U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

File w/ Technology Transfer

STATEMENT BY JORDAN D. LEWIS
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BEFORE THE SUBCOMMITTEE ON DOMESTIC AND INTERNATIONAL SCIENTIFIC PLANNING AND ANALYSIS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MAY 4, 1976

GOOD MORNING MR. CHAIRMAN AND DISTINGUISHED MEMBERS OF THE SUBCOMMITTEE:

I AM FLATTERED TO HAVE THIS OPPORTUNITY TO COMMENT ON TECHNOLOGY AND PUBLIC POLICY. THIS IS AN IMPORTANT, INDEED VITAL, ISSUE OF OUR ERA. OUR PRESSING BUT OFTEN CONFLICTING NEEDS FOR FOOD, ENERGY, A CLEAN ENVIRONMENT, ADEQUATE HEALTH CARE AND OTHER SERVICES, ALL AT REASONABLE COSTS, CAN ONLY BE ACHIEVED THROUGH AN EFFECTIVE BLEND OF TECHNOLOGICAL AND INSTITUTIONAL CHANGE GUIDED BY THOUGHTFUL PUBLIC POLICIES.

RECOGNIZING THE MAGNITUDE OF THESE ISSUES, THE FEDRERAL GOVERNMENT HAS BECOME A MAJOR SPONSOR OF CIVILIAN RESEARCH AND DEVELOPMENT. BUT R&D IS ONLY ONE STAGE IN TECHNOLOGICAL CHANGE. THE SUCCESSFUL CONDUCT OF AN R&D EFFORT, WHETHER PUBLICLY OR PRIVATELY FUNDED, IS NECESSARY BUT NOT SUFFICIENT TO ASSURE THAT THE RESULTS OF THAT R&D WILL FLOW INTO MARKET USE. IT IS THEREFORE CRITICAL THAT WE SEEK TO UNDERSTAND THE FULL PROCESS OF TECHNOLOGICAL

CHANGE AND HOW PUBLIC POLICY AFFECTS IT. THIS IS THE FOCUS OF MY TESTIMONY THIS MORNING.

TO UNDERSTAND THE CONTEXT OF MY REMARKS IT IS USEFUL TO VIEW THE PROCESS OF TECHNOLOGICAL CHANGE AS COMPRISING THREE STAGES:

- RESEARCH AND DEVELOPMENT, WHICH PROVIDES THE KNOWLEDGE BASIS FOR TECHNOLOGICAL CHANGE;
- PRODUCTION, IN WHICH NEW KNOWLEDGE AND OTHER RESOURCES ARE INCORPORATED IN GOODS, PRODUCTIVE PROCESSES, OR SERVICES; AND
- MARKET USE, WHEREBY THE FRUITS OF PRODUCTION ENTER THE MARKETPLACE AND PROVIDE SOCIAL AND ECONOMIC BENEFITS.

GOVERNMENT ACTIVITIES INFLUENCE BOTH THE RATE AND DIRECTION OF TECHNOLOGICAL CHANGE. INDEED THERE IS SUBSTANTIAL EVIDENCE THAT VIRTUALLY EVERYTHING THE FEDERAL GOVERNMENT DOES--R&D SPONSORSHIP, THE PROVISION OF SUBSIDIES, REGULATION, INFORMATION DISSEMINATION, AND EVEN PROCUREMENT OF GOODS AND SERVICES FOR ITS OWN NEEDS--SIGNIFICANTLY INFLUENCES THE EVOLUTION OF TECHNOLOGY FOR NON-FEDERAL MARKETS. THE RELATIONSHIPS BETWEEN THESE ACTIVITIES AND THE PROCESS OF TECHNOLOGICAL CHANGE ARE DEPICTED GRAPHICALLY IN THE ACCOMPANYING FIGURE. I WILL DISCUSS THESE RELATIONSHIPS ON SOME DETAIL IN A MOMENT.

AN IMPORTANT EARLY STEP IN THE DEVELOPMENT OF TECHNOLOGY POLICIES

IS TO RECOGNIZE THAT WE ARE TALKING ABOUT A NUMBER OF QUITE DIFFERENT MARKETS, AND CONSEQUENTLY QUITE DIFFERENT SETS OF POLICIES.

IN THE PAST, AND ENAMORED WITH MAJOR TECHNOLOGICAL SUCCESSES IN FEDERAL MARKETS--PRIMARILY OUR DEFENSE AND SPACE EFFORTS--WE BELIEVED THAT IF TECHNOLOGY COULD PUT US ON THE MOON IT COULD SOLVE OUR SOCIAL PROBLEMS AS WELL. PERHAPS. BUT WE NOW RECOGNIZE THAT THE DYNAMICS AND VALUES OF NON-FEDERAL MARKETS ARE QUITE DIFFERENT AND MUST BE SEPARATELY APPRECIATED FOR THE DESIGN OF USEFUL TECHNOLOGY POLICIES.

IN THE UNITED STATES, COMPETITIVE MARKETS COMPRISE THE BASIC MECHANISM FOR ALLOCATING RESOURCES IN THE PRIVATE SECTOR. COMPETITION FOR CUSTOMERS ON THE BASIS OF PRICE AND QUALITY ARE THE FUNDAMENTAL MECHANISMS THAT ASSURE THE PRODUCTION OF NEEDED GOODS AND SERVICES AT THE LOWEST POSSIBLE COSTS. NO SOCIETY HAS FOUND A MORE EFFICIENT ECONOMIC MACHINE. GOVERNMENT INTERVENES IN PRIVATE MARKETS ONLY WHEN THE MARKET MECHANISM IS UNABLE TO PRODUCE SOCIALLY DESIRED LEVELS OR TYPES OF OUTPUTS.

IN ADDITION TO PRIVATE MARKETS, WE HAVE THE MYRIAD AND RAPIDLY GROWING COLLECTION OF STATE AND LOCAL GOVERNMENTS THAT ALLOCATE RESOURCES THROUGH A POLITICAL-ECONOMIC PROCESS THAT IS NEITHER WELL UNDERSTOOD NOR ECONOMICALLY VERY EFFICIENT AS COMPARED TO PRIVATE MARKETS. THERE IS NO CLEAR BOUNDARY BETWEEN PUBLIC AND

PRIVATE MARKETS. PRIVATE FIRMS COMPETE FOR THE BUSINESS OF PUBLIC AGENCIES, AND OFTEN PROVIDE SERVICES THAT COMPETE WITH THOSE OFFERED BY THE AGENCIES THEMSELVES.

MR. CHAIRMAN, ONE GREAT CHALLENGE TO OUR NATION IS TO DESIGN PRIVATE MARKET INTERVENTIONS THAT MEET OUR NEEDS WHILE OTHERWISE MINIMALLY DISRUPTING THE MARKETPLACE. A SECOND GREAT CHALLENGE IS TO UNDERSTAND HOW WE MIGHT HELP OUR PUBLIC MARKETS BECOME MORE PRODUCTIVE.

HAVING PRESENTED THE MARKET CONTEXT FOR TECHNOLOGY POLICIES, WE MAY NOW TURN OUR ATTENTION TO A DISCUSSION OF THESE POLICIES. OUR PURPOSE IN THE EXPERIMENTAL TECHNOLOGY INCENTIVES PROGRAM (ETIP) IS TO EXAMINE THESE POLICIES THROUGH ANALYSIS AND INSTITUTIONAL EXPERIMENTATION TO PROVIDE BETTER GUIDELINES FOR POLICYMAKERS. MY REMARKS ARE BASED ON OUR OWN EXPERIENCE AND ON OUR OBSERVATIONS.

RESEARCH & DEVELOPMENT

THE RATIONALE FOR FEDERAL SPONSORSHIP OF CIVILIAN R&D IS THAT "MARKET FAILURE" (AS IN THE CASE OF BASIC RESEARCH) OR "MARKET IMPERFECTIONS" HAVE CAUSED NON-FEDERAL UNDERINVESTMENT IN R&D IN TERMS OF THE SOCIAL BENEFITS DERIVED FROM THAT R&D. BUT THESE SAME MARKET FAILURES OR MARKET IMPERFECTIONS MAY ALSO INHIBIT THE NON-FEDERAL PRODUCTION AND MARKETING INVESTMENTS NEEDED TO

CONVERT THE R&D INTO SOCIAL BENEFITS.

THIS LAST POINT GAINS SIGNIFICANCE IF WE RECOGNIZE THAT MOST OF THE COSTS OF TECHNOLOGICAL CHANGE OCCUR AFTER THE R&D STAGE HAS BEEN COMPLETED. MOREOVER, A COMPREHENSIVE REVIEW OF OVER 2,000 CASE STUDIES OF TECHNOLOGICAL CHANGE PUBLISHED IN SCIENCE TWO YEARS AGO CONCLUDED THAT "MARKET FACTORS APPEAR TO BE THE PRIMARY INFLUENCE ON INNOVATION. FROM 60 TO 80 PERCENT OF IMPORTANT INNOVATIONS IN A LARGE NUMBER OF FIELDS HAVE BEEN IN RESPONSE TO MARKET DEMANDS AND NEEDS. THE REMAINDER HAVE ORIGINATED IN RESPONSE TO NEW SCIENTIFIC OR TECHNOLOGICAL ADVANCES AND OPPORTUNITIES."

OTHER PROBLEMS WITH FEDERALLY-SPONSORED CIVILIAN R&D HAVE BEEN HIGHLIGHTED IN TWO RECENT STUDIES. ONE STUDY, CONDUCTED FOR ETIP BY ARTHUR D. LITTLE, CONCLUDED THAT "FEDERALLY-FUNDED CIVILIAN R&D IS NOT SUFFICIENT TO BRING ABOUT TECHNOLOGICAL CHANGE IN THE PRIVATE SECTOR TO ANY SIGNIFICANT EXTENT." ANOTHER STUDY, PREPARED BY PROFESSOR ROBERT GILPIN OF PRINCETON FOR THE JOINT ECONOMIC COMMITTEE OF CONGRESS, ARGUES THAT THE ECONOMIES OF SCALE ARGUMENT OFTEN USED TO JUSTIFY FEDERAL CIVILIAN R&D INVESTMENT DOES NOT STAND UP UNDER CAREFUL SCRUTINY.

THESE OBSERVATIONS TEMPT US TO CONCLUDE THAT OUTSIDE OF BASIC RESEARCH, WE HAVE NO CLEAR MARKET-ECONOMIC CRITERIA FOR FEDERAL FUNDING OF CIVILIAN R&D.

EVEN WHEN FEDERAL CIVILIAN R&D SUPPORT IS WARRANTED, THE A.D. LITTLE REPORT I JUST MENTIONED, PLUS OTHER STUDIES HAVE SHOWN THAT THE R&D RESULTS HAVE OFTEN NOT FLOWED EFFECTIVELY INTO INTENDED MARKETS. THE EXTENT TO WHICH MARKET IMPERFECTIONS COMPRISE A BARRIER TO THIS FLOW IS UNKNOWN. ~~BUT MOST OBSERVERS~~ HAVE NOTED A WIDESPREAD LACK OF EFFECTIVE MARKET-ECONOMIC PLANNING IN GOVERNMENT R&D AGENCIES. ~~WITHOUT SUCH PLANNING~~, R&D PRIORITY SETTING AND PROJECT DESIGN IS NOT LIKELY TO BE WELL COUPLED INTO MARKET NEEDS. EVEN WITH SUCH PLANNING, HOWEVER, THE RELATIVE ISOLATION OF AN R&D AGENCY FROM THE MARKETPLACE SUGGESTS THAT WE SEEK NEW INSTITUTIONAL MECHANISMS, SUCH AS CONSORTIA, TO COUPLE MORE EFFECTIVELY THE FUNDERS, PERFORMERS, AND PROSPECTIVE USERS OF THE R&D.

PERHAPS BECAUSE OF THESE PROBLEMS, THERE HAVE BEEN SUGGESTIONS THAT THE GOVERNMENT PROVIDE TAX CREDITS FOR R&D. THE HYPOTHESIS, WHICH I BELIEVE TO BE CORRECT, IS THAT BUSINESS FIRMS ARE BETTER EQUIPPED TO PLAN AND CONDUCT MARKET-RELEVANT R&D THAN ARE GOVERNMENT AGENCIES. ANOTHER ADVANTAGE IS THAT THERE IS NO PATENT OWNERSHIP ISSUE, WHICH IS PURPORTED TO BE A MAJOR BARRIER TO THE FLOW OF TECHNOLOGY FROM GOVERNMENT SPONSORED R&D INTO COMMERCIAL USE. IN SPITE OF THESE ADVANTAGES THERE ARE PROBLEMS ASSOCIATED WITH R&D TAX CREDITS THAT, I BELIEVE, MUST BE HEAVILY WEIGHED WHEN CONSIDERING THIS POLICY INSTRUMENT.

FIRST, AS MY EARLIER COMMENTS SUGGEST, IT IS NOT CLEAR THAT INCREASED

R&D EXPENDITURES WILL PRODUCE A CORRESPONDING INCREASE IN BENEFITS. SECOND, THE PROVISION OF RESOURCE-SPECIFIC INCENTIVES (IN THIS CASE FOR INCREASED R&D) PRESUMES THAT GOVERNMENT CAN ALLOCATE ECONOMIC RESOURCES BETTER THAN PRIVATE MARKETS CAN. IN SHORT, THAT GOVERNMENT KNOWS THE PROPER MIX OF TECHNOLOGY, LABOR, LAND AND CAPITAL TO ASSURE OUR WELL-BEING. IN FACT, ALL THE EVIDENCE WE HAVE SUGGESTS THAT JUST THE OPPOSITE IS TRUE.

WHAT THEN OF GOVERNMENT INTERVENTIONS WHEN MARKETS ARE UNABLE TO PRODUCE SOCIALLY DESIRED OUTPUTS? AND WHAT OF TECHNOLOGY? I BELIEVE PART OF THE ANSWER IS THAT WE SHOULD DESIGN INTERVENTIONS THAT PROVIDE NECESSARY INCENTIVES AND OPPORTUNITIES FOR PRIVATE MARKETS TO RESPOND TO SOCIAL NEEDS BUT WHICH DO NOT DICTATE OR CONSTRAIN RESOURCE ALLOCATION IN RESPONDING TO THOSE NEEDS. BECAUSE PRIVATE MARKETS TEND TO UNDERINVEST IN TECHNOLOGICAL CHANGE, INTERVENTIONS IN PRIVATE MARKETS SHOULD BE SENSITIVE TO THE NATURE OF TECHNOLOGY, BUT BLIND TO TECHNOLOGY PER SE. FOR PUBLIC MARKETS THE PICTURE IS LESS CLEAR. SOME OF THE BARRIERS TO TECHNOLOGICAL CHANGE AND OTHER RESOURCE ALLOCATION ARE UNDERSTOOD. MOST ARE NOT.

SINCE MOST OF THE COSTS, RISKS, AND UNCERTAINTIES ASSOCIATED WITH TECHNOLOGICAL CHANGE ARISE AFTER THE R&D STAGE, THE MAJOR THRUST OF TECHNOLOGY-SENSITIVE POLICIES SHOULD BE ON THE PRODUCTION AND MARKETING STAGES. I HAVE CHOSEN TO DISCUSS SUCH POLICIES IN THE CONTEXT OF THE BASIC POLICY INSTRUMENTS AVAILABLE TO THE GOVERNMENT.

SUBSIDY

GOVERNMENT SUBSIDIES ARE INTENDED TO RAISE THE LEVELS OF ECONOMIC

ACTIVITY IN PARTICULAR SECTORS ABOVE THOSE WHICH WOULD BE MAINTAINED BY THE MARKETPLACE OPERATING ALONE. SUBSIDIES ARE PROVIDED IN THE FORM OF CASH GRANTS, TAX REDUCTIONS, LOANS AT BELOW-MARKET INTEREST RATES, AND LOAN GUARANTEES. FEDERAL SUBSIDIES FOR CAPITAL, LAND, AND LABOR (NOT INCLUDING WELFARE) AMOUNT TO ABOUT $100 BILLION ANNUALLY. SINCE SUBSIDIES INFLUENCE THE COST AND AVAILABILITY OF THESE ECONOMIC RESOURCES, THEY CAN GENERALLY BE ASSUMED TO INFLUENCE THE WAY TECHNOLOGY IS EMPLOYED IN SUBSIDIZED MARKETS.

A COMPREHENSIVE ETIP STAFF REVIEW OF FEDERAL SUBSIDY PROGRAMS HAS FOUND ONLY A FEW EVALUATIONS OF THESE PROGRAMS. THESE EVALUATIONS HAVE GENERALLY CONCLUDED THAT THE PROGRAMS STUDIED HAVE FAILED TO CORRECT MARKET DEFICIENCIES, ARE OFTEN DIRECTED AT OUTMODED OR NON-EXISTENT OBJECTIVES, REDISTRIBUTE INCOME TO THE AFFLUENT, AND HAVE COSTS THAT FAR EXCEED THEIR BENEFITS TO SOCIETY AS A WHOLE.

FOCUSING SPECIFICALLY ON TECHNOLOGY WE FOUND FOR EXAMPLE, THAT FAVORABLE TAX TREATMENT IS USED TO ENCOURAGE FIRMS TO INVEST IN POLLUTION ABATEMENT EQUIPMENT EVEN THOUGH IN MANY CASES POLLUTION REDUCTION MIGHT BE ACHIEVED AT LOWER COST THROUGH A GREATER USE OF SUPPLIES SUCH AS CHEMICALS AND FILTERS, OR THROUGH CHANGES IN PRODUCTION TECHNOLOGY THAT WOULD REDUCE OR ELIMINATE THE CREATION OF WASTE PRODUCTS.

SUBSIDIES CAN ALSO DISTORT CAPITAL FORMATION IN PUBLIC MARKETS. WE KNOW, FOR EXAMPLE, FROM EXPERIENCE WITH THE BAY AREA RAPID TRANSIT SYSTEM IN SAN FRANCISCO, THAT THE INCLUSION OF TECHNOLOGY THAT IS AHEAD OF THE STATE OF THE ART CAUSES SERIOUS INEFFICIENCIES, BECAUSE OF FREQUENT BREAKDOWNS AND HIGH MAINTENANCE COSTS. BUT USING TECHNOLOGY THAT IS WELL BEHIND THE STATE OF THE ART WOULD ALSO BE INEFFICIENT.

WHILE FIRMS OPERATING IN PRIVATE MARKETS MAY MAKE SIMILAR MISTAKES, THE COMPETITIVE MECHANISM WILL GIVE THEM INCENTIVES NOT TO REPEAT THESE MISTAKES. THE ABSENCE OF SUCH A MECHANISM FROM PUBLIC MARKETS IMPLIES THAT WE MUST BE MORE INTELLIGENT IN OUR PLANNING OF SUBSIDY PROGRAMS.

IN ADDITION TO PROBLEMS WITH THE RATE OF CAPITAL FORMATION VIS-A-VIS TECHNOLOGICAL CHANGE, WE ALSO HAVE PROBLEMS WITH THE DIRECTION OF CAPITAL FORMATION. WHAT IS THE APPROPRIATE BALANCE BETWEEN SUBWAYS AND BUSES, FOR EXAMPLE? THE ANSWER BEARS HEAVILY ON WHAT R&D WILL BE PURSUED.

THESE EXAMPLES AGAIN INDICATE THE BASIC DIFFERENCES BETWEEN PRIVATE AND PUBLIC MARKETS. IN THE FIRST CASE OUR SUBSIDY POLICIES PROVIDE INCENTIVES FOR RESOURCE ALLOCATION. IN THE SECOND CASE, GOVERNMENT MAKES THE RESOURCE ALLOCATION DECISIONS. IN EITHER CASE THE POLICIES SEEM TO BE INEFFICIFNT. BUT THE REMEDIES ARE CLEARLY QUITE DIFFERENT.

IN RECENT YEARS IT HAS BEEN SUGGESTED THAT GOVERNMENT SUBSIDIZE VENTURE CAPITAL MARKETS. THE REASONING HAS BEEN THAT SMALL FIRMS HAVE BEEN PARTICULARLY IMPORTANT SOURCES OF TECHNOLOGICAL INNOVATIONS, AND FURTHER THAT THE SUPPLY OF VENTURE CAPITAL IS INADEQUATE TO SUPPORT SUCH FIRMS. AT PRESENT, THERE IS WIDESPREAD DISAGREEMENT AS TO THE RELATIVE IMPORTANCE OF SMALL FIRMS. BUT A RECENT COMPREHENSIVE ANALYSIS OF VENTURE CAPITAL MARKETS CONDUCTED FOR ETIP HAS FOUND NO EVIDENCE OF SUBSTANTIAL MARKET IMPERFECTIONS THAT RESTRICT THE FLOW OF FUNDS TO SMALL TECHNOLOGY-BASED FIRMS. THE STUDY NOTED THAT ADEQUATE FUNDS MAY NOT BE FLOWING INTO NEW TECHNOLOGICAL VENTURES IF ECONOMIC CONDITIONS REDUCE THE RELATIVE ATTRACTIVENESS OF SUCH ACTIVITIES TO PROSPECTIVE ENTREPRENEURS. BUT THE STUDY DID FIND THAT GOVERNMENT ATTEMPTS TO SUBSIDIZE THE VENTURE CAPITAL MARKET WOULD LIKELY ONLY DISPLACE PRIVATE FUNDS.

SO MUCH FOR CAPITAL SUBSIDIES. LET'S LOOK AT LABOR FOR A MOMENT. PROFESSOR MICHAEL PIORE OF MIT, SPEAKING AT A RECENT SYMPOSIUM IN WASHINGTON, NOTED THAT TECHNOLOGICAL CHANGE CAN CAUSE STRUCTURAL UNEMPLOYMENT BECAUSE IT OFTEN REQUIRES SKILLS THAT DISPLACED WORKERS DO NOT HAVE. WORKERS THUS TEND TO RESIST SUCH TECHNOLOGICAL CHANGES. IN THE VERNACULAR OF MY TESTIMONY, LABOR IS HINDERED IN ITS REALLOCATION. ACCORDING TO PROFESSOR PIORE, OUR MANPOWER TRAINING PROGRAMS HAVE NOT BEEN EFFECTIVE IN CLOSING THE GAP, FOR THEY EMPHASIZE CLASSROOM TRAINING WHEREAS SKILLED AND SEMI-SKILLED JOBS ARE BEST LEARNED THROUGH ON THE JOB APPRENTICESHIP.

FINALLY, WE NOTE THAT GOVERNMENT R&D FUNDING IS A LABOR SUBSIDY AS WELL AS A TECHNOLOGY SUBSIDY, SINCE IT DIRECTLY INFLUENCES THE DEMAND FOR AND SUPPLY OF SCIENTIFIC AND ENGINEERING TALENT.

HERB HOLLOMON OF MIT HAS OBSERVED THAT DURING THE MID-TO-LATE 1960'S WHEN FEDERAL CIVILIAN R&D EXPENDITURES WERE GROWING RAPIDLY, SCIENCE AND ENGINEERING SALARIES ROSE MUCH MORE RAPIDLY THAN THOSE IN THE GENERAL LABOR FORCE BECAUSE THE GROWTH IN DEMAND FOR SCIENTISTS AND ENGINEERS OUTPACED THE GROWTH IN THE SUPPLY OF THESE PROFESSIONALS, BUT THE DEMAND FOR THEIR OUTPUT DID NOT CONTINUE TO GROW AS RAPIDLY. THIS HAD THE EFFECT OF REDUCING OUR RETURN ON INVESTMENT IN R&D. DR. HOLLOMON HAS ALSO NOTED THAT THE PARTICULARLY STRONG GROWTH IN SPACE-RELATED R&D SHIFTED THE SUPPLY OF TECHNICAL TALENT INTO SPACE-RELATED DISCIPLINES AT THE EXPENSE OF MARKET-ORIENTED DISCIPLINES.

REGULATION

WITH SUCH NOTABLE EXCEPTIONS AS THE EQUAL EMPLOYMENT AND CIVIL RIGHTS LAWS, GOVERNMENT REGULATION PERTAINS PRIMARILY TO PRIVATE MARKETS. THIS REGULATION TAKES MANY FORMS: ECONOMIC REGULATION IN WHICH RATES OR PRICES AND MARKET ENTRY ARE CONTROLLED; HEALTH, SAFETY AND ENVIRONMENTAL REGULATION IN WHICH MANDATORY STANDARDS MUST BE MET OR LICENSES OBTAINED PRIOR TO MARKETING A PRODUCT; ANTITRUST REGULATION BY WHICH BUSINESS CONCENTRATIONS IN RESTRAINT OF TRADE ARE INHIBITED; WHAT WE MIGHT CALL INFORMATION REGULATION, WHICH HAS THE PURPOSE OF ASSURING THAT THE INFORMATION IN CERTAIN TRANSACTIONS IS ACCURATE AND SUFFICIENT; AND THE PATENT LAWS, WHICH PROVIDE FOR EXCLUSIVITY OF OWNERSHIP OF INVENTIONS FOR A PERIOD OF YEARS.

IN ORDER TO IMPROVE OUR UNDERSTANDING OF REGULATION, ETIP IS ENGAGED IN A SERIES OF POLICY EXPERIMENTS WITH REGULATORY AGENCIES. THESE HAVE INCLUDED:

- A SERIES OF EXPERIMENTS CONDUCTED IN COOPERATION WITH THE NUCLEAR REGULATORY COMMISSION, THAT TESTED NOVEL ADMINISTRATIVE PROCEDURES FOR ACCELERATING THE DEVELOPMENT OF CONSENSUS NUCLEAR STANDARDS. THESE EXPERIMENTS, NOW BEING FORMALLY EVALUATED, APPEAR TO HAVE REDUCED THE TIME REQUIRED TO DEVELOP DRAFT STANDARDS FROM YEARS TO MONTHS.
- A PROGRAM BEING CONDUCTED IN COOPERATION WITH EPA THAT IS SEEKING TO BUILD SPECIFIC INCENTIVES FOR PRODUCT INNOVATION INTO EPA'S PESTICIDE REGULATIONS. ACCORDING TO EPA, THIS IS THE FIRST TIME THIS AGENCY HAS EVER SOUGHT TO INCLUDE INCENTIVES FOR INNOVATION IN ANY OF ITS REGULATORY ACTIVITIES.
- A SERIES OF EXPERIMENTS WITH SEVERAL STATE PUBLIC UTILITY COMMISSIONS AND BEING CO-MANAGED BY ETIP AND THE FPC, THAT IS TESTING VARIOUS ADMINISTRATIVE PROCEDURES FOR REDUCING REGULATORY LAG, RESTRUCTURING ELECTRICITY RATES, AND PROVIDING ECONOMIC INCENTIVES TO UTILITIES TO IMPROVE THEIR PERFORMANCE AND THUS INCREASE THEIR ABILITY TO INVEST IN MORE PRODUCTIVE TECHNOLOGY.
- THE INITIATION OF A NEW PROGRAM WITH THE FOOD AND DRUG ADMINISTRATION THAT WILL DEVELOP AND TEST THE USE OF A POST MARKETING SURVEILLANCE SYSTEM FOR NEW DRUGS. IN THIS PROGRAM, NEWLY RELEASED DRUGS WILL BE CLOSELY WATCHED FOR SAFETY AND EFFICACY. DRUGS THAT DO NOT PERFORM AS

EXPECTED WILL BE QUICKLY REMOVED FROM THE MARKET, OR WILL BE RELABELED. IF THIS WORKS AS EXPECTED, FDA MAY USE THE SYSTEM TO FOLLOW IMPORTANT NEW DRUGS THAT HAVE BEEN RELEASED EARLIER THAN USUAL.

- A SURVEY OF SMALL BUSINESSES THAT FOUND THAT FEDERAL REGULATORY ACTIVITIES HAVE A SMALLER IMPACT ON PROFITS THAN HAD BEEN GENERALLY PERCEIVED.
- A JOINT EFFORT WITH THE FEDERAL RAIL ADMINISTRATION THAT IS SEEKING TO DEVELOP COMPREHENSIVE GUIDELINES FOR THE REGULATION OF REFRIGERATED RAIL TRANSPORTATION, THE OBJECTIVE BEING TO PROVIDE INCENTIVES FOR PRODUCT (REFRIGERATED BOXCAR) AND SERVICE INNOVATIONS IN THE REGULATORY STRUCTURE. ONCE THE GUIDELINES ARE DEVELOPED THEY WILL BE SUBMITTED TO THE ICC FOR ADOPTION BY THAT AGENCY.
- AN EXPERIMENTAL PROGRAM WITH OSHA THAT IS TESTING THE USE OF COMPUTERS TO SPEED THE DEVELOPMENT AND IMPROVE THE QUALITY OF REGULATORY STANDARDS BY IMPROVING THE ACCESS TO ALL RELEVANT INFORMATION.

WHY ARE THESE EXPERIMENTS IMPORTANT?

THERE IS WIDESPREAD AGREEMENT THAT REGULATION HAS A PERVASIVE IMPACT ON BOTH THE RATE AND DIRECTION OF TECHNOLOGICAL CHANGE. BEYOND THIS OBSERVATION THERE IS LITTLE AGREEMENT AS TO WHAT THE IMPACT IS AND WHETHER IT IS "GOOD" OR "BAD." I WILL TRY TO BRIEFLY SUMMARIZE THE STATE OF AFFAIRS.

ECONOMIC REGULATION APPEARS TO HAVE SEVERELY INHIBITED ANY FORM OF INNOVATION IN RAILROADS, CAUSED OVER-INVESTMENT IN SERVICE INNOVATIONS AND UNDERINVESTMENT IN PRICE-REDUCING INNOVATIONS IN AIRLINES, INHIBITED CERTAIN FORMS OF INNOVATION WHILE ENCOURAGING OTHERS IN ELECTRIC UTILITIES, AND DISCOURAGED THE GROWTH OF CATV IN ORDER TO "PROTECT" TV BROADCASTERS FROM THIS COMPETITION. INDEED ANALYSIS OF ECONOMIC REGULATION STRONGLY SUPPORTS THE PRESIDENT'S CONCLUSION THAT MUCH TRUCKING, AIRLINE AND OTHER ECONOMIC REGULATION IS UNNECESSARY AND SHOULD BE RELAXED. RESTRAINTS ON MARKET ENTRY AND INFLEXIBLE PRICE OR RATE STRUCTURES INHIBIT RESOURCE ALLOCATION AND THUS DISCOURAGE DESIRABLE TECHNOLOGICAL CHANGES IN THESE SECTORS.

BUT THE PICTURE IS NOT ALWAYS CLEAR. LAGS IN RATE DECISIONS IN THE RATE-BASE FORM OF ECONOMIC REGULATION HAVE BEEN SHOWN TO ENCOURAGE THE INTRODUCTION OF COST-REDUCING TECHNOLOGY WHEN COSTS ARE NOT RISING RAPIDLY. IN CONTRAST, WHEN COSTS ARE RAPIDLY MOUNTING, WHICH HAS BEEN OUR RECENT EXPERIENCE, IT APPEARS THAT REGULATED FIRMS BECOME RISK-AVERSE AND TEND TO AVOID INVESTING IN NEW TECHNOLOGY, COST SAVING OR NOT. WHAT IS THE POLICY IMPLICATION HERE? CERTAINLY THERE IS NO CONSENSUS ON THE MATTER.

THE SITUATION IS EVEN MORE COMPLICATED REGARDING HEALTH, SAFETY AND ENVIRONMENTAL REGULATION. A STUDY BEING COMPLETED AT MIT AND REPORTED AT A RECENT SYMPOSIUM HAS FOUND THAT THE RECENTLY MORE STRINGENT OSHA STANDARDS FOR VINYL CHLORIDE PRODUCTION HAVE

STIMULATED THE ADOPTION OF INNOVATIONS THAT HAVE RESULTED IN LOWERED PRODUCTION COSTS. AS YOU UNDOUBTEDLY RECALL, THERE WAS GREAT CONCERN IN THE VINYL CHLORIDE INDUSTRY WHEN THE NEW STANDARDS WERE FIRST PROPOSED.

CONSIDER DRUG REGULATION. SOME OBSERVERS CONTEND THAT LEGISLATION INTRODUCED IN 1962 SIGNIFICANTLY SLOWED THE DEVELOPMENT OF NEEDED NEW DRUGS. OTHERS CLAIM THAT THE 1962 LEGISLATION ACTUALLY INCREASED THE OUTPUT OF USEFUL DRUGS. YET OTHERS DISAGREE, CLAIMING THAT IT HAS SIMPLY BECOME MORE DIFFICULT TO MAKE BASIC PHARMACEUTICAL DISCOVERIES, THUS SLOWING THE APPEARANCE OF NEW DRUGS.

AND STUDIES CONDUCTED FOR THE NATIONAL SCIENCE FOUNDATION HAVE CONCLUDED THAT REGULATION OFTEN STIMULATES THE GROWTH OF NEW INDUSTRIES AND THE DEVELOPMENT OF NEW TECHNOLOGIES THAT PROVIDE GOODS THAT EFFECTIVELY SUBSTITUTE FOR THOSE THAT HAVE BEEN REGULATED.

WITH RESPECT TO ANTITRUST, THERE IS NO AGREEMENT AS TO WHEN THIS FORM OF GOVERNMENT INTERVENTION MIGHT ENCOURAGE OR INHIBIT TECHNOLOGICAL CHANGE. THE QUESTION RESTS ON ISSUES OF MARKET STRUCTURE THAT ARE NOT YET WELL UNDERSTOOD, AND THE ANSWERS APPEAR TO BE DIFFERENT FOR DIFFERENT ECONOMIC SECTORS.

I COULD GO ON TO DISCUSS OTHER FORMS OF REGULATION, BUT MY COMMENTS WOULD BE THE SAME. WE KNOW THAT REGULATION EFFECTS TECHNOLOGY,

BUT WE SIMPLY DO NOT KNOW ENOUGH ABOUT IT TO DRAW MANY USEFUL CONCLUSIONS.

PROCUREMENT

GOVERNMENT IS THE LARGEST BUYER OF MANY CONSUMER, OFFICE, HEALTH CARE, AND SERVICE GOODS IN THE NATION. AS A CONSEQUENCE, IT HAS LONG BEEN HYPOTHESIZED THAT GOVERNMENT PROCUREMENT MIGHT HAVE A POWERFUL INFLUENCE ON TECHNOLOGICAL CHANGE BY PROVIDING AN EARLY MARKET FOR INNOVATIVE PRODUCTS, THEREBY REDUCING MARKET ENTRY RISKS FOR SUPPLIERS.

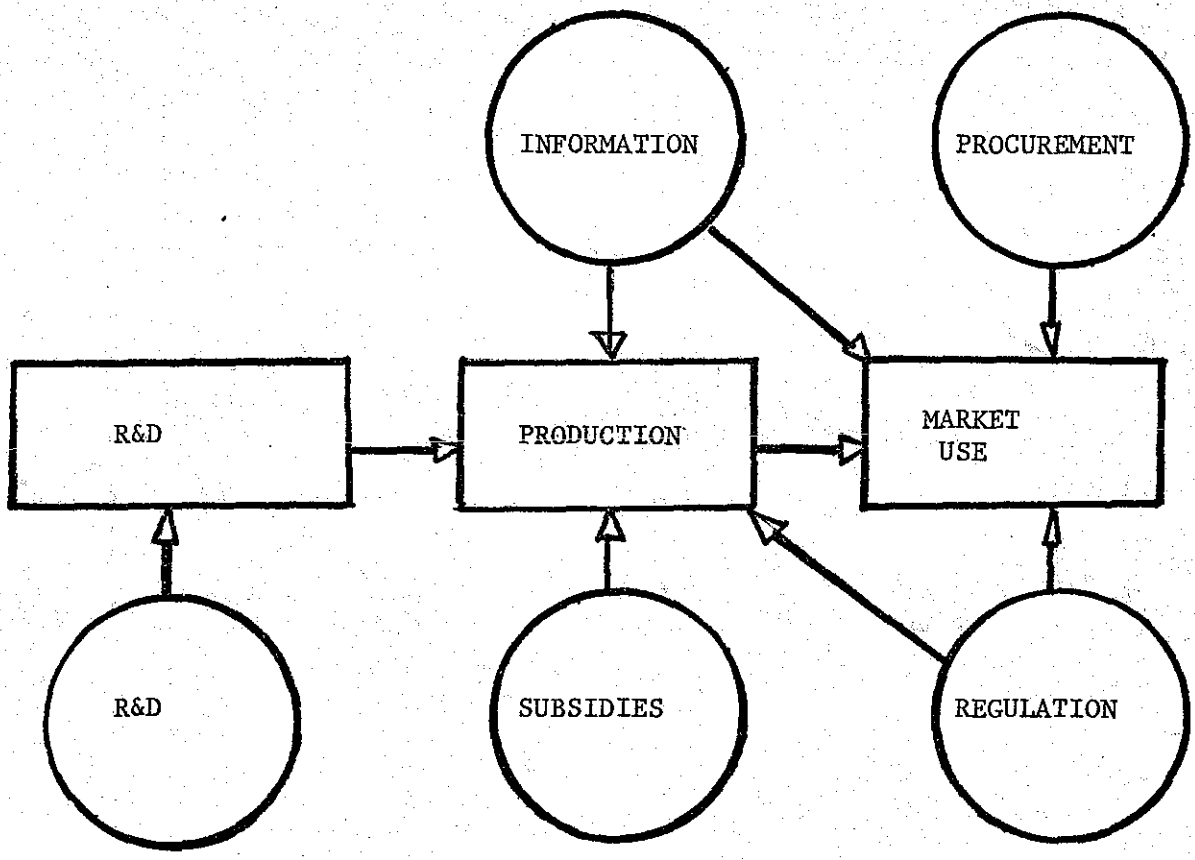
THE EXPERIMENTAL TECHNOLOGY INCENTIVES PROGRAM (ETIP) HAS BEEN CONDUCTING A SERIES OF PROCUREMENT EXPERIMENTS TO TEST THIS HYPOTHESIS WITH THE GENERAL SERVICES ADMINISTRATION (GSA), THE VETERANS ADMINISTRATION, AND NUMEROUS STATE AND LOCAL GOVERNMENTS. THESE EXPERIMENTS ARE TESTING THE USE OF LIFE CYCLE COSTING (FIRST INTRODUCED INTO CIVILIAN AGENCY PURCHASING BY ETIP INITIATIVE), PERFORMANCE SPECIFICATIONS, CONTRACT CLAUSES THAT PROVIDE FINANCIAL INCENTIVES FOR COST-SAVING INNOVATIONS, PRODUCT WARRANTIES, AND REDUCING MARKET FRAGMENTATION AND DUPLICATIONS OF EFFORT IN STATE AND LOCAL PURCHASING SO THAT USEFUL TECHNOLOGY CAN FLOW MORE RAPIDLY INTO PUBLIC MARKETS.

WHILE IT IS TOO EARLY TO DRAW GENERAL CONCLUSIONS FROM THESE EXPERIMENTS, THEY HAVE ALREADY STIMULATED PRODUCT INNOVATIONS THAT HAVE SUBSEQUENTLY BECOME AVAILABLE TO CONSUMERS, AND HAVE PRODUCED MILLIONS OF DOLLARS IN COST SAVINGS FOR THE FEDERAL GOVERNMENT.

Conclusion

Mr. Chairman, you have invited me to testify on the impact of various government policies on technological change. I can summarize my testimony by observing that almost everything Government does influences the pace and direction of technological change, that the impact is different in public and private markets, and indeed is different from sector to sector within those markets. I would judge that the impact of Government activities other than R&D may often be greater than that of the R&D support itself. Unfortunately, we do not have a good understanding of these events.

I am happy to have had this opportunity to appear before you, and will be happy to respond to any questions you might have. If the committee would like, I can provide copies of any of the reports I have mentioned.



RELATIONSHIPS BETWEEN STAGES OF TECHNOLOGICAL CHANGE (DEPICTED BY BOXES) AND FEDERAL POLICY ACTIVITIES (DEPICTED BY CIRCLES)

Biography of
Jordan D. Lewis

Jordan D. Lewis became Director of the Experimental Technology Incentives Program (ETIP), National Bureau of Standards in September 1973.

A native of Chicago, Lewis received bachelors' degrees in Physics and Mathematics (1960), masters' degrees in Nuclear and Information Systems Engineering (1963), and a Ph.D. in Thermonuclear Physics (1966) all from the University of Michigan. He joined Battelle Memorial Institute in 1966, and was Manager of General Operations of Battelle Development Corporation and then Director of Applied Technology Programs for Battelle's Columbus Laboratories, prior to his appointment as ETIP's Director.

As a research scientist and engineer, Lewis' work ranged from the physics of thermonuclear plasmas to the control of nuclear power reactors. At Battelle his work involved market planning and research and development for a wide range of electronic, electromechanical, chemical, and optical products, processes, and systems.

The holder of several patents, Lewis has authored numerous papers on technological development and marketing, and is co-editor of the book, Industrial Approaches to Urban Problems.

Lewis served as U.S. Delegate for Industrial Innovation Policies to the Organization for Economic Cooperation and Development (Paris), is a member and past officer of the American Association for the Advancement of Science, the Institute of Electrical and Electronics Engineers, the Academy for Contemporary Problems, and Sigma Xi.