FAA and several other government agencies to see if patents issued to these other agencies might be of interest to the FAA and vice-versa. The FAA patent attorney (within the Office of the General Counsel) reviews the weekly listings in the *Gazette* published by the U.S. Patent Office–this review, informal and of recent origin, has not as yet uncovered items of significance to the FAA, according to the patent attorney. Sometimes the FAA will receive patent disclosures from other agencies—sometimes the FAA will reciprocate.[2]

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Inventions to Be Patented

All invention disclosures are routed to the patent attorney in the Office of the General Counsel. This office is responsible for the processing of disclosures and for the ultimate decision as to whether or not to file for a patent unless a contract provides for the contractor to obtain the rights involved, in which case he will perform evaluation and filing actions himself. If the rights belong to the government or if the contractor waives his title, the Office of the General Counsel asks FAA's Development Services to perform both a technical (has an invention been made?) and an application (where and how might the "invention" be used? by whom? how much additional development is needed?) evaluation. These evaluations serve as the basis for the decision made by the Office of the General Counsel as to whether or not to file for a patent. The evaluations in 1964 of the cellular tank for fluids[3] that produced negative answers on the application aspect and resulted in a decision not to file for a patent is a typical example of the patent selection process.

The evaluation process itself is informal and personalized. The judgments rendered are based upon what the individual evaluator knows and thinks about the state of the art and the needs of the aviation industry. However, interviews with the staff members who evaluated three recent disclosures[4] indicated that a knowledgeable, conscientious, and apparently quite effective evaluation had been made in each case. The current FAA evaluation process is directed primarily at the aviation field and concern with other areas is nominal.

The fact that the FAA owns only a few patents was attributed in interviews for this report to two factors:

(i) The agency's primary focus, according to technical staff personnel, on applications of technology rather than on research.

(ii) The agency's lesser concern with patenting, according to legal staff members, in comparison with other government agencies such as NASA. (However, FAA efforts in the period from 1964 through 1966 aimed at further defining patent policy and procedure do indicate an increasing concern in this area.)

2. Determination of Rights to a Patented Invention

Under Executive Order 10096 the agency receives title to invention produced during the course of an employee's normal duties. The question of contractor/government rights is most often settled at the time contracts are let, although contract provisions are not rigid and uniform with regard to allocating title to inventions. Rather, contracts tend to be tailored to the situation–for example, while agency contracts usually call for full rights to accrue to the FAA, cost sharing contracts for supersonic transport development provide for full rights to accrue to both the government and the cost sharing contractor with the cost sharing contractor's right to grant sublicenses for supersonic transport use being subject to government approval. In the event of refund of cost share, all rights vest in the government, including the right to preclude use by the contractor. In

[2] A case in point was a disclosure in 1964 on a cellular tank for fluids. This disclosure was forwarded by the Assistant General Counsel for Patent Matters, NASA, to the Patent Counsel, FAA, who requested FAA's National Aviation Facilities Experimental Center (NAFEC) to evaluate the disclosure. The NAFEC sent a negative report to the FAA Patent Counsel, who then provided the disclosure to JAG, USAF, for DOD consideration.

[3] See footnote 2.

[4] The "E-Z" bucking bar, a beacon reply counter, and a mosaic boundary generator.

person responsible for the administration of specific FAA contracts with outside firms, and the project manager is the program or technical staff person principally concerned with the agency's area of activity that includes the contract in question.

Prior to contract close-out the contracting officer must give the project manager a certificate of acceptance, which includes a statement of inventions (if any) that "reasonably appear to be patentable." This statement may be based upon statements from the contractor or upon such other bases as the contracting officer deems necessary. The certificate of acceptance is forwarded to the Office of the General Counsel by the project manager. Any disclosures made are forwarded to the Office of the General Counsel through the contracting officer as prescribed by contract.

One other form of monitoring exists. For R&D, all contractor-generated reports covering contract accomplishments and all internal project reports are reviewed by the Program Analysis and Reports Branch, Executive Staff, Systems Research and Development Service. This review, in addition to other objectives, identifies reports containing information on possible inventions. The review appears to rest largely on the reviewer's judgment or on the fact that an invention was so identified in the report. The reports identified as containing information on inventions are then sent to the Office of the General Counsel. There previously undisclosed inventions may presumably be picked up.[2] One such case cited to Harbridge House concerned an undisclosed low inertial switch on a pendant cable.

[2] It should be noted, however, that the major reason for this review is to obtain decisions from the General Counsel as to whether or not reports should be subject to restricted distribution.

EXHIBIT 1

INVENTION REPORTS* SUBMITTED TO THE DEPARTMENT OF THE INTERIOR

FY 1962 - FY 1966

AGENCY	1962	1963	1964	1965	1966	TOTAL
Bureau of Mines	13	29	34	64	55	195
U.S. Fish and Wildlife Service	12	6 (4 in-house, 2 contractors)	9 (8 in-house, 1 contractor)	10 (9 in-house, 1 contractor)	9 (6 in-house, 3 contractors)	46
U.S. Geological Survey	7	5	13	14	17	56
Office of Saline Water	3 (2 in-house, 1 contractor)	10 (2 in-house, 8 contractors)	23 (1 in-house, 22 contractors)	26 (2 in-house, 24 contractors)	39 (4 in-house, 35 contractors)	101
Bureau of Reclamation	8	2	4	6 (5 in-house, 1 contractor)	10	30
Bonneville Power Administration	1	2	3	3	4	13
Bureau of Indian Affairs	1	1	4	3	1	10
National Park Service	1	–	1	–	1	3
Bureau of Land Management	–	4	1	3	2	10
Office of Coal Research	–	–	5 (1 in-house, 4 contractors)	7 (all contractors)	25 (2 in-house, 23 contractors)	37
Southeastern Power Administration	–	–	1	–	–	1
Public Health Service**	–	–	–	1	–	1
Office of the Solicitor	–	–	–	–	1	1
Office of Water Resources Research	–	–	–	–	1 (contractor)	1
TOTAL	46	59	98	137	165	505

*All invention reports are in-house, unless otherwise noted.

**One report submitted in 1965 from this HEW activity.

contractors are required to report only subject inventions, in which rights are defined by contract, no provision is made for claim to title in the Invention Disclosure Contractor form.

When the inventor is a department employee, he submits a detailed description of the basis for his claim through his superior to the Office of the Solicitor for a determination. If the Patent Counsel favors the inventor's claim, his determination is routinely submitted to the Commissioner of Patents for approval. Should the Patent Counsel reject the claim, the inventor may appeal to the Commissioner.

3. Selection for Promotion

The department has provided little formal guidance to its personnel as to the methods or criteria to be followed in deciding which inventions to promote. While approval and issuance of licenses is the responsibility of the Office of the Solicitor, promotion of government-owned inventions is generally left to the various research groups. But research personnel contracted—for example, in the Office of Coal Research—stated that their responsibility for an invention ends with the application for a patent.

As a result of this uncertainty concerning responsibility, and because of the relatively small number of patents issued to the department, no process for selecting particular patents for promotion has been undertaken. Rather, all patents are given essentially the same publication and publicity treatment.

4. Determination of Promotional Approaches

Promotional approaches used for contractor and in-house patents are similar—with emphasis on publications and journals, including the journal of patents available for license that is distributed regularly by the U.S. Patent Office. With regard to in-house patents, the Departmental Manual states:

> In order that the public may obtain the greatest possible benefit from inventions in which the Secretary has transferable interests, inventions assigned to the Secretary upon which patent applications have been filed shall be publicized as widely as possible, within limitations of authority, by the Department, by the originating agency, by the division in which the inventor is employed, and by the inventor himself in his contacts with industries in which the invention is or may be useful. Regular organs of publication shall be utilized to the greatest extent possible. In addition, it shall be the duty of the Solicitor, upon being advised of the issuance of any patent assigned to the Secretary, to take steps towards listing the patent, in the register in the Patent Office established for that purpose, as available for licensing.

This is a good description of the actual promotional approach applied to the department's patents. The various bureaus and offices issue news releases on many aspects of their R&D work, sometimes highlighting inventions significant to the department's missions or having special public interest or publicity value. For example, two Bureau of Reclamation inventions were mentioned in department news releases:

- —In 1963, a "free loader" aircraft warning light for use on high-voltage transmission lines.
- —In 1966, a means of overcoming interruptions of service on interconnected power systems.

Conferences and symposia are also utilized to present the results of various department research programs to the public. For example, OSW held the First International Symposium on Water Desalination in Washington during December 1965. Patents in desalination held by the department were necessarily discussed in detail in the nearly 100 technical papers presented. However, OSW personnel stated that promotion (aimed at increasing utilization) of patents was not a primary purpose of the discussion of these patents. And that, in fact, some emphasis was placed on an economic analysis indicating that commercial utilization of many OSW-developed inventions was not economically feasible at that time. In order to ultimately achieve the widest possible utilization of its work, it has been OSW policy to caution potential users that considerable development may be required in arriving at a commercial product or process. An example of this is the reverse osmosis desalination membrane technology.

While the department does not have any specific method of evaluating its promotional approaches, there was a general feeling among personnel contacted that interested parties are generally well-informed on department patents available. As evidence of this, the Assistant Solicitor related the case of the response to a news release on a Bureau of Mines technique for post-radioactivating a fluid used in tracing underground oil or water flow. The press inaccurately reported that this technique could *detect* oil or water underground, and, as a result, the department was deluged by almost 200 inquiries from potential licensees.

Specific promotional activities of the various bureau and office include:

(i) *Bureau of Mines.* This bureau publishes technical reports on its research, circulating a large number of them on a worldwide basis. It also issues press releases on publications and new developments. The bureau maintains a close

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

The Department of the Interior does not have an extensive program for promoting the utilization of its patents because patented inventions currently form only a small part of the department's R&D output. However, Harbridge House believes that the prospect of significantly increased expenditures in resources research and the likelihood of technical breakthroughs in areas such as water desalination and pollution control may well result in increased patent activity in the future.

The department's policy on exploiting inventions is passive and permissive, rather than active and directive. As shown in Figure 2 (Interior), the department granted only six licenses for use of six of its patents during the fiscal year 1966; moreover, it has granted only 23 licenses for use of 21 patents during the past five years (the fiscal years 1962 through 1966). [See Exhibit 3, Appendix I (Interior).]

The department's objectives in its patent utilization policies are related to its generally defensive policy on obtaining inventions—to protect the taxpayers' investment in R&D by preventing other interests from gaining control of resulting inventions. Thus, the department's utilization policy is mainly to ensure that its inventions are "available" to the general public at no additional cost. To this end it grants only nonexclusive, royalty-free licenses and makes no attempt to discover or prohibit unlicensed use.

There is no individual or group in the department assigned overall responsibility for the promotion of utilization of patented inventions. The agencies that contract for R&D (for example, the Office of Coal Research) have stated that their responsibility for inventions officially terminates once their work is completed and they have reported all resulting inventions to the Office of the Solicitor.

The Patent Counsel within the Office of the Solicitor is responsible for evaluating the patentability of each invention, filing patent applications, deciding whether to waive patent rights, and receiving and approving applications for licenses. There is informal coordination between R&D personnel and the Patent Counsel on patent and licensing actions. For example, the Patent Counsel stated that he always asks the opinion of the cognizant technical personnel as to whether a license should be granted to an applicant and whether contractor-reported inventions should be patented.

Both legal and research personnel of the department believe that invention utilization is much higher than the limited number of licenses would indicate. This view is not based on certain knowledge, as no detailed analysis of utilization has ever been undertaken, but rather on the fact that those firms most interested in the department's work (contractors or cooperators) obtain license rights through their contracts. Thus, they do not generally bother with the formality of requesting licenses. This particularly applies to firms working with the Bureau of Mines on a cooperative basis and to contractors of the Office of Coal Research.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Inventions to Be Patented

It is Department of the Interior policy to patent and retain title to all inventions that are potentially beneficial to the public. This policy, which applies both to in-house inventions and those developed under contract, is based on the premise that the department's research programs are intended to benefit the public and that, accordingly, inventions made as a result of such research should not be patented by private interests. Thus, as already stated in this report, the department's reasons for patenting are essentially defensive—that is, to preclude others from taking out patents on inventions resulting from government-funded research. This reasoning was derived in part from the Attorney General's Report of 1947, *Investigation of Government Patent Policies and Practices.*

Department criteria for selecting items to be patented are largely informal. The Assistant Solicitor stated that patents are sought on all inventions thought to be "significant" in the sense of their novelty and breadth of potential application.

Responsibility for initiating patent action via disclosure rests with the inventor, his immediate superior, and the Office of the Solicitor in the case of in-house research; and with the inventor, the cognizant government project director, and the Office of the Solicitor in the case of research performed under contract or grant. As part of a disclosure, the inventor submits a brief report to his superior (or, in the case of a contractor, to the cognizant government project director) *and* the Patent Counsel (Office of the Solicitor),

C. Sources of Inventions

Naturally enough, the patents obtained by the various agencies came from the areas where they spent the bulk of their research dollars. Thus the two agencies—OSW and the Office of Coal Research—that primarily contracted for research with private firms and research centers obtained most of their inventions from them [see Figures 1 and 2 (Interior)]. For example, in the fiscal year 1966 these agencies obtained 58 invention disclosures from contractors and six from in-house employees. The remaining agencies obtained 96 invention disclosures from in-house work and only four from outside sources. In previous years the preponderance of in-house-developed inventions was even greater. In the fiscal year 1965 105 out of 137 inventions (or 77 percent) were developed in-house, in the fiscal year 1964 there were 71 out of 98 (or 72 percent), in the fiscal year 1963 49 out of 59 (or 83 percent), and in the fiscal year 1962 45 out of 46 (or 98 percent). [See Exhibit 1, Appendix I (Interior).]

D. Policies on Encouragement and Disclosure of Inventions

1. Encouragement of Inventions

Within the Department of the Interior, various agencies provide inducements to its employees for inventing patentable items. These are of three types:

(i) Employees of all agencies may be granted foreign rights to inventions developed in their normal line of work. They may receive both domestic and foreign title to inventions developed completely outside their agency work, with the government retaining royalty-free license only for domestic use.

(ii) Direct monetary awards may be paid for outstanding achievements. The Bureau of Mines and OSW offer a $50 staff award for each patent application and an additional award on issuance of a patent. Up to many thousands may be paid on recommendation of the Civil Service Commission. For example, an employee of the Bureau of Reclamation received a $3,000 award for inventing a regulator for a hydroelectric unit that was patented in 1965.

(iii) Invention activity is recorded in an employee's personnel file and may be taken into account in promotions.

Possible inducements to contractor inventiveness are:

(i) Contractor may be granted foreign rights.

(ii) Contractors automatically receive a royalty-free, nonexclusive domestic license to their own inventions, and thus may gain valuable experience and a commercial advantage during the two or three years before a patent application is filed and approved and licenses become available to competitors.

However, regardless of the method used for obtaining research support, bureaus and offices within the department are governed by the patent policy established and administered by its Office of the Solicitor. This policy has undergone substantial revision in the past six years. Prior to 1960, contractors were largely permitted to retain title to any invention made under contract under policies which were designed to permit such retention of title in equitable circumstances, with the government receiving a royalty-free license and the contractor agreeing to issue licenses to the public upon reasonable royalty terms. Following the enactment of the Saline Water Conversion Act, the policy was altered to require that title to inventions be vested in the government, with a royalty-free license remaining with the contractor, except when it would be inequitable for the department to take title because of substantial independent contributions made to the invention by the contractor. Under the latter situation the government is given a royalty-free, nonexclusive license. In addition, under the most recent policy the contractor has been required to grant background patent licenses royalty-free to the government and at reasonable royalties to any responsible applicant. These changes have resulted from the departments's interpretation of statutes and other guidance such as the following:

(i) The Coal Research Act of July 7, 1960 (74 Stat. 337, 30 U.S.C. 666).

(ii) The Helium Act Amendments of September 13, 1960 (74 Stat. 920, 50 U.S.C. 1676).

(iii) The Saline Water Conversion Act of September 22, 1961 (75 Stat. 628, 42 U.S.C. 1954b).

(iv) President Kennedy's Statement of Government Patent Policy of October 12, 1963.

A typical patent clause states that the contractor will grant to the government". . .the full and entire domestic right, title, and interest therein, subject to the reservation in the Contractor of a royalty-free, nonexclusive, and irrevocable license." In addition, ". . . for the practice of any Subject Invention in [the particular area of work of the contract] the Contractor agrees upon request to grant to the Government under any Background Patents a nonexclusive, nontransferable, and royalty-free license . . . [and] . . . the Contractor agrees to license for the practice of any Subject Invention any

FIGURE 1 (INTERIOR)

ESTIMATED FEDERAL R & D FUNDS OBLIGATED TO THE DEPARTMENT OF THE INTERIOR

FY 1966*

($ in millions)

Agency	Research		Development	In-House	U.S. Firms and Research Centers	U.S. Educational Institutions	Other		Total**
	Basic	Applied					U.S.	Foreign	
Bureau of Mines	4.6	21.7	4.0	30.0	–	0.3	–	–	30.3
U.S. Geological Survey	20.3	6.3	–	26.3	–	0.3	–	–	26.6
Bureau of Commercial Fisheries***	7.0	13.6	4.7	18.9	–	1.4	4.5	0.4	25.3
Bureau of Sport Fisheries and Wildlife***	3.1	11.9	2.3	8.6	–	0.4	8.4	–	17.3
Office of Saline Water	5.7	4.8	8.1	2.0	13.2	2.5	0.8	0.2	18.6
Office of Water Resources Research	3.2	3.2	–	0.4	–	5.9	–	–	6.3
Bureau of Reclamation	0.2	5.1	–	2.7	–	1.9	0.8	–	5.4
Office of Coal Research	–	1.4	2.3	–	2.5	0.5	0.7	–	3.7
National Park Service	2.1	–	–	1.4	–	0.6	–	–	2.1
Bureau of Land Management	–	0.6	0.1	0.2	–	0.5	–	–	0.7
Bonneville Power Administration	–	0.2	0.3	0.4	–	0.1	–	–	0.5
Bureau of Outdoor Recreation	–	0.1	–	0.1	–	–	–	–	0.1
Bureau of Indian Affairs	–	–	–	–	–	–	–	–	–
TOTAL	46.2	68.9	21.8	91.0	15.7	14.4	15.2	0.6	136.9

*Source: NSF 66-25, Tables C-5, C-8.

**The slight deviation between the total figures for R & D and in-house and contractor inventions occurred when the figures were rounded off.

***The Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife are included within the U.S. Fish and Wildlife Service.

work closely with various segments of the agricultural industry in implementing UR&D-developed products and processes. It is claimed that this close association permits UR&D personnel to informally evaluate the relative effectiveness of the product or process and to identify areas where improvements may be made.

The department has established a number of special committees to assist in evaluating its overall R&D activities. These committees necessarily consider as a part of overall evaluation the degree to which the agricultural community is exploiting the department's inventions.

Fianlly, ARS officials have stated that a comprehensive cost/benefit analysis is currently being made of 100 ARS inventions. The usefulness of the study results in evaluating invention exploitation will, of course, depend primarily on how the inventions were selected for study.

occasion it has been contracted. Frequently, the engineering development work may include establishment of a pilot plant operation or other "scaling up" processes. For example, the Eastern UR&D division is currently operating two pilot plants–one involving a continuous foam drying process for milk, and the other an explosive puff dehydration process for fruits and vegetables.

Responsibility for recommending which inventions warrant this type of promotional effort rests initially with the cognizant UR&D laboratory and division. Among the laboratory staff who may participate in, or contribute to, this determination are the inventor and his superior, the patent advisor, and the assistant director for industrial affairs. Some economic analysis and review may be made by members of a small ARS product and process evaluation staff and a final decision made either by the laboratory director or the ARS administrator.

While no specific guidelines have been established, ARS personnel cited a number of criteria as having a bearing on the decision to undertake further development of an invention. These criteria include the potential market for the invention, the estimated amount of additional development required, and the likelihood that industry might be willing to exploit the invention without further government promotion. The degree to which these and other factors are, in fact, reviewed and evaluated is questionable. In the UR&D divisions, for example, there is apparently no formal procedure for systematically reviewing data on these factors. The emphasis in the analytical effort underlying the decision is placed on the question of what additional development effort will be required, rather than on the question of demand–thus, the analytical approach has often been rather superficial. While the department conducts a variety of market tests and analyses, there have apparently been relatively few instances in the past when a comprehensive market analysis was made specifically for the purpose of deciding whether or not a particular invention should receive further development. Rather, it appears that laboratory personnel have relied heavily on their own knowledge, opinion, or "feel" as to whether a demand is likely to exist for a proposed product or process.

Evaluation of whether or not a firm or other outside group might be willing to undertake and finance further development presents another type of problem. ARS personnel generally agree that if the primary purpose in promoting an invention is to encourage its exploitation–as seems to be the case–then logically the government should not continue to develop (or otherwise promote) an invention once industry has indicated a willingness to assume responsibility for this effort. The problem that confronts ARS personnel is predicting what industry is likely to do with a particular invention. It has been pointed out that most firms are reluctant to discuss new product plans in more than the most general terms. Moreover, even if a firm does express an interest in exploiting a particular invention, there is no guarantee that this will actually be done, or done in a manner consistent with the interests of the agricultural community. For example, there is always the possibility that the firm undertaking further development may establish a proprietary or patent position that can be used to block widespread use of the basic invention. Thus, for these and other reasons, possible industry interest in undertaking further development of a particular invention apparently is *not* a major consideration in selecting inventions for further government development.

4. Determination of Promotional Approaches

a. *Dissemination of Information.* Responsibility for overall departmental coordination of the dissemination of information is vested in the ARS director of information, who has developed general guidelines regarding the format, clearance, distribution, allowable costs, and other factors bearing on the method of publication.

As already mentioned in this report, all department inventions receive several forms of promotion. In addition to the invention resumes published by the Government Information Center, Bureau of Standards, all patented inventions are published in the *Patent Office Gazette* and, until its recent discontinuation, in the SBA's Product List Circulars. Abstracts of patents and publications of technical findings are also published periodically by the various UR&D divisions.

In the case of technical papers prepared by in-house inventors, it is clear that the decision to promote an item, selection of media, and implementation are all performed simultaneously by the inventor when he, with his supervisor's approval, decides to proceed. It is also clear that such decisions are based largely on personal evaluations of the potential technical interest in the invention–not on any developed standards or criteria of potential commercial or industrial usage.

Other forms of promotion, largely technical in nature, are the ARS series publications, technical bulletins, research monographs, and handbooks. The decisions to promote items by these media are largely made by ARS technical personnel. Criteria for such decisions are not clear, but they generally appear to be predicated more on an appraisal of technical significance than specific consideration of industrial application.

particularly those of the abstract type, regularly publish information about patents. Patent owners or associations of individual organizations frequently exchange information on granted patents. The Department of Agriculture encourages the inclusion of information on its patents in pertinent trade journals. Patents are also included in various lists published by the Department of Agriculture and by other Government agencies. In addition, the Government-assigned patent provides a procedure, through its licenses, for the Department to exercise a degree of quality control of products manufactured under the licenses where there is a substantial reason for such control.[1]

* * * * *

b. *The Selection Process.* Department criteria for selecting items to be patented are not entirely clear. The stated position of Patent Counsel, Office of the General Counsel, is that patents should be sought on all patentable inventions that are related to specific department programs. Others in the department, who follow a broader guideline, stated that if the invention has potential value for the agricultural community, it should be patented. Actually, department practice in the past appears to have been one of patenting anything patentable.

In addition, department regulations do not specify the manner or criteria for determining whether inventions should be patented. In fact, the initial determination rests with the research employee, or his immediate superior, because if he does not submit the invention the matter is closed. A submitted case may also be halted at any point in its administrative route to the Patent Counsel on the grounds that an invention has not been made—that is, it is not technically new. Normally, the Office of the General Counsel does not enter into this determination unless requested.

2. Determination of Rights to a Patented Invention

Essentially, department patent rights fall into three categories: patents assigned to the government, patents dedicated to the public, and patents "in which commercial rights are retained by the inventor"—that is, patents in which the inventor takes title and the government receives a license. Subsections a and b describe the application of these rights to in-house and contract/grant inventions.

[1] Representatives of the Office of the General Counsel could not recall ever having used the license as a means of enforcing quality of licensee products.

a. *Domestic Rights to In-House Inventions.* Department of Agriculture policy on patent rights to in-house inventions is predicated on Executive Order 10096. As suggested by the statistics for the fiscal years 1963, 1964, and 1965 set forth in Figure 2 (Agriculture), the department usually takes title to any patent arising from an invention made by in-house personnel in the course of their official duties. The Patent Manual states that the department generally takes title in these three situations:

(i) The the subject matter is of such nature that some measure of quality control over the products manufactured under the patent is desirable to safeguard the agricultural community.

(ii) If legislative authority to grant exclusive licenses is anticipated.

(iii) If title is required for public relations purposes and for obtaining information on the utilization of the invention.

On the other hand, where quality control is not necessary, the invention may be dedicated to the public, and anyone is then free to use the invention without a

FIGURE 2 (AGRICULTURE)
DEPARTMENT OF AGRICULTURE PATENT RIGHTS
FY 1963 - FY 1965

	1963	1964	1965
Disclosure of inventions for which government rights in U.S. have been determined:	158	145	133
–Government has title	157	144	126
–Government has license	0	1	6
–Government has no rights	1	0	1
Total U.S. patent applications filed by department:	145	146	129
–Government has title	145	145	126
–Government has license	0	1	3
–Government has no rights	0	0	0
Disclosure of inventions for which determination was made to publish, rather than to patent:	10	11	28
U.S. patents issued:	89	59	82
–Issued to department	87	55	81
–Issued to employee (government has license)	2	4	1

FIGURE 1 (AGRICULTURE)
SCOPE OF UR&D PROJECTS

1. Number of projects – FY 1965

Projects	Domestic	Foreign	Total
Active at beginning of 1965	419	152	571
Initiated or revised in 1965	138	41	179
Terminated in 1965	95	25	120
Active at end of 1965	462	168	630

2. Domestic in-house expenditures–FY 1965

Projects	Salaries and Expenses
Cereal and forage crops	$6,632,204
Cotton, wool, and other fibers	5,721,648
Fruits and vegetables	4,338,709
Oilseeds	3,901,988
New and special plants	3,164,175
Poultry, dairy, and animal products	6,126,038
Total	$29,884,762

$19,250,000 in new construction funds were appropriated in the fiscal year 1964 for obligation in the fiscal year 1965.

C. Sources of Inventions

The fact that the vast majority of new inventions—not only within ARS, but within the Department of Agriculture as a whole—has come from in-house research programs is underscored by the department's statistics for the fiscal years 1963, 1964, and 1965. In 1963 out of 153 total invention disclosures, 144 were in-house and only nine were contractor; in 1964 out of 182–145 were in-house and only 37 were contractor; and in 1965 out of 318–277 were in-house and only 41 were contractor.

There are several reasons for the differential in the number of in-house and contractor disclosures. One reason is the differences in funding levels between the two research programs, with 80 to 90 percent of total research funds earmarked for in-house programs. Perhaps even more important is the type of research performed under contract—as opposed to that performed in-house. Typically, outside organizations are used primarily for "scaling up" purposes; that is, for proving the feasibility of larger-scale applications of inventions. For this reason, the opportunities for contractor inventiveness are limited.

D. Policies on Encouragement and Disclosure of Inventions

The Department of Agriculture has no specific program for encouraging inventiveness or the disclosure of inventions—either on the part of its own employees or contractors. It takes the position that both in-house and contracted personnel have been hired and are paid a salary to be inventive and that additional direct inducement should not be necessary. However, the department apparently does make a conscious effort in the case of in-house employees to tie advancement, at least in part, to the degree of inventiveness shown—particularly by the number of publications and patents of professional staff members.

The control aspects of disclosure procedures for both in-house and contractor inventions are largely informal. Departmental personnel are expected to report any potential inventions to their immediate supervisors, using a standard form, OGC-3: Invention Report, provided for this purpose. In the case of UR&D programs, copies of this report are also forwarded to the patent advisor assigned to each laboratory. The inventor, his supervisor, and the cognizant patent advisor thereupon determine whether a patentable invention has been made and, if so, whether patent action should be initiated.

Essentially the same procedure is followed for the disclosure of contractor inventions. A new invention may be disclosed in the contractor's periodic progress report or it may be the topic of a special report. In UR&D programs, the report goes to the cognizant government project director who determines, in conjunction with the cognizant patent advisor, whether a patentable invention has been made and, if so, whether patent action should be initiated.

APPENDIX I (AEC)
STATISTICAL SUMMARY

EXHIBIT 1

PATENTS ISSUED ON AEC-SPONSORED WORK AND RIGHTS THEREIN

	U.S. Patents Issued to AEC	Contractors retained exclusive rights in U.S. patents in non-atomic energy fields (outfields)	Contractors retained nonexclusive licenses in U.S. patents	Nonexclusive, royalty-free licenses granted by AEC on U.S. patents (exclusing Col. 3)	Foreign patents issued to AEC	U.S. patents in which contractor retained title-govt. has nonexclusive license*
Total as of 11/60	2,499	139	409	802	721	207
Additional to 11/61	250	52	39	49	460	36
Additional to 11/62	209	51	44	75	242	50
Additional to 11/63	227	53	30	65	389	84
Additional to 11/64	230	34	39	59	388	20
Additional to 11/65	252	39	34	44	424	8
Totals	3,667	368	595	1,094	2,624	405

*These patents are not included in Col. 1.

specific technology—these efforts may lead to tours through and contracts with an AEC—sponsored laboratory.

The Division of Technical Information and other AEC divisions sponsor and support 25 specialized information centers, most of which are located at AEC laboratories and staffed by contractor personnel. Each center specializes in a particular field. In responding to requests for information, these centers try to provide answers rather than simply leads to published data. The centers also publish quarterly technical progress reviews such as Nuclear Safety, and, from time to time, do state-of-the-art reviews, data compilations, and listings of all applicable patents—these reviews, compilations, and listings may be published as reports, articles, or conference proceedings.

The information centers will benefit from the current program at Oak Ridge on computer-based data retrieval. This program should be far enough advanced to serve as the basis for publishing Nuclear Science Abstracts. It will be able to provide patent references and other data automatically to the information centers after submission of a profile of its interests.

The Division of Technical Information, which is responsible for publicizing applications of AEC developments, publishes such publications as The Atomic Bonus, a pamphlet covering nonnuclear uses of inventions. The inputs to such publications are usually selected by AEC employees at Oak Ridge through routine review of patents.

This year the Industrial Cooperation Office at Argonne, in cooperation with NASA, began publication of "technical briefs," most of which relate to nonnuclear patents or inventions. The Argonne office has found a good source of inventions in the Chicago Operations Office's disclosure file of nonpatented inventions. In this way, the Argonne office has turned up 257 disclosures which, it believes, have potential commercial use.

Promotion of commercial uses of nuclear processes takes place in a number of other AEC divisions besides the Division of Technical Information—Isotope Development, Reactor Developments and Technology, Biology and Medicine, Space Nuclear Systems, and Peaceful Nuclear Explosives. For example, the Division of Isotope Development will first identify firms that make up the major portion of an industry interested in a particular technology, and, from these, attempt to interest companies in the development of specific isotope uses. The division personnel will write to these firms, visit them, and try to sell their managers on the ideas. Twenty firms were contacted in this manner regarding the program involving irradiated impregnated wood (see 5 below for a discussion on promotion of this program through attempting to interest firms in cooperative pilotplant work), while three supermarket chains were approached in connection with irradiated fish.

In addition to the types of promotion already described, the local offices of the AEC may generate commercial interest through press releases on processes or activities. For example, when the "ultra-clean room" was announced, stories placed in local papers by the field offices, in addition to Headquarter's releases, led to inquiries by companies in various areas. Inquiries have continued to come in and 39 parties have been licensed, and have resulted in annual sales of several millions.

e. Promotion in the Form of Further Development Work by the Government

In some cases of additional AEC-sponsored development, a patent may be involved; in others, simply an advancing technology. In the Division of Isotope Development, for example, a project manager initiates a cost-benefit analysis when he feels that the basic technology has advanced far enough on a laboratory scale. There is no standard form for this procedure. It is tailored to the needs of a particular project. The cost-benefit analysis is made by the project team and personnel from the Office of the Director of Planning and Evaluation within the Division of Isotope Development. The analysis considers estimates of costs for further development and pilot-plant work, full-scale processing costs, market potential and the economic base for it, return on estimated investment, and so forth—for example, in the case of irradiation of fish for 30-day shelf life, the discounted benefits over 10 years are estimated to be 20 times all development costs.

The results of the cost-benefit analysis go to the division's Technical Evaluation Committee, which represents most of the division's top management. This committee reviews the analysis and discusses it with the project manager. They recommend action to the General Manager, who has the final power of decision for sponsoring additional development. To put the effort in perspective, the division's annual budget for promotion in the form of further development runs from $7 million to $8 million.

In one instance, the AEC, as an outgrowth of its own need for remote-controlled manipulators, stimulated commercial utilization of several basic patents. The agency's initial orders for prototypes were followed by production orders from both the AEC and the U.S. Navy; by that time, the publicity generated by the devices, the extent of government application, and the indications of a commercial market led several firms to take up the products.

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

The agency is vitally interested in promoting the public exploitation of new technology arising from the operations its supports. A significant point that must be grasped to understand the AEC's role in patent utilization is that the agency's principal concern is with the utilization of technology related to nuclear energy rather than with the utilization of specific inventions. To the extent that this technology involves government-owned patents, the agency is interested in the promotion and utilization of these patents by those outside the government. AEC activities to promote the utilization of patents include the publication of abstracts, technical briefs, and conference papers; the conduct of atomic fairs and exhibits; and the operation of pilot plants.

The agency's objective in promoting the utilization of patents is exploitation of a public asset—the innovation or invention. Remuneration or cost recovery is not a motivating factor behind agency efforts; and neither is there any specific desire to aid or abet any particular segment of the economy, but rather the Agency endeavors to promote competition, foster small business, and create an atomic energy industry. The utilization practices described in this report are consistent with the agency objective.

Decisions on patents and licenses are made within the Office of the General Counsel where the Assistant General Counsel for Patents assumes responsibility for reviewing the disclosure of possible inventions, making searches to determine patentability, and determining whether and where patent applications are to be filed. His office also receives license applications and grants licenses on commission-owned domestic and foreign patents. The Division of Technical Information (Administration Group), through publications and through its data centers, is responsible for disseminating technical information including patents. (Also, the Division of Public Information in its various publicity releases may include information on available patents.) Contractor operations—disclosures and reports—are monitored by the Division of Contracts (Operations Group) and technically reviewed by appropriate divisions.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Inventions to Be Patented

The AEC acquires title to patents on contractor inventions in the field of atomic energy because the law (Section 152, Atomic Energy Act) so requires. The intent of the law is to insure total government access to the products of government-sponsored atomic energy research and development, while concurrently allowing the government (through licensing) to maximize public access. Thus the patenting process is used primarily to protect the government in the use of its own developments and to make the same available for general use.

Many innovations—particularly those outside the field of atomic energy—are never patented. After screening by the contractor's patent department and then by the AEC patent representatives in the field, formal invention reports are submitted by the field offices to the Assistant General Counsel for patents in the Office of the General Counsel at AEC Headquarters. Screening at this level leads to filing on only about one in six invention reports. This decision rests principally on questions of patentability, anticipation, advance over prior art, utility, obviousness, and sufficient data on which to base an application.

2. Determination of Rights to a Patented Invention

In general, rights to inventions and patents are covered by contract provisions. The AEC uses three types of patent clauses in its contracts. All three reserve the right to the AEC to determine whether a patent application shall be filed and to make disposition of the title and rights in atomic energy inventions at the time of disclosure or later. The first type of clause reserves determinations of all rights to the Government. The second type of clause permits a contractor who has an industrial and patent position and performs the research in a private facility to retain at least a nonexclusive, royalty-free license. The third type of clause permits a contractor with an established nongovernmental industrial and patent position to retain an exclusive license (except for the government license) for uses other than the production of nuclear material or atomic energy. In any of these cases, the contractor may be granted more rights than the minimum provided for in the contract. For example, a contractor under the first type of clause may be granted at his request the exclusive rights of the third type of clause in a particular invention because that invention satisfies the requirements of the rights of the latter clause.

Rights to AEC inventions and patents are usually determined at the time of disclosure by the contractor. All decisions regarding rights are made in the Office of the Assistant General Counsel for Patents, and are based

FIGURE 1

EXAMPLES OF THE CYCLE FROM INVENTION TO ISSUANCE OF A PATENT

A. CASE HISTORY OF INVENTION MADE BY CONTRACTOR'S EMPLOYEE AND WAIVED BY NASA TO CONTRACTOR*

Specimen Holder
U.S. Patent No. 3,148,275
Waiver No. W-149
North American Phillips Co.
NASA Case No. 1334

May '59	Jan '61	1961	Feb 8, '62	Apr 4, '62	Apr 13, '62	Jul 24, '62
NASA executed prime contract with JPL	JPL executed subcontract with subcontractor	Subcontractor's employee made invention	Subcontractor filed patent application in U.S. Patent Office	Subcontractor reported invention to NASA and simultaneously petitioned for waiver	NASA General Counsel executed notification of determination that title of invention was with NASA	NASA waived foreign rights to petitioner in accordance with waiver regulations

Aug 24, '62	Feb '63	Feb 15, '63	Mar 7, '63	May '63	Sept 8, '64	Dec 21, '64
Petition for domestic rights reviewed by NASA field patent attorney at JPL	ICB held meeting and acted favorably on petition	Instrument of Waiver executed by Deputy Administrator	Instrument of Waiver accepted by Petitioner	Petitioner forwarded confirmatory license to NASA for patent application	U.S. Patent No. 3,148,275 issued to petitioner	Petitioner advised NASA that invention is in use by petitioner and additional commercial use is planned

B. CASE HISTORY OF INVENTION MADE BY NASA EMPLOYEE*

Frangible Tube

Oct '60	Apr '61	July 18, '61	Sept '61	Feb '62	May '62	June '62	July 12, '62
Invention conveived by inventor	First successful operational test	Invention published at industrial conference [Stat. Bar]	Invention disclosed to NASA patent counsel	Favorable technical evaluation completed, P-1; search authorized	NASA patent attorney makes patentability search	Patent application authorized	Patent application filed in U.S. Patent Office [Prior to Stat. Bar]

Oct '62	Mar '63	Feb '64	June '64	Aug 4, '64	Sept '64
NASA Technical Note published describing invention	$300 monetary award given to inventor by NASA ICB	NASA Tech Brief published describing invention	Nonexclusive license granted by NASA under patent application	Patent issued to NASA Administrator	Patent first listed available for nonexclusive license

*Prepared by Licensing Division, Office of Assistant General Counsel for Patent Matters, NASA.

the taped descriptions of every new document. Citations of the documents that appear to match are reviewed by the RDC staff, and copies of the appropriate documents are then forwarded to the client. As the RDC professional staff gains familiarity with the client's requirements, the profiles are refined by client-staff interaction to identify those materials in which the client have been fully satisfied. In addition to the automatic matching of "interest profiles" against taped descriptions of documents, the RDC's also conduct retrospective searches. The client may bring the RDC a problem that he feels is unique. A "problem profile" is then drawn up and the taped citations of technical documents are rapidly searched to provide materials relevant to solving the client's problem.

b. *The Patent Organization.* The Office of the Assistant General Counsel for Patent Matters does not play a direct role in either the selection of items for promotion or the selection of appropriate media as described above. However, the patent organization does promote *all* NASA-patented inventions in one way. A list of NASA-owned inventions available for licensing is published in the *Official Gazette.* The list is revised periodically. The list of NASA-owned inventions available for foreign licensing is not now published, but is available upon request from NASA Headquarters. At present the patent organization does not publish abstracts of NASA-patented inventions for publication.

c. *Evaluation of Promotional Approaches.* To an extent NASA has a monitoring and review process that provides some means of evaluating the effectiveness of its promotional media. For the past three years the University of Maryland has been under contract to the NASA Office of Technology Utilization to study factors that facilitate or impede the "transfer" of NASA-generated new technology. During the past year the Office of Industrial Applications at the University of Maryland has been following up inquiries received by TUO's at the local (field) installations. Inquiries are docketed in the office of the local TUO, and a copy of each inquiry is forwarded to the Office of Industrial Applications. This office then contacts the interested party, and correspondence is maintained as long as the party continues to express interest in a given item of new technology—during the process, considerable data are gathered, including information on how the interested party first became aware of the innovation or invention. Under the terms of the contract the University of Maryland makes periodic progress reports to NASA Headquarters. It is not clear, however, that this program has yet had any impact on the selection of appropriate publications media for promotion.

In the case of the RDC's, the rate of renewal subscriptions for their services is a significant measure of their effectiveness. At present the renewal rate is running at more than 75%.

5. Arrangements for Commercial Access to an Invention

The Administrator, NASA, has statutory authority to establish and promulgate regulations specifying the terms and conditions under which licenses will be granted for the practice of NASA-owned inventions. Accordingly, NASA has established and published its *Patent Licensing Regulations* and its *Foreign Patent Licensing Regulations.* These regulations and the arrangement pursuant thereto are administered by the Office of the Assistant General Counsel for Patent Matters.

NASA's role is largely reactive in terms of finding firms to practice NASA-owned inventions. After promotion of inventions, NASA relies on interested parties to request licenses. Prospective applicants usually write to NASA requesting information regarding commercial rights. From this point on, the Licensing Division provides the applicant with all possible assistance. NASA even permits a licensee who has been granted a license to to practice an invention on which NASA has filed a patent application to inspect and make copies of the application.

NASA has authority to grant both nonexclusive and exclusive licenses. With the exception of foreign licenses, NASA does not charge royalties; since no foreign licenses have been granted by NASA to date, there has been no experience in the matter of charging royalties.

NASA grants nonexclusive, royalty-free licenses on its U.S. patents and applications. There are no criteria for selecting firms for a nonexclusive, royalty-free license. NASA stands ready to grant such a license to any applicant, and the license specifies no fixed period of time. If no exclusive license has been granted, NASA will continue to grant nonexclusive licenses on an invention during the entire term of the patent. Contractors automatically receive an irrevocable, nonexclusive license to contract inventions by the terms of NASA regulations.

An invention cannot be listed as available for exclusive licensing until two years after the patent has been issued, and then only if the invention has not yet been practiced. If there is a request for an exclusive license, NASA will contact current licensees and ask if the invention has been practiced. If the invention has not yet been practiced, the current licensees are invited to apply for an exclusive license, thereby creating completely separate decision from the decision to promote or not to promote (generally, to publish or not to publish) an item of technology. To recapitulate, the decision to file or not to file a patent application is made by the Patent Organization within the Office of the General Counsel, based on criteria developed by this office. The decision to promote or not to promote an item of technology is made by the Technology Utilization Division based on a different set of criteria, and executed by a different professional staff—the members of the Technology Utilization Division. There are two distinct processes, theoretically coordinated at the local level—the NASA local installation— where the local patent counsel and the TUO work closely together. However, if the two processes are not coordinated at this level, they are simply not coordinated at all, which sometimes happens.

It is possible that a reported invention on which NASA later files for patent may be rejected in the evaluation process for promotion for any of several reasons—first of all, if the TUO feels that the invention has only government use; second, if it is felt that the invention has only marginal significance or that its commercial potential is limited; third, purely and simply because different people's knowledge of the state of the art differs. Conversely, it is possible for an invention on which NASA has not filed a patent application (such as one having marginal patentable significance) to be selected for promotion.

Some of the less formal ways in which NASA inventions may be selected for promotion should be mentioned here in passing. Individual technical personnel publish papers on work performed under NASA programs. In addition, press releases on inventions are issued both by NASA Headquarters and by the local (field) installations.

Another informal way in which inventions may be selected for promotion involves symposia sponsored by NASA local installations or by NASA Regional Dissemination Centers. Several of these field units have sponsored symposia or conferences in which industry has participated. Items with which the installation or center is particularly identified are sometimes promoted on such occasions. Because these field units sponsor the symposia on their own, it is up to them to select the particular items to be promoted.

4. Determination of Promotional Approaches

a. *The Office of Technology Utilization.* Through its two divisions, the Technology Utilization Division (TUD) and the Scientific and Technical Information Division (STID), the Office of Technology Utilization is responsible for announcing the availability of NASA technology identified, documented, evaluated, published, and disseminated as part of the Technology Utilization Program.

While TUD issues a number of publications designed to be of interest to industry outside the aerospace field, its best-known publication is the *Tech Brief*. If it is decided that a NASA-sponsored item is worth publishing, this bulletin is issued for the item as an "attention-getter." Designed specifically to reach potential users as early as possible (two to six months after disclosure), the *Tech Brief* describes the innovation or invention, tells how the innovation or invention works, provides a diagram where appropriate, and sometimes suggests possible areas of application.

In the case of an invention, if the patent status is known at the time of publication of the Tech Brief, this information is obtained from the patent organization and included in the Tech Brief. (Normally, the attorney concerned with licensing in patent organization acts as the liaison with TUD.) In any case, the Tech Brief reader is advised to write the Office of the Assistant General Counsel for Patent Matters for information regarding commercial rights.

Another reference that the Tech Brief contains is designed to provide more technical information about the innovation or invention—the reader is invited to write the TUO at the cognizant local installation, who has a "backup" packet of technical material that he will provide the interested party free. In the past, the TUO with or through the Patent Division has even gone so far as to put the potential developer in actual contact with the inventor.

Publication of the Tech Brief began in 1964. As of Mid 1966 approximately 1,100 of these bulletins had been issued.

Other important publications of TUD are the Technology Utilization Reports and the Technology Surveys. Each Technology Utilization Report gives in-depth treatment to a single innovation or invention or a group of related items. About 30 of these reports have been issued as of Mid 1966.

Each Technology Survey is a full state-of-the-art analysis that identifies and analyzes the more extensive contributions made by NASA employees and/or NASA contractors to a particular technology, such as magnetic tape recording, and contains suggested nonaerospace applications for this technology. These survey reports are written by "experts" under contract. Ten *Technology Surveys* had been published by Mid 1966.

All innovations or inventions that are deemed to have significant commercial application are potential candidates for one or more TUD publications. The

PART II. Analysis of Program to Promote Patent Utilization

A. General Policies and Responsibilities

NASA has an active and well-defined program designed specifically to interest industry in the new technology resulting from NASA-sponsored R&D programs. Established in 1962, NASA's present technology utilization program developed as a unique response to the statutory obligation contained in Section 203 (a) of the 1958 Space Act, which states that NASA shall provide for the widest practicable and appropriate dissemination of information concerning NASA's activities and the results thereof. This program attempts to interest industry in any item of new technology, whether patentable or not. For this purpose the Office of Technology Utilization, containing the Technology Utilization Division and the Scientific and Technical Information Division, has been created.

The objectives of the NASA technology utilization program are to maximize the availability and utilization of a national resource—NASA-sponsored new technology—by the general public. Recovery of federal investment through licensing fees for example, is not an objective. The promotion of competition is not a direct objective of the NASA technology utilization program although competition is fostered indirectly through the broad dissemination of technology. Under this program, described below, the single basic objective is fostering maximum public use of new knowledge.

NASA's patent organization under the direction of the Assistant General Counsel for Patent Matters, has primary responsibility in matters relating to inventions and patents. The patent organization is concerned with the reporting of inventions, the decision regarding whether or not to file a patent application, and matters relating to waivers and licensing. The administering of the contract administration clause regarding NASA new technology is the joint responsibility of the Technology Utilization Division and the patent organization. The Office of Technology Utilization has the primary responsibility for getting industry interested in NASA-generated inventions and innovations. By issuing news releases, the Public Information Division in the Office of Public Affairs plays a role in bringing to the attention of the public items of interest regarding NASA's activities and NASA's new technology. Of these several offices, the patent organization, the Office of Technology Utilization and the Inventions and Contributions Board play the principal roles in the field of patent utilization.

B. The Process of Ultimately Encouraging Commercial Utilization of Patents

1. Selection of Inventions to Be Patented

NASA's primary objective in patenting are to obtain infringement and procurement protection on inventions that the government expects to use, to insure availability to the public of inventions believed to have commercial potential, and to recognize the inventive contributions of NASA employees.

Considerably fewer inventions are patented by NASA than are reported to NASA. As of December 31, 1965 NASA had received a total of 6,542 disclosures of inventions, and had filed patent applications on 1,055 of which 340 have issued into patents.

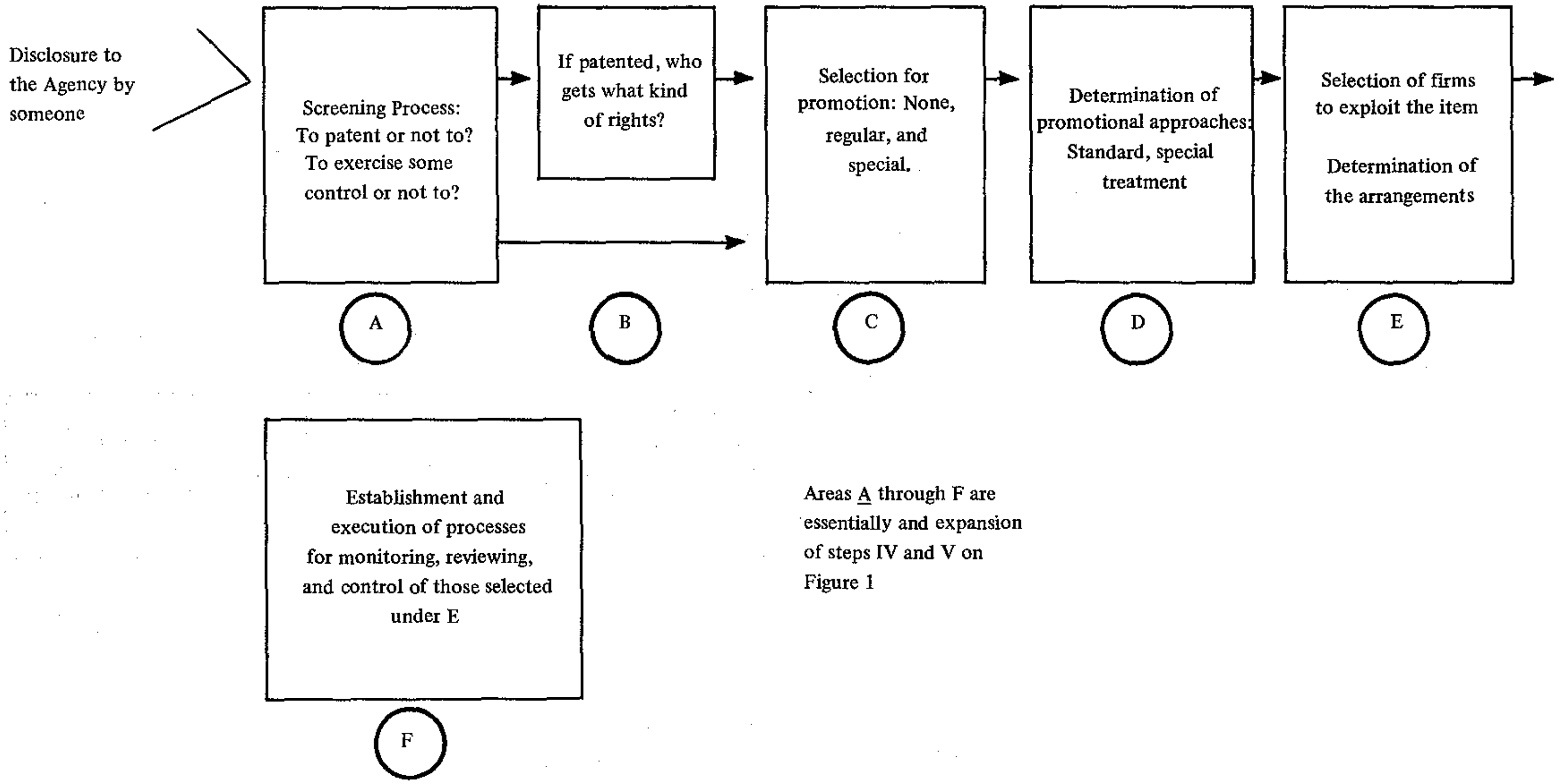
Although the actual decision regarding whether or not to file a patent application is made at NASA Headquarters in the Office of the Assistant General Counsel for Patent Matters, the chain of decisions involved begins as soon as an invention has been docketed in the office of the Patent Counsel at the local installation and a case number has been assigned. At this time, the employee's supervisor (in the case of an employee invention) or the technical monitor of the contract (in the case of a contractor invention) is sent a standard evaluation form. This person then performs a technical evaluation of the invention, using such criteria as novelty, performance, potential government use, and potential commercial use.

On the basis of this technical evaluation, the local Patent Counsel assigns one of three possible priority ratings: P-1, indicating sufficient interest to warrant filing; P-2, a standby rating indicating either insufficient information or the fact that the invention is only conceptual at present; or P-3, indicating insufficient interest and resulting in the case's being inactivated. In assigning the priority rating, the local Patent Counsel is asked to judge whether the invention is:

(i) One of primary importance to the aeronautical or space activities of the United States; or
(ii) a pioneer discovery; or
(iii) a substantial advancement in the art; or
(iv) the subject of a substantial existing or prospective government production or use; or
(v) an inventions with substantial promise of commercial utility.

FIGURE 2

ILLUSTRATIVE SEQUENCE IN THE PROMOTION OF COMMERCIAL UTILIZATION OF TECHNOLOGY



objectives (to establish its primary motivation) and its policies and practices (to identify what it does)—thus the second area has been divided into two subareas. The second subarea—agency policies and practices—is broken down into six steps:

- Selection of inventions to be patented.
- Determination of rights to a patented invention.
- Selection (of technology) for promotion.
- Determination of promotional approaches.
- Arrangements for commercial access to an invention.
- Review and control of commercial utilization.

As shown in Figure 1, these steps—which involve events IV and V in Figure 1—are a part of a broader sequence of events in the development of government inventions for commercial use. The six steps are essentially an expansion of events IV and V and relate to each other as shown in Figure 2. Selection for promotion and determination of promotional approaches generally have been the major areas of concern in this report.

To make comparative analysis easier, this research plan has served as a common basis for all review reports in this task. However, it has not been considered to be a rigid framework and thus has not been rigidly or arbitrarily maintained. Rather, where appropriate, specific departures have been made and noted in the text. For example, because the "functional" breakdown into the six steps listed above does not really exist for SBA, this agency's activities have been discussed in terms of programs rather than functions.

D. General Observations

The principal aim of Volume III has been description rather than analysis. However, certain findings have emerged and should be considered. These general findings are:

(i) There are a wide variety of approaches to utilization. At one extreme is the NASA approach, which involves discrete, conscious, and identifiable steps. At the other extreme are actions in some agencies where the steps are interrelated, sometimes unconscious, and frequently wholly subjective.

(ii) Even within individual agencies, the promotional approaches to utilization and utilization actions are not always consistent in their treatment of one invention and another. At least in part, this occurs because responsibility and authority are often unclear and criteria for action are frequently lacking.

(iii) In a majority of the agencies, the primary motivating force behind utilization is the staff directly engaged in R&D.

(iv) With but few exceptions, the agencies have little interest in promoting utilization (of technology) in areas outside their mission or sphere of interest [for example, the Department of Agriculture concentrates on reaching the agricultural community, FAA on aviation, and HEW (PHS) on public health and medicine].

(v) There is a general lack of concern about utilization of patented items *per se*. Inventions may be patented without any further organized concern about what to do with them and, conversely, inventions are often promoted without knowledge or concern about the patent (ownership) status.

(vi) In general, the policies and practices of the various agencies are well documented and understood as far as the patenting process is concerned. However, policies and practices with respect to the heart of utilization activities—selection for promotion, determination of promotional approaches, provisions for commercial access, and so forth— are often absent, not widely known, or not recognized as being needed.

(vii) In the determination of whether or not to patent an invention, an evaluation of its commercial potential or industrial application is normally made. However, in only one agency was there significant evidence that this evaluation provided any basis or usefulness in the process of deciding what, how, and where to promote.

(viii) There is little evidence that interagency activity provides the transmission from one agency to another of information about technology that has been useful for utilization purposes.

EXHIBIT A-1
PROCEDURES OF ONE PHARMACEUTICAL FIRM FOR SCREENING CHEMICAL COMPOUNDS FOR BIOLOGICAL ACTIVITY

February 16,1967

"At ... we estimate that 60% of our domestic R&D budget for new prescription pharmaceuticals supports preclinical research. This is basic research aimed primarily towards:

1. The development of screens or tests for discovering biological activity in chemical compounds.
2. Discovering the best ways to operate such screens.
3. Laboratory work to confirm biological activity or to extend our knowledge of such activity.

"We operate an antibacterial screen in which we test in the test tube as many new and old compounds as we can gather from all sources. About 20,000 compounds go through this screen yearly. However, these are not entered into our formal testing program described below unless there is an indication of activity.

"About 4,000 compounds are entered each year into our formal testing program. Each compound in this program may be tested in various ways over a period of many years.

* * * * *

"... Certain compounds are screened through all our basic screens. However, as a rule, our experts in structure activity designate tests in from one to five of the screening areas.

"The ... basic screening areas may be roughly divided into 12 groups, including basic neurological, antiviral, parasitic, cardiovascular, and endrocrine. In order to estimate the cost of screening in one of the simplest areas it will be useful to look at basic neurological screening where relatively standard central nervous system effects are studied.

* * * * *

"Detail on each of the steps involved follows:

"Logging-in the Compound

A naked compound is received in the laboratories then formally assigned an . . . accession number. Its structure is coded for computer work. Its official chemical name is assigned. After the paper work, the compound is evaluated by a structure-activity expert who decides to what testing areas the compound should be submitted. The compound is then sent to an embargo area from which it is circulated to the designated testing programs. Results of the testing flow back to the control office.

"Dose Range Test

All compounds are submitted to a dose range test in a series of 6-12 mice or rats over a range of increasing doses in order to look for gross biological activity on a qualitative basis. Among these effects are hypotonia (a form of sedation), ptosis (a drooping of the eyelids), catalepsy (a form of immobility), vasodilatation (flushing of the skin), tremors or shaking, stimulation, etc. Such effects may be indicative of various biological activities, for example, sedative, anticonvulsant, stimulant, blood pressure lowering.

"Primary Screening

The results of the dose range test may indicate what primary screening may be recommended for the compound. An example of such a primary screen might include a dose range test in another animal species such as the monkey, dog, or cat, plus specific tests such as analgesia (elevation of pain threshold), reversal or reserpine ptosis (to pick up antidepressant activity), antagonism of metrazol-induced seizures (for anti-anxiety activity), antagonism of tryptamine (antidepressant activity), rage test (anti-anxiety activity), and the proceed unless a drug was disapproved to 180 days for review and a mandatory approval. And more extensive research in support of all aspects of new drug development was provided as a result of the regulations. The practical effect of the new regulations (see Figure A-4) is that detailed clinical work and case reporting are carried out to support the NDA by proving efficacy as well as safety, and that the professional qualifications of proposed clinical investigators have to be established with the FDA. At the same time, the FDA has taken a more comprehensive interest in labeling, production, and quality control of new products, thus further lengthening the approval process.

FIGURE A-3
FDA PROCESSING TIME FOR HUMAN NDA'S*

Year	PMA Figures	
	NDA's in Survey	Average Days Required**
1958	153	102
1959	172	106
1960	127	136
1961	98	191
1962***	NA	NA
1963	61	327

NA = Not Available

*This refers to human NDA's as opposed to veterinary NDA's. The NDA's approved are for new chemical entities and duplicate single products. This does not include new dosage forms, which are usually included under the supplemental NDA's.

**The average number of days that the NDA was considered by the FDA. This does not include the time required by firms to do additional work requested by the FDA.

***1962–when the new drug regulations were passed–was a year of transition. Therefore, PMA figures were not given for this year.

The processing of NDA's now generally takes 12 to 32 months from the time a company first submits the NDA to the FDA for approval. In reviewing the history of the processing of NDA's for nine important new drugs, one drug firm found that it took 12 to 18 months to obtain FDA approval for four of these drugs, 21 to 24 months for three of them, and 30 and 32 months respectively for the other two drugs.

In addition to the increase inthe length of time required for processing the NDA's the new drug regulations and the tighter FDA control that has accompanied them have had several other major effects:

(i) A substantial decrease (see Figure A-5) in the number of NDA's submitted annually to the FDA for approval.

(ii) A substantial decrease (see Figure A-5) in the proportion of NDA's approved annually by the FDA.

(iii) The ultimate–and most important–effect: a marked decrease in the number of new drugs marketed annually (the figures below were put together by a major pharmaceutical firm from various industry sources):

1959	1960	1964	1965
63	45	17	23

FIGURE A-4
MARKETING REQUIREMENTS OF THE 1962 DRUG AMENDMENTS*

PRE-1962	POST-1962
Clearance for safety–automatic approval by lapse of time.	Clearance for safety and proof of effectiveness–active approval of FDA.
Most of these requirements were implied but not tightly drawn in 1938.	–Truthful labeling. –Nothification of patient as to experimental status. –Reporting of adverse effects. –Tighter quality control and inspection authority. –More qualified clinical investigators. –Better clinical records.
Trade names and common names.	Uniform nomenclature.
No advertising control.	Advertising control.

*The 1962 Drug Amendments to the Federal Food, Drug, and Cosmetic Act of 1938 became law October 10, 1962.

into hundreds of pounds[2] and in the replacement of specimens that had become moldly during shipment. Moreover, an inordinate amount of the investigator's time was invested in expediting shipment and in getting customs clearance.

The process of synthesizing new chemical compounds from chemical raw materials is often complex. To illustrate, in attempting the synthesis of new steroid or penicillin-like compounds, an investigator might be able to start from complex chemical structures such as those found in the catalog–including 10,000 organic chemical items–of a prominent research chemical supplier or from interesting compounds made by industrial chemical or pharmaceutical firms. Regardless of his source of raw materials, the investigator would have to check the professional literature to make certain that the compounds to be synthesized would be new and likely to produce interesting biological results. Additional, he would have to design, validate, and incorporate verification procedures to establish the successful completion of each step toward synthesis.

The result of most research efforts in the chemistry of synthetic medicinal compounds is a family of final compounds, plus a number of intermediate compounds developed during intermediate steps in the synthesis.[3] One investigator estimated that, while a specific compound could probably be synthesized and verified according to an established procedure in three to six months, the research effort required to work out the synthesis, validate it, and make a whole family of compounds could take several years.

2. Screening and Evaluation

a. *Introduction*

When a novel medicinal compound has been prepared from either natural or synthetic sources, there is usually no informationabout its probable effects on biological systems–for example, stimulation of the central nervous system. The purpose of the screening and evaluation phase is to determine the biological effects and possible utility of the new compound.

Screens may be divided into two general categories: broad screens and specific screens. If the new compound is similar to compounds that have already been tested and some hypotheses can be formed as to its potential activity, the investigator responsible may decide to bypass broad screens and go directly to more specific screens. (See Exhibit A-1 for an example of one firm's procedures for performing broad and specific screens of chemical compounds for biological activity.)

b. *Broad Screening*

Initial screening steps (primary or broad screens)[4] are the general test procedures designed to reveal broad categories of biological activity that may be analyzed further in more specific pharmacological screening. Initial screening can take several forms. For antibacterial evaluation, the compound may be tested against cultures of bacreria in test tubes (in-vitro testing); for local anesthetic action, the compound may be analyzed with the earthworm test,[5] for a general assay of the activity and toxicity of the compound in animals (broad animal screen), the compound may be injected intraperitoneally into mice or rats (in-vivo testing)[6] which are then observed for changes in behavior and health. These changes may then form the basis for more specific testing. A typical form used in reporting back to the investigator on the first broad animal screening of compounds is shown in Figure A-2. The technician running a test using this report keeps a time history of each observed phenomenon for each animal (one sheet per animal) for the duration of the test. Other variations of the same type of form, with either more or less data, are used by other screening activities.

Broad screens are generally easy to set up, inexpensive to run, and capable of evaluating many compounds quickly. These screens are used in the pharmaceutical industry, in university departments of pharmacology, and in commercial and nonprofit testing laboratories. It is at the point where these early biological tests show utility that medicinal compounds are usually patented. To secure a patent an investigator must demonstrate both chemical novelty and biological utility.

[2]It might take hundreds of pounds of raw material to obtain sample quantities of 3 to 10 grams of the extracted material.

[3]Synthesis takes place in various steps. The product of any step is an intermediate compound, while the product of the final step is the final compound.

[4]Specific estimates of cost, throughput (the number of compounds evaluated by the screening), and validity of results for broad screens were made by various interviewees during the study. These estimates are included, as appropriate, in later parts of the report.

[5]This test, recently devised, has become an inexpensive indicator of local anesthetic activity. To conduct the test the tail of a live earthworm is dipped first into the candidate local anesthetic compound and then into dilute hydrochloric acid (HCL). The earthworm's aversion to HCL will cause its tail to withdraw violently from the acid if the potential anesthetic compound is inactive. Anesthetic activity of the compound will delay or reduce the action of the earthworm's tail.

[6] In contrast to in-vitro testing, which involves test tubes, in-vivo testing is a term used to denote any testing done with live animals.

technical products, such as aircraft, jet engines, computers, or communications equipment. Although as much as 75 percent of their sales may be direct to the government, these firms frequently sell identical products to commercial markets. Inventions developed during the course of R&D activities tend to be auxiliary components and subsystems or incremental improvements to the basic product. These inventions are not as important to these companies in sustaining sales or selling new products as is the basic engineering management and production capability of the firm. New ideas and inventions are incorporated in product modifications or in new models with little consideration given to the protection offered by patent rights. Using a new idea to enhance product performance is regarded as more important than assuring that the company owns the right to use it. A change in government patent policy from license rights to title rights would probably have little effect on the business activities of these firms and on their interest in continuing to undertake government contract work.

3. Patents Are Valuable for Defensive Purposes.

Some firms believe that corporate ownership of patents offers flexibility in design, both in the United States and abroad (through ownership of corresponding foreign patent rights), and provides trading material for cross-licenses with competitive firms. Ownership of a patent, however, as a prerequisite for new product development is a relatively minor factor compared with market considerations and investment requirements associated with commercialization of the invention. A change in government patent policy may affect firms in this category by causing them to choose more carefully the areas in which they are willing to undertake government research. Faced with the possibility of being unable to obtain title to patents they develop, these firms may refuse to contract in research areas that would impair their operational flexibility.

4. Patents are Important in Establishing Proprietary Market Positions.

Firms having this attitude actively seek ownership of patents. Ownership of an entire patent portfolio, as well as of individual inventions, is actively used by these firms to establish and maintain proprietary positions in new technologies, as well as in established product areas. Invariably, however, estimates of market potential and corporate investment requirements determine which product areas are developed. The makeup of the patent portfolio may indicate the direction for product development in order to strengthen proprietary positions, but development is rarely, if ever, undertaken solely because patent protection is available. A change in government policy from license rights to title rights would limit the government-sponsored R&D activity of firms in this category because of possible conflict with company-sponsored research activities. Contract opportunities would be examined on an individual basis and, in many cases, the government might be refused.

5. Ownership of Patent Rights and Maintenance of Proprietary Positions Are Fundamental Precepts of Business Operations.

Firms in this category regard patent rights as essential to their business activities, and are careful to avoid government claims or conflicts over ownership of inventions. Their policies generally lead them into one of two business patterns. In the first pattern, firms will assure corporate ownership of patents before initiating work on a government contract. They may assure ownership either by negotiating contracts that permit them to acquire title to patents on inventions they may develop, or by developing and patenting basic inventions with limited private funds and then seeking contract work in order to develop additional technical competence, push the state of the art, explore a new technology, or determine if commercial applications may begin to be drawn off. In these situations, firms deliberately select areas of government research to match their commercial interests in order to generate product ideas with commercial possibilities. New research firms with strong technical abilities and limited capital typically follow this pattern, as do specialized firms that have concentrated their business in a limited area of technology.

In the second pattern, firms isolate government work from their commercial operations and pursue these activities separately. Frequently, inventions derived from government contract work will be assigned automatically to the government to avoid title conflicts or commingling with company-sponsored R&D. In other cases, government R&D will be undertaken only in areas where there is no potential conflict with corporate proprietary objectives and in order to enhance the corporate image. The technical value of government contracts to the commercial interests of these firms is rarely considered a valuable supplement to in-house research and development.

serious problems in supplying the site, providing necessary pumping equipment, or finding water. It did doubt, however, that the experiment could be conducted unless patent arrangements could be worked out.

The company held numerous patentable inventions in the extremely patent-sensitive area of solution mining, and believed it would be impossible to be involved in the subject experiment without introducing some of the preliminary thinking on solution mining that would normally result in patents. In addition, the Bureau was not bringing any expertise to the effort. Because of this, Solution Mining believed that the cooperative research could only result in its losing, at least in part, patent rights that would otherwise eventually belong to the company. No specific patent proposal was sent to Solution for review.

In June 1966 the research center contacted the company and suggested the following approach: If the Bureau could form the solution cavity and run some specific experiments to acquire fundamental engineering data, the Bureau would be satisfied with the data only, excluding work on patentable items. In addition, the Bureau stated its willingness to work at the site on an alternating basis, thus allowing the company to conduct its own experiments without Bureau participation or supervision. At the time of this report, neither party had acted on this approach.

Because the cooperative support of Solution Mining could not be enlisted, the solution mining program has not proceeded beyond the preliminary planning stage. It remains on file for possible submission to the Bureau of the Budget for funding at a future time. Thus, what was originally considered a significant program of considerable interest to the mining industry never got under way. Bureau personnel feel that progress in solution mining is being held to a minimum because of patent issues among the government and prospective cooperators.

should, in fact, pay royalties on the use of background patents. The company in Case 12, above, wanted to limit the government's royalty-free use up to and including the demonstration plant phase. Although the reason for this was never specifically stated, we assume that the company's position was based on the expectation of a potentially significant future market for desalination plants.

Kemco, in Case 20, below, was quite explicit about its reason for wanting the government to pay royalties. The program under consideration had originally been performed on a cost-sharing basis with OSW, and, as a result, Kemco had invested approximately $500,000. Kemco maintained that unless the government paid some royalty on the background patent used in the plant, it could never recover its investment in the remaining 13 years of the patent. The government at one point agreed with Kemco's position, but later attempted to obtain a royalty-free license.

CASE 20

Although most water desalination processes have been based on physical methods of separation, Kemco proposed an interesting chemical process to OSW in 1960. The contract subsequently negotiated provided that Kemco and the government were to pay for the work on an equal basis. The question of patent title did not arise until the contract termination in June 1963.

At that time, OSW informed the contractor that any continuation of the work would require a revised patent clause to conform with the standard patent provisions of the Saline Water Conversion Act. It was subsequently agreed that the government would bear the full burden for all costs under a succeeding contract and that Kemco would agree to certain patent clauses requested by the Office of the Solicitor.

Work progressed most satisfactorily and, before the second contract expired in 1964, a third contract was successfully negotiated, to run for six months at a cost of $310,000. Kemco would continue bench-scale research of the hydrate process and would design and prepare specifications for a pilot plant.

Once again, the government would bear all costs. At the close of negotiations, OSW requested a royalty-free license for the government to Kemco background patents. The company firmly refused to grant the requests. In a telegram to the OSW director, it stated: "It deprives us of the opportunity to eventually recoup our investment and violates our obligation to the inventor. It is further not in keeping with the understanding negotiated between Kemco and the Department of the Interior when the government took over 100 percent sponsorship of research in 1963. We are accordingly notifying you that we are closing down operation of the pilot plant on June 1, 1966, moving our personnel back to Pittsburgh, and preparing the final report."

Further negotiations proved fruitless, so the pilot plant was, indeed, closed on June 1, and all Kemco employees left by June 15. In support of its position, Kemco quoted the last sentence of Section 4(b) of the Saline Water Conversion Act, which reads: "This subsection shall not be so construed as to deprive the owner of any background patent relating thereto of such rights he may have thereunder."

Kemco felt that proper interpretation of he law was that the foreground patents should be freely available to the general public, but if these improvements are dominated by or require a license under the contractor's background patents, such a license may bear a reasonable royalty. Kemco maintained that a patent owner is entitled to charge for the use of his patent and that requiring a royalty-free license deprives him of this right.

The pilot plant remained idle until May 1967; and, according to OSW, the program experienced a serious setback. The government had invested $1,222,050 on the process since 1960 and Kemco had invested $495,000 when negotiations with Kemco terminated. OSW reports that subsequently, a competent contractor was engaged to operate the pilot plant. This work continued for approximately 14 months and was terminated when it was concluded that the process lacked potential in achieving low-cost water de-salting.

h. *Patent Provisions Were Generally Unacceptable.* In Case 21, below, the company merely voiced general opposition to the patent provision.

CASE 21

In April 1966, officials of the Mineral Mine, which is operated by Mineral Corporation of America, invited officials of Mines' Denver Mining Research Center to participate in a cooperative effort to evaluate the molybdenite deposit. They asked research center personnel to help determine the optimum drill-hole spacing for obtaining geological information, the object being to delineate and establish the grade and tonnage of the ore body that extended from an edge of the current pit.

After several discussions with research center personnel, Mineral Corporation decided to hire a private consultant to conduct the research. According to members of the research center, the Bureau's patent clauses heavily influenced the company in making this decision. No formal negotiations had been started, and no further background patent rights on ion exchange membranes would be limited to use in reverse osmosis apparatus. OSW agreed, and in an October letter forwarding the executed contract, SWTW, spelled out the technical and legal understandings on which its acceptance of the contract was based. The negotiations thus concluded on November 16 set the stage for the next round on a related proposal.

About a month after it had submitted its first proposal to OSW, SWTW had submitted a second proposal for the development of a high-temperature, thin-membrane electrodialytic process of converting sea water. However, because of the complexity of patent negotiations in the first project, the contractor requested the consideration of the second proposal be suspended until the first contract had been negotiated. The first set of negotiations, however, did not create any precedent for the second proposal. Specifically, SWTW proposed to add a provision stating "that the contractor shall not unreasonably use his background patent to prevent a responsible applicant from using a subject invention for the conversion of saline water to fresh water if the contractor is not going to use the subject invention."

OSW objected on the grounds that the purpose of the background provisions was to make certain that the public would be able to practice any subject invention. The contractor balked and, after similar extended negotiations, a compromise was reached which stated "the Contractor is not obligated to license the Background Patent provided that the Standard Commercial Item upon which the Subject Invention can be practiced and which is an embodiment of the Background Patent is also available." During the next five months, the parties negotiated their differences over five subsidiary patent issues and reached agreement on a contract.

CASE 16

In early November 1961 the FRSW Company submitted an unsolicited proposal to OSW for purifying sea water by reverse osmosis. The hollow fiber membrane concept for purifying sea water by reverse osmosis appeared to be a logical extension of the broad research background that the company maintained in the areas of textile fibers and ion exchange.

Accordingly, when the company reviewed the contract document proposed by OSW, which included the standard patent clauses, it stated that it could neither agree with nor consent to the contract as written. FRSW had assumed that a patent clause similar to that in a 1960 FRSW-OSW contract would be utilized. This clause had provided that title to all inventions and patents obtained during performance of work under the proposed contract would remain the property of the contractor, and the government would receive a non-exclusive royalty-free license for governmental use. However, the Saline Water Conversion Act of 22 September 1961 had been passed in the meantime.

The company detailed its technological background and qualifications for the work proposed. Its director of research noted that "several years of research had disclosed promising commercial applications of the reverse osmosis process, and these applications are being actively pursued in separate proprietary programs." The Office of the Solicitor stated that it would take into consideration:

(i) The amount of money expended in research and development as defined under the contract;
(ii) Any background patents and/or patent applications relating to the field;
(iii) Proprietary data and technical capabilities.

If the contractor's total background position was such that it significantly out-weighed what the government would expend under the contract, title could be left with the contractor. FRSW supplied OSW with most of the information required.

After reviewing the facts on hand, the Office of the Solicitor felt that FRSW did not have a background position strong enough to outweigh the proposed government expenditure. However, the government was willing to consider joint title, compulsory licensing, or leaving the title with the contractor who would then agree to grant the government a royalty-free license to use, as well as the right to sublicense. FRSW refused these alternatives, and offers and counter-offers continued through June of 1962, when it became apparent that a stalemate existed.

FRSW continued to pursue its desalination research and experimentation, and OSW project personnel felt that it had lost the chance of obtaining a valuable technique. However, OSW reports that it subsequently has contracted with other firms in the same general areas of technology, employing ideas of at least equivalent merit.

e. *Patent Policy Could Be Interpreted Too Broadly.* In 4 of the 24 cases, including four universities, it was maintained by contractors that the requirement to assign title to subject inventions to the government could be interpreted to include all inventions made by professors, staff members, and others who were working in the same field, but not under the subject contract. Two of these—Cases 17 and 18—are described below.

CASE 12

In May 1963 WT, Inc., met with OSW personnel to discuss the company's capability to conduct a program of fundamental and applied research in electrochemistry as applied to desalination. As a result of the meeting, on June 20, WT submitted a proposal of a 12-month R&D effort based essentially on its previous success in solving electrode capacity problems in fuel cell technology. The Department of the Interior's draft contract provided for the assignment of title in subject inventions to the government and the granting of a royalty-free license to the government under background patents.

Objecting to the latter provisions, WT requested elimination of the requirement to grant a license for "any use by or for the Government to produce fresh water from saline water for consumption by or on behalf of the Government"; instead, it requested that the clause provide for limiting the royalty-free use to the government to the development program, up to and including any demonstration phase of the pilot plant, and the payment of reasonable royalties thereafter. To justify its position, WT cited two previous contracts with OSW that contained essentially the same patent arrangements. Both had been entered into subsequent to the 1961 amendment to the Saline Water Act. It felt particularly vulnerable because no pertinent background patents were identifiable at the time of contract negotiation. It, therefore, was concerned about jeopardizing its extensive patent position in the field of electrochemistry which would be pertinent to the proposed work.

The Office of the Solicitor saw no reason to depart from usual departmental policy in the case. However, the Solicitor was willing to agree that the government should pay reduced royalties on any background patents for government use. The clause would be stated as follows: "In the event the contractor's Background Patents may be infringed by or for the Government, the Government shall receive credit in the amount equal to its contribution under the contract toward any royalties it is required to pay."

WT would not accept this provision. In October, negotiations were renewed, and the Department of the Interior expressed a willingness to accept a top-gallonage limitation for royalty-free government use of background patents. Under this arrangement, the government would be permitted to build desalination plants using any subject invention, or using any process apparatus or composition of matter which was the subject of work called for by the contract, with so many gallons per day of plant capacity to be royalty-free. A final contract was executed by both parties after some 17 months of negotiations.

CASE 13

Northern University proposed a study of canal ecology to the Bureau of Reclamation in September 1965. After receiving a copy of the Bureau's standard patent clauses, the principal investigator stated that the university patent attorney could not let the university accept a patent with "such rigorous patent requirements." Unless these requirements could be reduced, the university would be forced to withdraw its proposal. The Office of the Solicitor was prepared to grant two concessions:

(i) First, the requirement of a royalty-free license to the government under background patents was dropped because the requirement was not appropriate in the kind of research proposed.

(ii) An existing patent and a patent application assigned to the university (for which negotiations for exclusive licenses had been proceeding over a period of several years and were about to be successfully concluded) were specifically exempted from being considered as background patents.

The university was willing to accept these concessions and, after a four-month delay caused by negotiations, work began under the contract.

CASE 14

The PRC Corporation interested the Bureau of Mines in a cooperative effort to evaluate the use of sponge iron products in arc-furnace melting. PRC requested the following provisions with respect to patent rights:

(i) Each party to this agreement grants to the other party the right to manufacture and use, by and for itself, and in the case of the cooperator, for all affiliates of the PRC Corporation, without payment of any royalties, any invention made in the course of the cooperative work herein provided for.

(ii) The cooperator agrees to grant nonexclusive and nondiscriminatory licenses under patent rights in any inventions made by its employees in the course of the cooperative work to any person upon payment of a reasonable royalty.

The Bureau's version of this provision was unilateral; that is, all of the rights flowed to the United States, and the cooperator neither retained nor received any patent rights from the United States. In subsequent negotiations the Bureau agreed to delete the background patent requirements in view of a representation by PRC that the sponge iron to be tested was similar to a sponge iron available through other processes and was, therefore, a research effort to study natural evaporation from free water surfaces. The Bureau approved the project and offered the laboratory a one-year contract for $40,000 in June 1965.

Ten days after receiving the proposed contract, the contractor informed the Bureau that the contract was unacceptable because of the background patent clause. After three months of negotiations, the laboratory accepted the provision because "we are more interested in performing the research than in engaging lengthy negotiations. Also, we are quite certain nothing patentable will result from this study." The laboratory also assured the Bureau that, in the future, when working on new ideas not yet reduced to practice, it would seek to avoid sponsorship by any government agency which takes title to inventions.

CASE 7

The Bureau of Mines and the MTL Corporation signed a cooperative agreement for the investigation and research of factors effecting the stability of open-pit slopes in 1961. The Bureau was to conduct the field and laboratory work; MTL Corporation was to contribute funds and prepare field working sites. As a result of several amendments, the agreement was extended to five years.

Negotiations on the final extension stopped in 1965 because MTL Corporation insisted that the 1961 patent clauses should be used instead of a new clause. The new clause provided for cross-licensing subject inventions. Even though cross-licensing was an exception to the Bureau's normal policy (since it only applied "where the cooperator has made a contribution which is greater than the Government's . . . or where the work could not otherwise be undertaken") MTL Corporation felt that this was an unacceptable concession. Counsel for the corporation urged several alternatives, including the total absence of a patent clause, as had been done with a current cooperative agreement with the Atomic Energy Commission.

Six months after work had been originally scheduled to begin on the final phase, MTL Corporation accepted the Bureau clauses indicating that it only signed because it was certain nothing patentable would result from the work.

CASE 8

In 1964 Technology University received a $10,000 contract from the Bureau of Reclamation to determine the resiliency of concrete arch dams to foundation movement. Impressed with the results of the study, the Bureau offered a subsequent contract upon completion of the first.

Five months passed without any word to the Bureau from Technology University, so in March 1966 the Bureau requested a status report. The university replied that it had been delayed by staffing difficulties and by objections to the patent clause. Although the university had not objected to the patent clause in the original contract, it now requested that the Bureau clause be deleted and the one based on Section 1(b) of the Presidential Memorandum on Government Patent Policy of 12 October 1963 be inserted in its place.

The Office of the Solicitor stated that it did not believe the research effort belonged under Section 1(b) because a university could not have "an established nongovernmental commercial position."[2]

Five months later the university accepted the proposed patent clauses after implying that nothing patentable was likely to result from the study. The patent disagreement and staffing problem delayed the study for one year.

b. *Background Patent Policy Could Endanger Contractors'/Cooperators' Present Patent Position.* The second most frequent objection, this argument was also raised in 9 of the 24 cases. One company indicated that the problem was particularly acute for small concerns whose survival might well depend upon their patent position. One university objected on general principles to this aspect of Interior's policy even though it did not affect the specific project then under negotiation. Three industrial firms and four educational institutions expressed concern that background patent requirements could jeopardize patent positions that had been established at considerable expenditure of their own talent, time, and money. This objection is illustrated in Cases 3, 5, and 6, above, as well as in the six examples below.

CASE 9

From 1953 to 1963 OSW sponsored a research program directed toward developing the reverse osmosis process of desalination. During a period in which OSW placed five industrial and university contracts, it learned, through technical publications, of a parallel effort being conducted by Professor A at Tech University. OSW considered Dr. A's work a highly desirable addition to its own research program in reverse osmosis; however, it made no formal effort to secure a proposal from him, having been informally advised that neither he nor Tech University would accept financial assistance from OSW for fear of endangering their patent position.

[2] The effect of the patent policy on achieving commercial utilization through universities and nonprofit institutions is discussed in Volume IV, Part III, *Commercial Utilization Through Nonprofit Institutions.*

reviewed are synopsized in subsection 2 to illustrate the contractual problems involved.

2. The Policy Issues

a. *Patent Clauses Were Inconsistent with Those of Other Government Agencies.* This objection, one of the two most frequently raised, was cited in 9 out of the 24 cases researched. In six cases—five universities and one chemical company—the Department of Defense patent policy was considered the "normal" and most desirable. One industrial firm pointed out that in a previous contract with the AEC it was permitted to retain title to inventions, a policy opposed to the Department of the Interior's requirement that title be vested in the government. One university felt that the Department of the Interior patent policy did not conform with the "uniform patent policy" set forth in President Kennedy's Statement of Government Patent Policy of October 12, 1963. The objection is illustrated by the eight cases vignetted below:

CASE 1

In early 1963 an associate professor of engineering at State University asked the Bureau of Reclamation for support in his investigation of water quality and salvage of domestic waste waters. The study would entail investigating the supplemental treatment needed to upgrade sewage effluent so it could be either recharged into the ground or reused in irrigation systems.

One year later, the professor asked the Bureau how to apply for a patent to cover developments resulting from the contract study. The Office of the Solicitor realized when the professor returned the forms that the patent provisions had inadvertently been omitted from the 1963 contract document. The Office of the Solicitor explained the oversight to the university and requested that the professor execute an "assignment of invention" document which would transfer the patent rights to the government. The Office of the Solicitor explained that this was a necessary procedure before further action could be taken on the professor's patent application. The university and the professor complied.

Two months before the contract was due to expire, the Bureau forwarded an amendment to the contract containing the standard patent clause, to continue the study for another year. Ten days later, the university returned the unsigned contract to the Bureau, citing the patent provisions as a barrier to contractual agreement.

State University contended that although the contract principally involved the university and the government, the study included several other agencies that had contributed either funds, facilities, equipment, or labor. It argued that, notwithstanding the professor's previous assignment, the university had no legal right to assign exclusive patent rights to the government. It maintained that it did not have the kind of control over its faculty members that was presumed in the wording of the proposed patent article.

The government was willing to modify the agreement in some respects, but not to the extent of waiving title to any inventions arising under the contract. After ninety days of negotiation, the parties were unable to reach agreement and the contract was permitted to expire before completion of the project. The Bureau of Reclamation feels that the inability to reach agreement caused a severe setback in a research program which is vital to the southwestern states.

CASE 2

In 1961 Midstate University submitted an unsolicited proposal to the Office of Saline Water (OSW) for a study to examine the properties and behavior a vapor pressure in distillation units. OSW endorsed the project with a recommendation that the scope of work be narrowed and that the project be extended from a one-year to a two-year study.

Seven months after submitting the proposal, OSW sent the grant documents to the university for execution. The university and the principal investigator took exception to the patent provisions of the grant and requested that such provisions be replaced by the "normal" provisions used in other government agency grants. Presumably Midstate University was referring to the Department of Defense patent provisions used in most contracts whereby the contractor or grantee—and not the government as specified in OSW clauses—retains title to any invention. After several telephone conversations and exchanges of correspondence with OSW officials over a three-month period, the university accepted the grant because the principal investigator was quite certain that no inventions would result from the research effort.

Despite Midstate's practical solution of the problem, a three-month delay was caused by the concern over patent rights.

CASE 3

In 1965 the Bureau of Reclamation initiated negotiations with State University for two studies to analyze the long-term stability of soils subjected to constant stress. Contract drafts for the studies included the Department of the Interior patent provisions of 27 April

FIGURE IV-1
PARTIAL ORGANIZATION CHART
THE DEPARTMENT OF THE INTERIOR

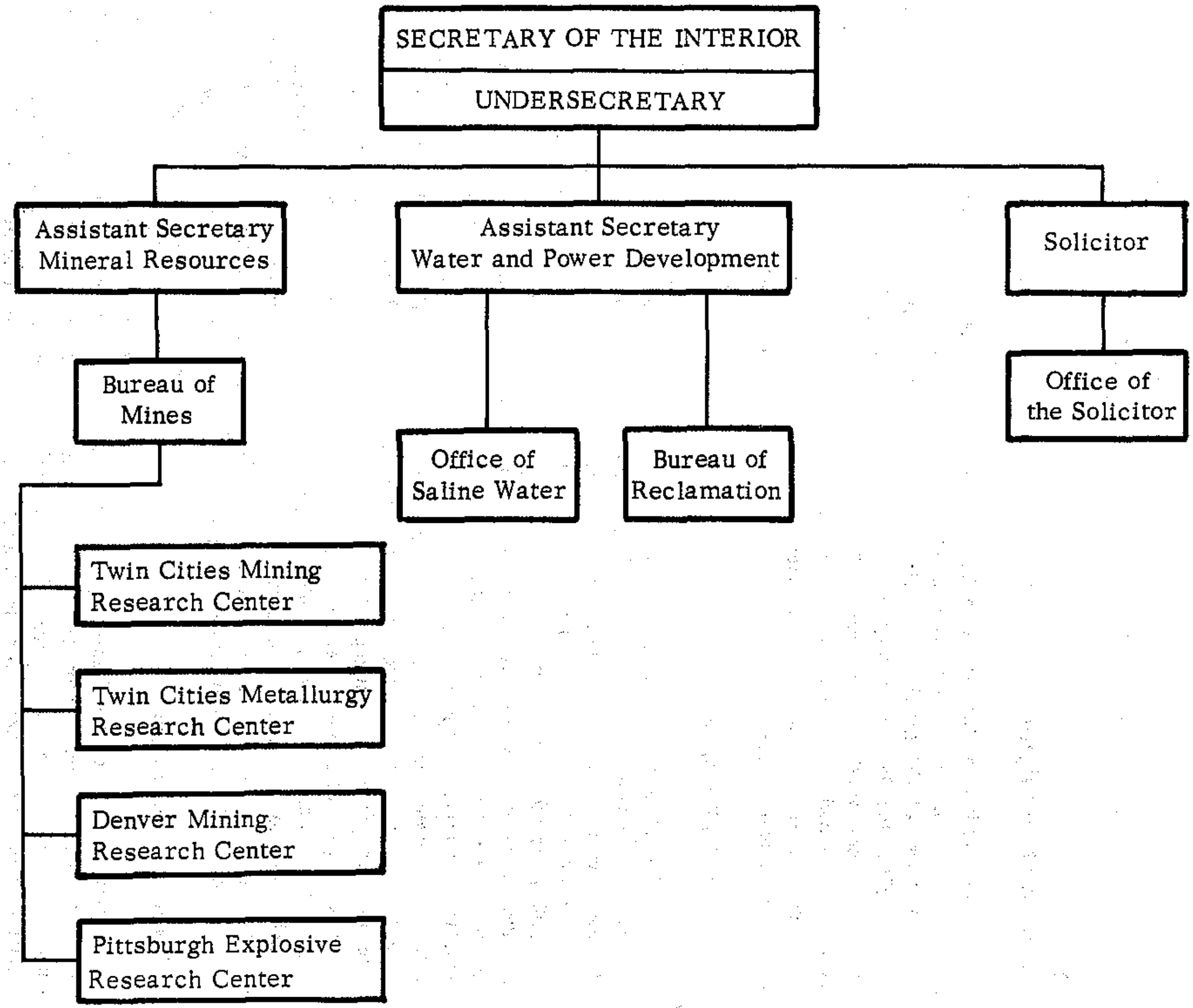
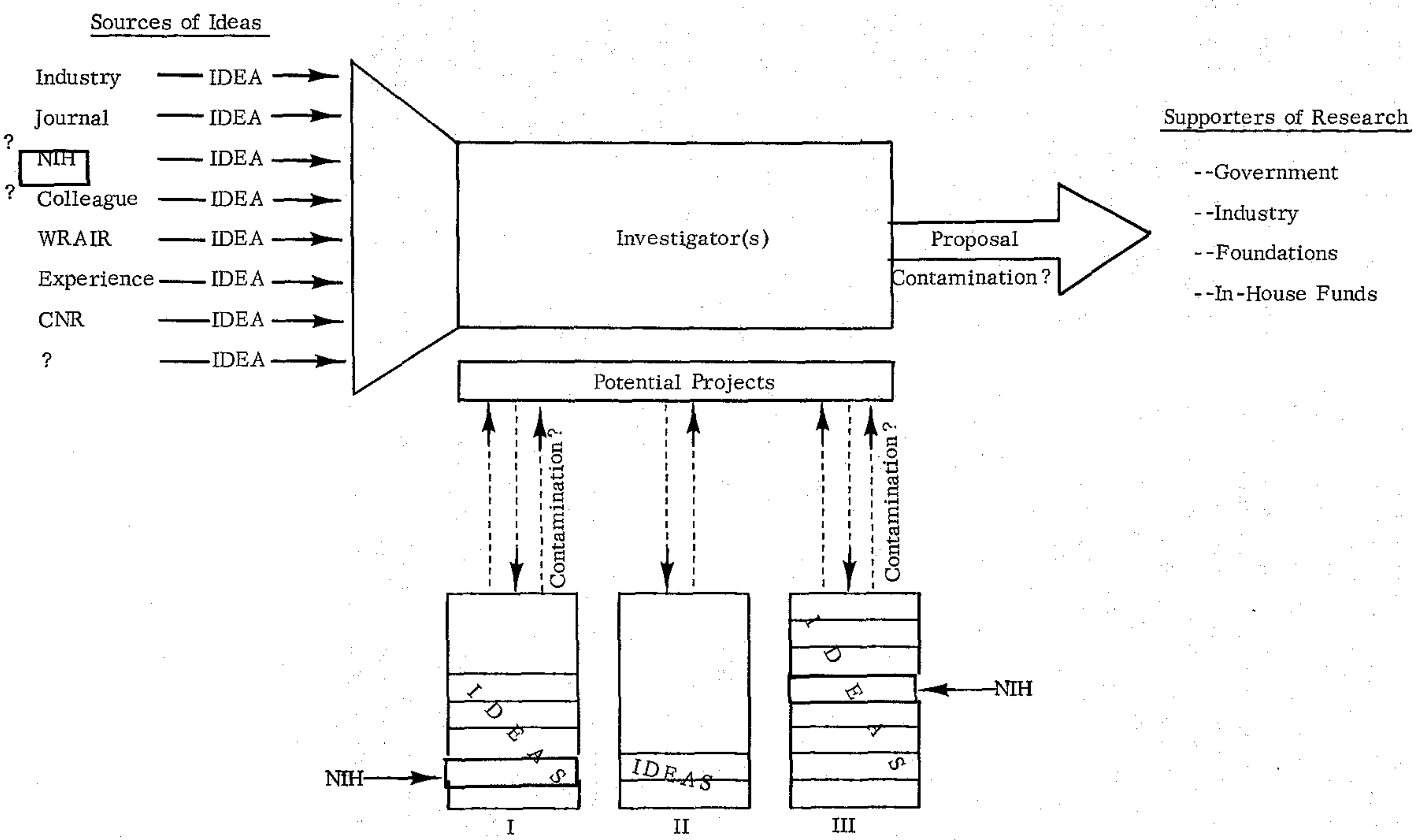
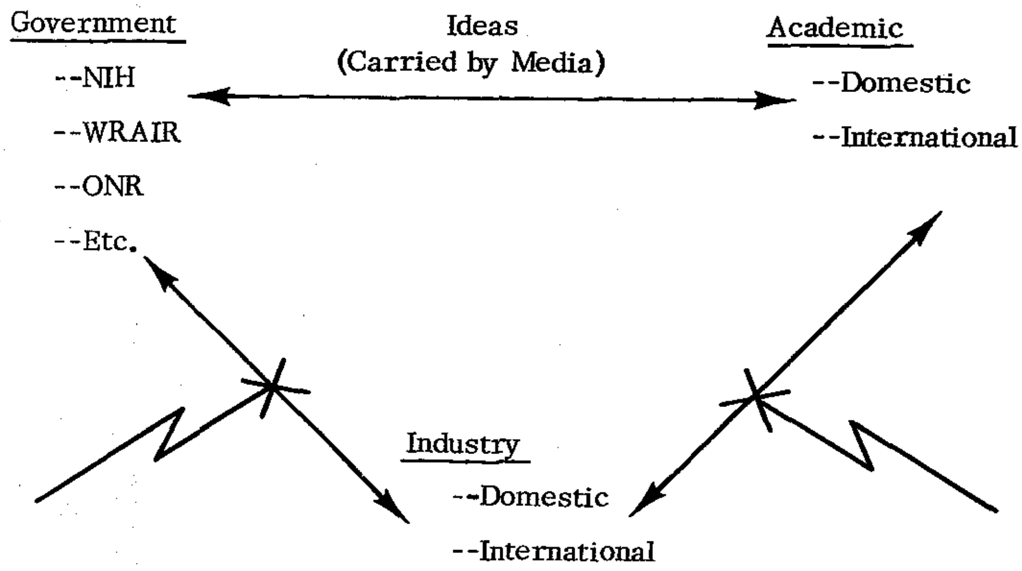


FIGURE III-15
THE INVESTIGATOR AS AN IDEA PROCESSOR*



*The effects of the 1962 revisions to HEW patent policy procedures are represented in red.

FIGURE III-14
EFFECTS OF DECREASE IN TESTING
ON IDEA FLOW IN DRUG RESEARCH*



LEGEND:

denotes limitations on media as a result of the decrease in testing:

Media	Limitations
Professional Journals	Limited biological data.
Professional Contacts	Talented men already absorbed in NIH work; issue of contamination.
Professional Meetings	Limited invitations and limited acceptances because of "conflict of interest."
Friendships	Less frequent contact.

*The effects of the 1962 revisions to HEW patent policy procedures are represented in red.

screening, extensive test results, and concomitant development work—means to the academic investigator that the work on his compound that is necessary for ultimate utilization is cut off in most cases at the development stage.

Also illustrated in Figures III-9, III-10, and III-11 is the second major effect of current government patent policy: the serious weakening of the communications links vital for the productive interchange of research ideas. To understand the extent of this effect, it is necessary to contrast these three figures with Figure III-8. In Figure III-8, the interchange of ideas among the NIH, university investigators, professional journals, and drug firms is accomplished through consulting relationships, work on compounds, test data, and papers. In the other figures, two of these media for interchange of ideas—the flow of compounds and test data from university investigators to the drug firms and back again to the investigators—have been eliminated. Although not indicated on these figures, the other two media—consulting relationships and papers—have been diluted by the lack of drug industry screening services for NIH-sponsored compounds. Drug firms currently seem to screen their consultants carefully; a criterion for an acceptable consultant seems to be noninvolvement with government research related to the drug firm's interests. With regard to papers, the lack of extensive—or even, in many cases, specific—test results has led to decreased publication of results of medicinal chemistry research. In addition, two media not shown in Figure III-8—contacts through scientific seminars and personal friendships—have been affected to some extent.

In summary, many extremely important contacts among academic, industrial, and government researchers in areas outside of cancer and malaria have been either eliminated or seriously decreased because of the current patent policy and the consequent threat of "contamination" of industrial research. (The question of "contamination" and the adverse effects on the interchange of ideas are considered in more detail in Figures III-14 and III-15.)

Figure III-12 has been included for comparison with Figures III-9, III-10, and III-11. Figure III-12 presents an equivalent representation of the drug development process when the compound originates under a drug industry grant to an academic investigator rather than under NIH sponsorship. Here, as in Figure III-8, the working relationship between the academic investigator and the drug firm screening his compound is very close, and research can be recycled or replanned as necessary to meet specific goals.

From the respective testing relationships shown in Figures III-8 through III-12, the roles and operating patterns of the various screening sources can be indicated—as illustrated in Figure III-13. The pharmacology department of a drug firm acts as a sort of sophisticated broker between an inventory of tens of thousands of compounds (some generated by academic investigators and some generated through in-house efforts) and the clinical requirements of the medical profession. Since it is specifically oriented to cancer and malaria, the pharmacology work done by CCNSC and WRAIR (not shown in Figure III-13) also falls in this category. The pharmacology department of a university probably functions more as a scientific knowledge-gathering organization operating with an inventory of compounds and producing state-of-the-art studies. Commercial testing organizations are less broadly focused than either the pharmacology department of a drug firm or the pharmacology department of a university. The operations of a nonprofit testing organization, not shown on Figure III-13, can resemble the operations of any of the other screening sources, depending on the specific circumstances of the nonprofit organization.

While Figures III-9, III-10, and III-11 consider both major effects of current government patent policy together, Figure III-14 focuses on the second effect alone: the serious limitations on productive interchange of research ideas. Practically every scientist interviewed in this study was worried about the comparative isolation of academic and government investigators from their drug industry counterparts.

Figure III-14 diagrams the ideal flow for the "free" exchange of ideas among industry, academic, and government scientists, and the restrictions placed upon this flow by current patent policy. Of course, the "free" exchange of ideas diagrammed here is only relatively free. The exchange of ideas cannot be completely free regardless of patent policy, since industry has proprietary positions to protect, government scientists may be inhibited by security restrictions, and all scientists may have embryonic projects not yet ready for release. In addition, for foreign investigators, language may be a barrier to idea flow.

In Figure III-14, the ideal flow of ideas is shown in black, while the restrictions placed upon it as a result of

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to have the greatest chance for utilization, cancer research and malaria research are attracting great interest and effort on the part of university investigators in medicinal chemistry. Compounds found, through government screening, to be useful in treating cancer or malaria are developed by the government and can be carried through the remainder of the drug development process to the consumer. These compounds, however, are not included in Figure III-9, which focuses on those NIH-sponsored compounds that are found to be ineffective in treating cancer or malaria but that might be useful in treating other diseases if they were screened specifically for activity against those diseases.

In-Vivo Screening
In-Vivo Screening R&D
Experimental Therapeutics

While the in-house skills of some of the commercial and nonprofit testing organizations would seem to be sufficiently varied to allow them to take compounds to the point of utilization, their experience is not as extensive as that of the drug firms, and they have not had reason to develop the capability of selecting candidate compounds for specific screens from among the thousand that might be presented. Because they operate on a contract testing basis, their costs tend to be high for specific tests on specific compounds and they represent the highest cost alternative ($500 to $2,000 per compound—see Figure III-2) for the individual investigator; for large projects (around $100,000 and up), however, their screening costs decrease to levels comparable to CCNSC and WRAIR.

d. *Academic Sources.* The colleges of pharmacy at the universities interviewed have set up their own screens to obtain rough qualitative data on the pharmacology of compounds of interest to their professional staffs. The arrangements established at Universities A and B below are individually described and represent organized and continuing screening programs. The arrangements at three other universities are discussed together and represent less formal or less successful attempts at in-house screening.

(i) *University A.* Annual costs—for direct labor (a full-time laboratory technician with a B.S. degree) and mice—to run the biological screen at the university's College of Pharmacy were estimated to range from $6,720 to $8,320. These figures do not include costs for office and laboratory space and capital equipment. Although this screen was operated primarily for the use of its own chemists, the College of Pharmacy has informal cooperative arrangements with the Department of Pharmacology of the university's medical school located at the county hospital. A member of the medical school's Department of Pharmacology served as adviser on the operation of the screen, and the College of Pharmacy and the Department of Pharmacology often traded equipment needed for special tests. The basic screen at the College of Pharmacy was not set up to work with animals larger than mice and rats; however, compounds of interest could be evaluated pharmacologically at the medical school with higher orders of animals if a faculty member of the Department of Pharmacology could be persuaded to either conduct or sponsor the tests.

Although the actual number of compounds screened annually was not known, a faculty member estimated that approximately 240 to 400 compounds were screened each year under five NIH grants and three NIH fellowships. Adding one or more intermediate compounds (used in the synthesis of the final compound) for each final compound that might require testing, the number of compounds to be tested probably would run 400 to 800 per year—yielding a cost of $10 to $20 per compound.

Commenting on the effectiveness of the college's available testing, one faculty member stated that he really valued the easy access to screening facilities, because any indication of biological activity could be easily observed firsthand and adjustments to his research plan could be made quickly. The costs of the in-house capability, he noted, were less than those of at least one outside testing facility, which had quoted costs as follows:

Pharmacological Screen (10 compounds)	$1,250
Toxicity	750
Analgesic Activity	1,250

However, another faculty member expressed regret that the compounds were not being screened by industry where the skills of professional pharmacologists would be more accessible and the requirements of the pharmaceutical marketplace could be more quickly brought in if positive test results occurred. To illustrate this problem, a colleague stated that one compound that had just been tested seemed to be approximately ten times as powerful as xylocaine. Since the compound had been synthesized under an NIH grant, the investigator was uncertain as to what his next step should be.

(ii) *University B.* Screening facilities, similar to those at University A, had been set up by the College of Pharmacy at University B. Here, competing interests of personnel responsible for the screening and of personnel synthesizing compounds tend to reduce the effectiveness of the screening operation. In this case, the screeners prefer to concentrate on the pharmacological aspects of reducing tumor sizes, its tests are not generally useful in other medical areas.

The total program of CCNSC is run almost entirely under contract. As Figure III-7 shows, CCNSC contract commitments for Fiscal Year 1965 totaled more than $22 million. Screening activities are included under "Drug Evaluation." Of the $4.8 million spent in this category, $2.2 million was spent on screening. The screening was done by 12 contractors.[5]

The screening operations of CCNSC emphasize a primary screen, through which approximately 17,000 to 18,000 compounds pass annually. Currently, two screening tests–one involving lymphoid leukemia in mice (code number L 1210) and one involving implanted leg tumors in albino rats (code Walker 256)–serve as the primary screen. Survival periods, animal weights, and tumor weights are the main parameters monitored for the animals.

Screening procedures are continually refined as a result of CCNSC's insistent search for tests that are more effective or capable of more positive correlation between man and animals. CCNSC spent $1.3 million in 1965 on the development and introduction of improved screening techniques. The original primary screen developed in 1955 consisted of three major tumor systems transplanted in mice against which all candidate compounds were tested by intraperitoneal injection of the compound. From 1955, parallel research has been conducted to determine the degree of correlation between activity in the animal systems used in the CCNSC's primary screen and activity in human cancer patients.

FIGURE III-7
CCNSC CONTRACT ACTIVITIES
(FISCAL YEAR 1965)

Nature of Contract	Cost ($ in millions)
Drug Procurement	$ 3.6
Natural Products Development	3.2
Drug Evaluation	4.8
Endocrine Evaluation	0.9
Coinical Evaluation	1.8
Animal Procurement and Supply	2.0
Research Services	1.5
Research and Development	5.1
Total	$22.9

Source: CCNSC.

The management aspects of the Cancer Chemotherapy Program directed by CCNSC require approximately 275 persons, including secretarial and clerical personnel; of this staff, approximately 30 persons are directly involved in drug development and approximately 20 persons in drug evaluation. The size of the Cancer Chemotherapy Program requires CCNSC to develop standardized test procedures, to monitor and enforce test standards, and to procure supplies to standard specification for use by the screening contractors and others. Each year CCNSC spends more than $2 million on the procurement and support of test animals (primarily hamsters, rats, and mice), which come from 27 different sources–a significant part of this effort is devoted to disease and genetic control of these animals. Screening reports from CCNSC are also highly standardized and are, therefore, not very responsive to specialized data requirements of individual investigators.

Because of the magnitude of its screening operations and its highly standardized approach, CCNSC can hold down its per-compound cost of primary screening to approximately $78.

[5] As of 1965, eight pharmaceutical firms were under contract to CCNSC for work in the Cancer Chemotherapy Program, which applies a more lenient patent policy than is the usual case with NIH programs. These firms and their aggregate contract amounts are as follows:

Company A	$ 87,000	Company E	$ 586,000
Company B	$ 99,000	Company F	$ 835,000
Company C	$197,000	Company G	$ 844,000
Company D	$179,000	Company H	$1,833,000

Of these firms, only Company E ($85,000 of its $586,000), Company F ($133,000 of its $835,000), and Company H ($440,000 of its $1,833,000) were engaged in screening work. The screening efforts of all three firms for CCNSC closely parallel, we believe, screening specialties that the firms had built up before contracting with CCNSC. Company H's efforts, by far the greatest among the three firms in terms of dollars, for CCNSC included:

Natural Product Collection and Isolation	Experimental Therapeutics
Natural Product Assay	Antibiotic Fermentation and Isolation
Animal Procurement	Production for Pharmacology and Clinical Tests
In-Vivo Screening	Pharmacology
In-Vivo Screening R&D	Clinical Management
In-Vitro Screening	

available pertaining to possible anti-hypertensive activity of the amino acid." When the potential usefulness of the compounds as anti- hypertensive agents is considered in conjunction with the lack of availability of specific testing for possible anti-hypertensive activity, one can conclude that the lack of pharmacological testing prevents full exploitation of the research reported in the article.

The lack of drug industry screening services means that certain chemically complete manuscripts cannot be published anywhere. One professor interviewed in this study said that he had six such manuscripts in his office. The compounds described in these manuscripts are derived from natural products, and the articles are inacceptable to both the chemistry journals (because the chemistry involved is not sufficiently fundamental) and the medicinal chemistry journals (because of the lack of biological test results).

(iii) *Incentive to circumvent the HEW procedures for patent policy administration.* Another important effect of the lack of availability of drug industry screening services is the incentive it provides the academic community to circumvent the rules. Virtually every chemist interviewed in this study mentioned ways in which it might be possible to "get around" the situation. One man indicated that he was seriously thinking of sending his compounds to Europe–even though the European firm would have to sign the Amended Patent Agreement, that firm would be so far removed from HEW jurisdiction that control and review of further research and utilization of the compounds would be virtually impossible. Another researcher thought that it would be possible to secure screening services through a third party, but he conceded that this approach might be fraudulent under current agreements and practice. Still another investigator felt that he could get his compounds tested by giving them to a friend who works at a pharmaceutical firm–the friend would take them in in the morning, test them, and bring them home at night. Not one of these men was practicing these ruses, but it is significant, we think, that many academic investigators are thinking along these lines–and that their research counterparts in the drug industry are sympathetic. Two pharmaceutical firms confirmed that they make no attempt to control any "bootleg" testing that may go on among their research professionals, but that they were unaware of any taking place.

An academic investigator who had recently returned from Egypt and India said that, if he were sure those countries could supply sufficiently expert biological screening services, he would send them compounds which related to their local diseases. He felt that this arrangement would get around the HEW procedures for patent policy administration while also benefiting the science of chemotherapy in the underdeveloped lands. This researcher said, however, that he was sufficiently uneasy about getting reliable test results to refrain, for the time being, from taking this action.

As a reaction to the effects described above, some academic institutions have attempted to set up their own screening services. University screening services will be described in detail in the next section of this report *(Alternative Sources of Screening),* but they can be summarized briefly here in terms of their general effectiveness as a possible solution to the investigators' dilemma. The attention given to screening is generally sporadic, with no follow-up when interesting activity is found. However, for many compounds, university testing is probably more effective than that provided by CCNSC or WRAIR, because university testing can be much more specific in terms of the particular nature and potential usefulness of the individual compound. The closeness of the tester to the synthesizer which allows the two to get together on short notice and the relative simplicity of the reporting of test results are other advantages of university screening. One faculty member said that almost any simple test that could be imagined could be set up quickly and run while the appropriate persons were present.

c. *Administrative Difficulties in Following Procedures for Patent Policy Administration.* The 1962 HEW procedures have created administrative difficulties for those university investigators charged with the responsibility of overseeing both government and industrial grants. In one case, the research administrator of an institution said that he had advised a junior member of the faculty who had been offered an industrial research grant of approximately $1,000 to decline the grant in order to avoid administrative complications and potential conflicts of interest with the much higher NIH grant that would probably be coming his way shortly.

At another institution, an academic researcher who had grants from both a drug firm and NIH indicated that

To the marginal cost of screening compounds might be added the royalty cost that a drug firm normally paid to academic investigators if their compounds were developed into new products. The royalty typically was paid for the idea rather than specifically for patents, and to this royalty might be added from time to time some industry support for the investigator's research at his institution.

b. *Benefits.* Several major benefits accrued to drug firms as a result of large-scale testing of university investigators' compounds:

(i) *Acquisition of proprietary rights.* In return for testing an academic investigator's compounds, the drug firm received either an option on exclusive rights or exclusive rights to the development and marketing of the compounds if they became interesting to the firm. The exact nature of the rights depended upon the patent policies of the investigator's institution, and probably on past relationships between the firm and the investigator and his institution.

(ii) *Wider accessibility to compounds and new ideas in medicinal chemistry, and increased chances of developing successful products.* Drug firms obviously benefit from testing as many compounds as possible in their biological screening programs. The inclusion of outside compounds in a screen broadens the coverage of the screen by the number of compounds added and increases the firm's chances of having a successful product come from that screen. Of the approximately 6,500 domestic academic compounds (out of a total inventory of 40,000 compounds)[4] that one firm has tested, two products have resulted, two more leads have been received for products that are now well into the development process, and two possible leads currently under investigation have been generated. Members of the research department of this firm feel that this rate of success is well above average, since normal attrition rates for any given compound (whether in-house or outside) run at 4,000 to 6,000 to 1.

(Now that the number of compounds acquired from academic sources in the United States is negligible, drug firms are turning more and more to foreign academic sources for their outside compounds. Figure III-6 shows one drug firm's acquisition of compounds from foreign academic sources in recent years.)

In addition to wider accessibility to compounds, drug firms have benefited substantially from the wider accessibility to advanced scientific ideas that they had when they were providing large-scale testing services to university investigators. While there is some evidence that the willingness of the drug firms to test compounds served as an incentive to academic investigators to pursue their work more vigorously, this was by no means a one-way incentive, for the drug firms received in return new ideas and improved compounds. For example, one university investigator's purely chemical work led to the development of a new diuretic agent by a drug firm.

(iii) *Lower costs by virtue of not doing their own synthesis of outside compounds.* Another way to look at the value of an outside compound to a drug firm is to impute a cost of synthesis to it—a cost that the drug firm would have had to bear if it had synthesized the compound in-house. The Director of Medicinal Chemistry at the Walter Reed Army Institute of Research estimates that it costs approximately $3,000 to synthesize an average compound of the type that he most frequently screens—the cost of synthesis seems to be about the same whether the work is done for him by drug firms, nonprofit laboratories, or government laboratories. The derivation of the estimate of $3,000 is as follows: Since one Ph.D and one assistant with total annual salaries and

FIGURE III-6
ONE PHARMACEUTICAL FIRM'S ACQUISITION OF CHEMICAL COMPOUNDS DEVELOPED BY FOREIGN ACADEMIC INVESTIGATORS

Year	Number
1960	96
1961	465
1962	716
1963	896
1964	601
1965	897
1966	1,143

Source: Information gathered in interviews with a pharmaceutical firm.

[4] The total number of compounds in this firm's inventory reflects, in general, the order of magnitude for firms in the industry as a whole. For example, a competitor estimated that it currently had approximately 35,000 compounds in inventory.

and mutually profitable relationship for 20 years when the National Institutes of Health began to fund research grant programs on a large scale in the mid-1950's.

According to the senior research men at one drug firm, contact between the pharmaceutical industry and universities was first established in the 1930's, when some of the members of industry research departments began to establish and build up contacts with academic research men. The pattern of these contacts usually was for the firm to provide biological testing for the professor's compounds in exchange for certain rights to any inventions made or reduced to practice during testing. If this aspect of the relationship proved satisfactory, the firm might offer small grants to support the academic man's work, might engage him as a consultant, would often recruit his students, and would recognize his contributions to any new products developed both through royalty agreements and through appropriate papers published in the technical literature.

This pattern of collaboration seems to have been rewarding for both groups. Almost all of the outside support for university research in medicinal chemistry came from the drug industry until the NIH began its grant programs. The drug firms received a substantial return for this investment in the form of both compounds and personnel. One firm estimates that, from a total inventory of about 40,000 compounds collected over the years, approximately 6,500 came from outside domestic academic sources. Another firm strongly believes in the value of the relationship as an aid in recruiting, since several of its biochemists now in technical management came to it from a leading university with which it maintained close ties.

The drug industry still sponsors medicinal chemistry research within universities to complement its own in-house research programs, and drug firms still retain university investigators as consultants. But fear of "contamination" through NIH-sponsored research has made the drug firms much more selective, and has severely restricted the growth of industry-sponsored university research as a total percentage of drug industry research expenditures. As Figure III-3 shows, the rate of growth of industry-sponsored research has lagged far behind the rate of growth of industry research expenditures as a whole.

b. *History of Collaboration Between the National Institutes of Health and the Academic Community.* The National Institutes of Health began to fund research grant programs on a large scale in the mid-1950's. Medicinal chemistry as a separate discipline began to be recognized as early as 1956, when the first grants in this area were funded under the sponsorship of the Pharmacology and Experimental Therapeutics Study Section at NIH. Growth of medicinal chemistry research has been so rapid that the Medicinal Chemistry Study Section formed at NIH in 1959 has now been split into two sections.

The increase in NIH support for medical research as a whole and in the area of medicinal chemistry has been dramatic—NIH support now goes to virtually all of the established medicinal chemists in the country. Figure III-4 shows the buildup in NIH funds for grants in all areas of medical research. At the present time, although figures are not available on grant funding by study section, the executive secretaries of the Medicinal

FIGURE III-3
DRUG INDUSTRY R&D EXPENDITURES
($ in millions)

Year	(A) Total R&D	(B) Portion of (A) Spent Outside the Drug Firms	(C) Portion of (B) Spent at Academic Institutions Other Than Medical Schools
1956	$110.0	$11.0	$3.8*
1957	127.0	13.0	4.5*
1958	170.0	13.0	Not Available
1959	197.0	18.0	1.8
1960	216.0	21.0	1.7
1961	245.0	25.0	1.6
1962	259.0	26.0	2.2
1963	292.0	32.0	2.2
1964	310.0	35.0	2.3

*These figures include costs for consultants and are not strictly comparable to the rest of the column.

Source: Data from Pharmaceutical Manufacturers Association.

2. Effects of Withdrawal of Screening Services for NIH-Sponsored Compounds on University Research Programs and Scientists

The withdrawal of the drug industry from providing large-scale testing services to academic investigators has had continuing effects. Academic investigators find that their work is often directly hampered by their lack of access to these screening services:

(i) In some cases, compounds simply accumulate untested with no insight obtained as to their biological activity.

(ii) Lack of test data may block receipt of further grants for additional work.

(iii) Lack of test data also may prevent publication of research results, since such journals as the *Journal of Medicinal Chemistry* require that papers submitted for publication contain the results of some pharmacological or biological testing of compounds.

(iv) In response to this pressure for data to publish, many academic investigators snatch at any available opportunity for testing—such as the government's screening programs for cancer and malaria research—regardless of relevancy. As a result, these investigators' compounds often do not receive the type of screening most appropriate to their nature and potential usefulness.

The frustrations resulting from the lack of large-scale drug industry screening services have led many academic investigators to consider ways of circumventing the HEW procedures for patent policy administration, including—

—having compounds tested in Europe, which is, the investigators feel, far enough removed from HEW jurisdiction to make control and review of further research and utilization of the compounds virtually impossible; and

—having compounds tested surreptitiously by friends who work for drug firms.

No investigators to our knowledge have taken these steps. We do believe it is significant, though, that they are thinking along these lines. The effects of the lack of large-scale drug industry screening services are felt by the entire range of academic institutions engaged in medicinal chemistry research. Even researchers at universities holding blanket agreements with HEW face formidable barriers to obtaining these screening services, since they construe the provisions of the NIH grants administration manual to require amended patent agreements from potential screeners in the drug industry.

Quite apart from the direct effects of the drug firms' withdrawal of screening services, we discovered that the revised procedures for HEW patent policy enforcement may be inhibiting the effectiveness of the individual academic investigator in other ways. The barriers raised by the revised procedures cut him off from the close collaboration he enjoyed before 1962 with his industrial counterpart. These barriers impose severe constrictions on the free flow of communications necessary to carry ideas back and forth between the drug industry and the academic community. The media that carry these ideas are professional journals, professional meetings and other relatively formalized contacts, and personal friendships. All of these media are currently inhibited, in several-sided and often interrelated ways: the professional journals through the lack of test data that, in turn, is a result of the lack of drug industry screening services; and the other media through the drug industry's fears of "contamination" of in-house research by NIH-sponsored research. (And, as discussed above, the "contamination" issue, to continue the circular process, has played the major role in the drug firms' continuing refusal to provide screening services for NIH-sponsored compounds.)

In addition to these effects, government patent and other policies create problems in administering research work at academic institutions. Researchers working on both industry and NIH grants must create and use complex administrative procedures that segregate research work, supplies, equipment, space, and, in effect, personnel, thus often inhibiting scientific communications within the institution.

3. Alternative Screening Methods

Basically, there are three kinds of screening methods available to the government:

(i) Government operations such as CCNSC and WRAIR.

(ii) Commercial and nonprofit laboratories.

(iii) Academic laboratories.

Figure III-2 provides a summary comparison of costs, effectiveness, and feasibility for these three screening sources.

The government activities are really only management activities which have all of the work done under contract. The array of contractors and the management skills seem to be such, however, that these facilities could take compounds all the way to utilization for specific compounds and specific disease areas.

Some of the commercial and nonprofit testing organizations also claim to be able to take compounds to the point of utilization. Their in-house skills would seem to be sufficiently varied to do this, but their experience is not really as great as that of the drug firms. At the same

(iii) Top management and research personnel from a commercial testing laboratory.

(iv) The patent personnel of HEW, PHS, and NIH, and management personnel from the government's two largest screening activities—the Cancer Chemotherapy National Service Center (CCNSC) and the Walter Reed Army Institute of Research (WRAIR).

C. Summary of the Major Findings Relating to the Three Study Questions

1. Costs and Benefits to Drug Firms of Screening NIH-Sponsored Compounds

For the drug firms, the cost of testing outside compounds is relatively low, being a marginal cost in many instances. Frequently, for the "quick look" needed in order to determine the desirability of further testing, outside compounds are merely added to a batch of in-house compounds going through a given screen.[3]

Before their withdrawal in 1962 from large-scale testing of university investigators' compounds, the drug firms received several major benefits in return for these services. First, they acquired proprietary rights—either an option on exclusive rights or exclusive rights—to the development and marketing of the compounds if the compounds seemed to have promise.

Second, the large-scale testing gave the drug firms wider accessibility to both compounds and new ideas in medicinal chemistry, and it increased chances of developing successful products. The constant stream of new academic compounds from the outside provided the drug firms with a strong connective link with the advanced thinking of the academic community. This additional coverage of the field of chemical possibilities gave the firms a higher statistical probability of discovering a useful compound, although the chances that any compound will reach utilization without incorporation of findings from other research are always slight. Now that the number of compounds acquired from academic sources in the United States is negligible, drug firms are turning more and more to foreign academic sources for their outside compounds (see Figure III-6).

Third, the drug firms benefited because someone else paid the cost of synthesizing the outside compounds—a cost that the drug firms would have had to bear if they had synthesized the compounds in-house. The cost of synthesis has been estimated at approximately $3,000 per compound.

[3] Appendix A describes the drug development process as background to the analysis in this part.

Fourth, the close contact between the drug firms and the universities often served the drug firms as a recruiting aid. When the relationship between a drug firm and an academic investigator was a fruitful one, the investigator was often hired as a consultant to the firm; when the investigator believed the drug firm's work to be interesting, he often referred graduate students to the firm.

As a necessary adjunct to their own research, drug firms still retain academic investigators as consultants, but on a much more selective basis; a major criterion seems to be the academic investigator's noninvolvement with government research in the same area in which the drug firm is pursuing its research. Otherwise the drug firm fears its in-house research will be "contaminated" by the government research in which the academic investigator is engaged—even though the firm never sees the compounds or other results of this research—and it will run the risk that HEW will assert a claim to ownership of any of its products and ideas that might be construed as having evolved in any way from the academic investigator's government research. *In summary, drug firms have stopped screening NIH-sponsored compounds because they are concerned that such testing might compromise their rights to results from their in-house research being conducted in the same area as the work involving the outside compounds.*

Presented schematically in terms of the steps in the drug development process up to the decision point for development of a promising compound into a drug, Figure III-1 shows the specific concerns of the drug firms, the patent policy issues affecting their decisions as to whether or not to screen a compound and subsequently develop it to the point of utilization. Figure III-1 demonstrates that the significant questions with regard to patent policy apply to the ownership of intellectual property—ideas—as well as to the ownership of a patentable product. If the government is involved in any of the answers to the questions, the drug firms' answer to an academic investigator is "No, we will not screen your compound; no, we will not take a chance on developing it into a drug." Thus, as Figure III-1 makes clear, the patent policy issues not only block testing of the compounds that result from NIH-sponsored research—they also block utilization of these compounds.

In all but two areas—cancer and malaria—drug firms' resources for development are needed in order for a compound to achieve utilization. Development work for promising compounds in cancer research and malaria research is handled by the appropriate arms of the government, the Cancer Chemotherapy National Service Center (CCNSC) and the Walter Reed Army Institute of Research (WRAIR).

estimated that at any given time 200 to 300 medicinal chemistry grants require extensive biological screening so the public can gain maximum benefit from the government's research investment.

NIH imposes an additional patent requirement if a company *contracts* with a PI on a funded basis to perform research or development work. The company must agree to license the government and other parties to manufacture, use, or sell inventions covered by any background patent necessary to the practice of foreground inventions developed under the contract.[4] Since the pharmaceutical firms were not proposing to work under contract in the cases reviewed, we were not able to assess the effect of this requirement on their participation. We assume that it could only increase their already negative response.

2. Contract Problem with Biomedical Devices

Two cases relating to development of biomedical devices and techniques were reviewed at NIH. The first case involved an unsolicited proposal to perfect a process that would materially increase the shelf-life of whole blood and make it storable at room temperatures. The second case involved the development and use of a miniaturized pressure transducer, which would be implanted in the bladder to enable researchers to explore the operation of the bladder more thoroughly.

Both cases exhibit the pattern found in medicinal chemistry: Companies with investments in private research and portfolios of background patents for products similar to those the government is proposing to develop for general use hesitate to deal with NIH if they must give up title to inventions developed under contract or rights in background inventions on which the products are based.

D. Effect of Patent Policy on the Medicinal Chemistry Program

A significant change in the relationship between PI's working under NIH grants and the pharmaceutical firms occurred in 1962. As mentioned above, the following requirements were established then:

(i) Annual invention statements had to be filed.
(ii) Pharmaceutical firms that offered to perform biological screening for grantees had to execute patent agreements.

The effect seemed to be the same as going from a license policy to a rigid title policy: Biological screening performed on grants was abruptly cut off. The long-range effects of this separation of synthesis of compounds and biological evaluation—two vital research elements—cannot be precisely estimated, but it is clear that academic and industrial researchers have been deprived of opportunities to work together and that many newly synthesized compounds are not being effectively tested for biological utility.

In 1962 the PI's working under NIH grants were forced to seek alternative sources for biological testing because pharmaceutical firms declined to collaborate. Four alternative screening sources were tried:

(i) Testing by other academic personnel interested in learning about specific compounds.
(ii) Use of commercial testing firms.
(iii) Submission of compounds to one or more national screening services such as:
  (a) the CCNSC;
  (b) the Walter Reed Army Institute of Research;
  (c) the Army Chemical Center.
(iv) Employment of pharmacologists and establishment of facilities—by the grantee—to serve the grant.

None of these sources is completely satisfactory and most of the grantees using alternatives (ii) and (iv) have had to request additional funds. Interviews with NIH personnel in the course of research suggest that there are more refusal cases within the NIH program than we have discussed. Harbridge House learned, for example, of another grant involving a professor working on a solvent to prevent or dissolve various blood clots. Despite some success with his NIH research, he could get no cooperation from industry because of the HEW patent policies. In a second instance, significant problems concerning patent right ownership have been experienced within the Artificial Heart Program. An industrial research organization, collaborating in the heart program with the PI, has filed patent applications on inventions that it claims resulted from its own engineering creativity but that NIH feels belong to the government. The case could become significant in government patent policy.

The 21 cases of refusal to participate in NIH projects present a very uniform picture. They indicate that it was difficult to obtain harmonious, productive industrial cooperation on research problems under HEW patent policy existing prior to 1966, and that this problem can be expected at NIH whenever an interface exists between industry and government-sponsored medical research. Research findings indicate that either substantially increased funds or more collaboration from pharmaceutical firms is necessary to secure effective testing. Medicinal chemists as well as pharmaceutical firms exhibited a high level of frustration because of the legal impasse. Thus, the HEW patent policy and practice appears to have had a noticeable adverse effect on the NIH program.

[4]This requirement was eliminated in November 1966.

FIGURE II-6
NUMBER OF NIH INVENTIONS REPORTED

Year	Number Reported
1953	2
1954	3
1955	6
1956	12
1957	6
1958	9
1959	16
1960	9
1961	33
1962	138
1963	206
1964	186
1965	152
1966 (through September)	133

Source: NIH Division of Research Grants Records.

1. Lack of Collaboration in Medicinal Chemistry Grants

As noted above, 19 of the refusals investigated related to testing compounds developed under medicinal chemistry grants. Normally 500 to 800 such grants are in operation at any given time, and they annually account for about $8 million of the NIH grant program. Under these grants, new compounds believed to have potential medical value are developed; chemical synthesis techniques are studied; the relationship of chemical structure to biological activity is investigated; and research opportunities to promote professional development of medicinal chemists are provided. The typical grant is conducted by personnel associated with universities or hospitals and may cover a period of several years. Frequently, many related compounds are synthesized and tested under a single grant.

Prior to 1962 pharmaceutical firms had routinely made tests for biological activity—at no charge—on compounds developed by grantees. Such screening, required to establish the usefulness of the compounds, is the first step in developing new drugs. According to estimates furnished NIH by the pharmaceutical firms, screening a compound to the point where sufficient data are available to support a Federal Drug Administration application may cost $200,000 to $500,000. Most compounds do not survive the initial broad screening, which costs considerably less than $200,000.

Since many significant discoveries in medicinal chemistry have occurred by accident rather than by plan, the practice is to screen large numbers of compounds for a wide range of possible uses. The NIH medicinal chemistry program thus provides a fertile source of new and potentially useful compounds for pharmaceutical firms to explore. Between 1955 and September, 1966, HEW patent policy has required that all rights in inventions arising out of NIH-sponsored research shall be determined by the Surgeon General. Prior to 1962, however, drug firms never signed agreements with the grantee or NIH regarding rights to inventions discovered in screening.

In 1962 NIH began requiring pharmaceutical firms to sign a patent agreement (see Figure II-7)[2] before being permitted to screen compounds developed under NIH funds. The agreement imposes four conditions on the screener:

(i) It shall not disclose the results of testing for 12 months, except with the consent of all parties concerned.

(ii) It shall promptly report the results of testing to the investigator and will furnish him the information demonstrating any utility or new use of the compound for use by the PHS in connection with any application for patent that organization may file.

(iii) It shall be permitted to obtain patent rights to new uses of the compounds developed at its own expense *except* under three circumstances:

- (a) Where the grantee contributed or participated in the conception or reduction to practice of such new use;
- (b) Where the patent would hamper, impede, or infringe on the intended use of the invention;
- (c) Where the new use is within the field of research work supported by the grant.

(iv) The government shall receive a nonexclusive, irrevocable, royalty-free license to any new use patent and shall also have the power to sublicense others for all governmental purposes.

Very few pharmaceutical firms have signed the required patent agreement and, therefore, very few have screened compounds for NIH since 1962.[3] Responses to a questionnaire sent to all NIH institutes in August 1966 indicated that no agreements from pharmaceutical firms existed. Case research by Harbridge House investigators uncovered three grants on which patent agreements had been signed by such firms. The executive secretaries of the two NIH Medicinal Chemistry Study Groups

[2] This agreement was revised in December 1966.

[3] Approximately 55 agreements using the revised form adopted in December 1966 were signed in 1967. Fifty-three of these agreements were signed by one drug company and two other firms were also involved.

FIGURE II-5
ANNUAL INVENTION STATEMENT[1]

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

PROCEDURE FOR SUBMISSION OF ANNUAL INVENTION STATEMENT

(Please read carefully)

Under Department of Health, Education, and Welfare regulations (45 C.F.R., Parts 6 and 8), Public Health Service patent policy provides that all inventions arising out of the activities assisted by Public Health Service grants and awards shall be promptly and fully reported to the Surgeon General. Determination of ownership, and whether patent protection on such an invention shall be sought and how the rights in the invention, including rights under any patent issued thereon, shall be disposed of and administered in the public interest shall be determined either (a) by the Surgeon General, or (b) by the grantee institution in accordance with its own policies, where a *separate formal institutional agreement* has been reached by the Surgeon General with the grantee institution concerned.

When inventions are to be reported, the person concerned should ask the appropriate official of his institution to request of the Division of Research Grants, National Institutes of Health, Bethesda, Maryland 20014, the reporting form and pertinent detailed instructions.

In addition to the formal reports described in the first paragraph, an Annual Invention Statement must be provided as part of the *requests for all continuation and renewal* of each type of Public Health Service grant and award. **This statement must be submitted whether or not an invention has occurred during the period of grant or award support for which continuation or renewal is being requested, and whether the invention was partially or fully supported by PHS funds.**

The Statement should include all inventions which might possibly be construed in any manner to be PHS grant or award supported or related.

Should a request for continuation or renewal be received without the inclusion of the Annual Invention Statement, the grant or award will not be paid until such time as the Invention Statement has been received.

The Invention Statement does not relieve the grantee institution or the scientist of responsibility for prompt reporting of inventions or discoveries.

When a grant or award terminates and no renewal application is planned, an Annual Invention Statement must be submitted within 30 days following termination of support.

The certification statement governing each type of Public Health Service grant and award appears on the attached page. Return original and first carbon to:

Division of Research Grants
National Institutes of Health
Bethesda, Maryland 20014

With the exception of the Fellowship award, each Statement will require two signatures: (1) the person responsible for the grant or award concerned and (2) the institution official responsible for patent matters. For the Fellow, the signature of the sponsor is also required.

DEFINITION OF TERMS USED IN ANNUAL INVENTION STATEMENT

Definition of an Invention. Any process, art or method, machine, manufacture, or improvement thereof may constitute an invention if it is new and useful, and would not have been obvious to a person having skill in the art to which it relates. A "process" may be either a connected series of steps or a new use of a process, machine, manufacture, or composition of matter. In a patent sense, the word "new" has a broader meaning than it has in common usage. The usual test of novelty applied by the Patent Office is the novelty search in which available printed matter is consulted to find if there is a previous description of the invention claimed. This search brings forth prior published knowledge. Any reference prior to the patent application is considered by the Patent Office to be prior art. A description published more than one year prior to the date of an application for patent constitutes a statutory bar to patenting. Prior unpublished experimental uses, abandoned experiments, or lost arts are not proper references.

An invention is useful in a patent sense if it is capable of performing some beneficial function.

Conception of the Invention. An invention begins with its mental visualization or conception. However, the conception must be complete and include the result as well as the means for bringing about that result. Because the conception is a mental process, it must be communicated to others who understand it before it can be proved satisfactorily. The date of conception is the earliest date to which an inventor can be entitled for priority purposes. If the inventor can demonstrate reasonable, continuous diligence in carrying out (constructing and testing) the conceived invention, for purposes of priority, he may be considered as having made the invention when he began the continuous diligence. If this diligence began immediately after conception, then the date to which the inventor is entitled is the date on which the invention was conceived.

Reduction to Practice of the Invention. The act of transforming an inventive concept into physical reality (construction and testing) is referred to as "reduction to practice" of the invention. The general rules of reduction to practice for the four most important classes of invention are:

(1) For a process – when it is successfully performed; this normally requires a test of results to demonstrate the success.

(2) For a machine – when it is assembled and tested or used.

(3) For an article of manufacture – when it is completely manufactured and tested or used.

(4) For a composition of matter – when it is completely composed and tested or used.

PROCEDURE SHEET
PHS-3945 (REV. 11-64)

[1]Form in use prior to September 1966.

FIGURE II-3 (Cont'd)

1955 Version	1957 Changes	1958 Changes
	provisions of 8.6, the Surgeon General in the negotiation of contracts with other than nonprofit organizations for the cancer chemotherapy research program shall be subject only to such limitations, and alternatives as the Secretary may approve for such program.	8.1 (b) with respect to grants, the contract may provide, with such special stipulations in the contract as may be deemed necessary in the public interest, for leaving the ownership and disposition of all domestic rights for determination by the contracting institution in accordance with such policies and procedures.
	Effective date. These amendments shall be effective upon date of publication in the Federal Register. Since they deal with grants, benefits, or contracts, notice of proposed rule making is not required.	Effective date. This amendment to be effective upon date of publication. Since it deals with grants and contracts notice of proposed rule making is not required.

had such limited equity [see Figure II-3, Section 8.2(d)] that it would not retain title to the invention. In no case has it released an invention on the basis that the invention was of minor importance [see Figure II-3, Section 8.2(d)]. As of September 1966, assignment of the invention to other organizations [see Figure II-3, Section 8.2(b)] has occurred about five times in the ten years of operation under HEW patent policies. Also, prior to this date Section 8.2(a) has never been used, and Section 8.2(c) is used only when the other government agency involved follows a policy similar to that of HEW. Under the authority of Section 8.1(a), blanket agreements have been entered into with 18 grantee institutions (see Figure II-4) permitting them to dispose of inventions in accordance with their own policies and procedures. Whenever NIH does not retain title under HEW policy, it acquires a nonexclusive, irrevocable, royalty-free license to use the inventions and the right to sublicense parties for all governmental purposes.

The cancer chemotherapy research program—operated by the Cancer Chemotherapy National Service Center (CCNSC) of the National Cancer Institute to screen large numbers of compounds for activity against cancer—receives special treatment under the regulations. Section 8.7 subjects it only to limitations and alternatives expressly approved by the Secretary of the Department. (Current practice is to permit contractors to retain title to inventions and to acquire a license for the government.) This program was singled out for special attention after industry refused to participate because it was subject to the modified HEW patent policy outlined above.

Although the NIH Division of Research Grants has been issuing grants since 1946, records of reported inventions have been maintained only since 1953. Annual statements of inventions (see Figure II-5) have been required from grantee institutions and contractors since 1962. The number of inventions reported—by year—to the Division of Research Grants is shown in Figure II-6. No comparable list is available for contracts, but the NIH patent adviser estimated that inventions are currently reported at the rate of 35 per year, up from a rate of 25 just two years ago.

C. Refusals to Deal with NIH

Harbridge House documented 21 cases of refusal to participate in NIH projects because of HEW patent policies. In 19 of these 21 cases, pharmaceutical firms refused to collaborate with principal investigators (PI's) in the biological testing of compounds developed by the latter under NIH medicinal chemistry grants. The remaining two cases involved refusals to contract for the development of biomedical devices. The patterns of the cases reported in Task Report 10 were virtually identical: The PI either had an existing relationship with a pharmaceutical company for the screening of compounds developed under NIH grants, or he anticipated making arrangements for biological testing after approval of the grant application. In each case the pharmaceutical company declined to contract or continue the relationship with the PI because it refused to sign a patent agreement. The pharmaceutical companies' positions were not substantially different from those discussed in the Department of the Interior cases in Part IV below, but the strength of the industry position, plus the consequences to the testing of new compounds, were so dramatic that we were led to examine further this matter in the *Drug Study* in Part III below.

1955 Version	1957 Changes	1958 Changes
8.2 Determination as to domestic rights. Rights in any invention not subject to disposition by the grantee pursuant to paragraph (b) of 8.1 are for determination by the head of the constituent organization as follows: (a) If he finds that there is adequate assurance that the invention will either be effectively dedicated to the public, or that any patent which may be obtained thereunder will be generally available for royalty-free and nonexclusive licensing, the effectuation of those results may be left to the grantee. (b) If he finds that the invention will thereby be more adequately and quickly developed for widest use and that there are satisfactory safeguards against unreasonable royalties and repressive practices, the invention may be assigned to a competent organization for development and administration for the term of the patent or such lesser period as may be deemed necessary. (c) If he finds that the interest of another contributing Government agency is paramount to the interest of the Department of Health, Education, and Welfare, or when otherwise legally required or in the public interest, the invention may be left for disposition by that agency in accordance with its own policy. (d) In all other cases, he shall require that all domestic rights in the invention shall be assigned to the United States unless he determines that the invention is of such doubtful importance or the Government's equity in the invention is so minor that protection measures, except as provided in 8.3 are not necessary in the public interest.	5. Section 8.3 is hereby amended to read:	
8.3 Licenses to the Government. Any arrangement or determination as to the disposition of rights in inventions pursuant to 8.1 or 8.2 shall require that there be reserved under any patent application or patent thereon, domestic or foreign, a nonexclusive, irrevocable, royalty-free license to the Government with power to sublicense for all governmental purposes.	8.3 Licenses to the Government. Any arrangement or determination as to the disposition of rights in inventions pursuant to 8.1, 8.2, 8.5 or 8.6 shall require that there be reserved under any patent application or patent thereon, domestic or foreign, a nonexclusive, irrevocable, royalty-free license to the Government with power to sublicense for all governmental purposes.	
8.4 Option to acquire foreign rights. In any case where it is determined that all domestic rights should be assigned to the Government, there shall be reserved to the Government, pursuant to Executive Order 9865 and Government-wide regulations issued		

FIGURE II-3
HEW PATENT POLICIES[1]

1955 Version	1957 Changes	1958 Changes
Part 8–Inventions Resulting From Research Grants, Fellowship Awards, and Other Research Arrangements	Part 8–Inventions Resulting From Research Grants, Fellowship Awards, and Contracts For Research	

Sec.
8.0 Policy.
8.1 Conditions to be included in research grants.
8.2 Determination as to domestic rights.
8.3 Licenses to the Government.
8.4 Option to acquire foreign rights.
8.5 Arrangements other than grants; fellowships.

Authority: 8.0 to 8.5 issued under Reorg. Plan No. 1 of 1953 (18 F. R. 2053; 3 CFR, 1953 Supp., E. O. 9865; 12 F. R. 3907; 3 CFR, 1947 Supp., E. O. 10096, 15 F. R. 391; 3 CFR, 1950 Supp.

8.0 Policy. (a) The Department of Health, Education, and Welfare each year is expending large sums in the form of grants for research. These grants are made primarily by the Public Health Service in carrying out its broad responsibility under the Public Health Service Act to promote and coordinate research in the field of health and to make available information concerning such research and its practical application. The scientific and technological advances attributable, in varying degrees to this expenditure of public funds frequently include patentable inventions.

(b) The Department, as a matter of policy, takes the position that the results of research supported by grants of public moneys should be utilized in the manner which would best serve the public interest. It is believed that the public interest will in general be best served if inventive advances resulting therefrom are made freely available to the Government, to science, to industry, and to the general public.

(c) On the other hand, in some cases it may be advisable to permit a utilization of the patent process in order to foster an adequate commercial development to make a new invention widely available. Moreover, it is recognized that inventions frequently arise in the course

Sources: Reprints from Federal Register, September 14, 1955; December 4, 1957; and February 27, 1958.

[1]The regulations were revised in October 1966 to reflect reassignment of patent matters to the Assistant Secretary for Health and Scientific Affairs.

PART II. Background on the Problem: The National Institutes of Health Programs

A. National Institutes of Health Programs

The National Institutes of Health (NIH) is the medical research arm of the Public Health Service (PHS), a branch of the Department of Health, Education, and Welfare (HEW). Located in Bethesda, Maryland, NIH consists of nine institutes and their supporting organizations. The individual institutes are "mission-oriented"—organized to combat specific disease areas through research. The NIH clinical center is a large research hospital in Bethesda.

Of the total $1.059 billion appropriated for NIH for Fiscal Year 1965, approximately $718.5 million went to medical and health-related research. This $718.5 million represented 39 percent of the nation's medical research support funded by both private and government funds. NIH direct research and collaborative studies accounted for $151 million of this research support. Contracts with industry for research studies and for the development of specific devices were funded from the $151 million.

NIH awards between 15,000 and 25,000 research grants each year, and the research grant program has been continually growing (see Figure II-1). In order to be awarded, a grant must be formally approved by one of the National Advisory Councils appointed by the Surgeon General to oversee the operations of the nine institutes. In practice, a study section of NIH consultants first reviews each application within its area of competence and then recommends approval or disapproval of the grant. The more than fifty study sections are shown in Figure II-2. The National Advisory Councils usually follow study section recommendations, subject of course to availability of funds. Although grant approvals may cover two-year to five-year periods, funds are released annually from NIH appropriations on the basis of priorities assigned by the study sections. Sometimes grantee institutions use the funds to subcontract for equipment or development and testing services needed to accomplish grant research.

FIGURE II-1
RESEARCH GRANTS
($ in millions)

Fiscal Year	Amount
1946	$ 0.78
1950	14.1
1955	33.9
1957	89.8
1960	202.9
1961	293.9
1962	433.7
1963	492.8
1964	529.2
1965	545.2
1966 (estimated)	604.4

Source: *Basic Data Relating to the National Institutes of Health, 1966,* Office of Program Planning and Division of Research Grants, National Institutes of Health, February 1966.

B. Patent Policy[1]

NIH follows HEW patent policies (see Figure II-3). Under these policies the Assistant Secretary for Health and Scientific Affairs has broad authority to determine disposition of rights to inventions reported under NIH grants and contracts. Subject only to specific requirements of statutes and executive orders, he may:

(i) Permit the grantee or contractor to retain title where he finds that "the invention will either be effectively dedicated to the public . . . or generally available for royalty-free and nonexclusive licensing . . . ." [Figure II-3, Section 8.2(a)]

(ii) Assign title to a "competent organization" for development and administration where he finds that (a) this will more adequately and quickly develop the invention for widest use and (b) adequate safeguards exist against unreasonable royalties and repressive practices. [Figure II-3, Section 8.2(b)]

(iii) Leave disposition of patent rights to another government agency that has contributed to the work. [Figure II-3, Section 8.2(c)]

(iv) Require title to be assigned to the government. [Figure II-3, Section 8.2(d)]

Prior to September, 1966, NIH, in practice, has almost always taken title to inventions resulting from NIH-sponsored research [see Figure II-3, Section 8.2(d)]. In two cases the government determined that it

[1]In general, this report does not reflect any organizational and operating changes made within HEW since September, 1966, at which time the responsibility for administration of patent matters within the Department and its operating agencies, including the responsibility for making the required determinations, was assigned to the Assistant Secretary for Health and Scientific Affairs.

Page

LIST OF FIGURES

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FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY
COMMITTEE ON GOVERNMENT PATENT POLICY
U.S. DEPARTMENT OF COMMERCE BUILDING
WASHINGTON, D.C. 20230

NOTICE

This volume is part of the final report submitted by Harbridge House, Inc. to the Committee on Government Patent Policy, Federal Council for Science and Technology, in compliance with Department of Commerce Contract No. 7-35087. This contract was sponsored by the Committee in order to acquire and analyze relevant data and information regarding the effects of government patent policy on the public interest. Volume I summarizes the results of the research conducted by Harbridge House, Inc. and Volumes II through IV provide backup data to Volume I.

This final report is published in the interest of making the results thereof available to the public at the earliest possible date. Publication is in no way intended to indicate concurrence in or approval of the findings or analysis of the data provided by the contractor.

Gerald D. O'Brien
Acting Chairman

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