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SYNTHETIC RUBBER: A CASE STUDY IN TECHNOLOGICAL DEVELOPMENT UNDER GOVERNMENT DIRECTION

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FOREWORD

This study was prepared by Robert A. Solo, department of economics, City College of New York, for the Subcommittee on Patents, Trademarks, and Copyrights as part of its study of the United States patent system, conducted pursuant to Senate Resolutions 55 and 236 of the 85th Congress. It is one of several being prepared under the supervision of John C. Stedman, associate counsel of the subcommittee.

Perhaps the most striking and revolutionary of recent events in the field of technological research and development has been the increasing role played by the Federal Government. What this may ultimately mean for the future of private research, the patent system and other time-honored institutions, it is still too early to say. Government support in this area has taken various forms. One of these has been to turn over to private industry the research and development tasks, with Government footing the bill. Despite its pervading importance in terms of subject matter, results, and financial outlay, surprisingly little attention has been given to examining and evaluating this procedure from the standpoint of its desirability, performance, and promotion of the national security and public interest.

The present study examines one of the dramatic wartime episodes in this area—the creation and development of the synthetic rubber industry. Professor Solo points up the shortcomings that appeared and the reasons for the difficulties that were encountered. One may hope that the lessons learned from this pilot-plant experience will help forestall similar mistakes in the comparable programs now underway or contemplated. Professor Solo's study is more than a mere historical study of an isolated episode of World War II. As the title suggests, it is an enlightening case study of a considered and extensively used governmental policy in action.

Professor Solo is well qualified to speak on the subject of synthetic rubber. The present study is the outgrowth and continuation of a research project undertaken by him several years ago, which earned him a doctor of philosophy degree from Cornell University. He is the author of a number of articles and treatises in the field of economics, including several that relate to various aspects of the synthetic-rubber program.

In publishing this study, it is important to state clearly its relation to the policies and views of the subcommittee. The views expressed by the author are entirely his own. The subcommittee welcomes the report for consideration, but its publication in no way signifies acceptance by the subcommittee of the statements contained in it. Such publication does, however, testify to the subcommittee's belief that the study represents a valuable contribution to patent literature and that the public interest will be served by its publication.

JOSEPH C. O'MAHONEY,
Chairman, Subcommittee on Patents, Trademarks, and Copyrights, Committee on the Judiciary, United States Senate.

DECEMBER 23, 1958.

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SYNTHETIC RUBBER: A CASE STUDY IN TECHNOLOGICAL DEVELOPMENT UNDER GOVERNMENT DIRECTION

By Robert A. Solo

CHAPTER I

STANDARD OIL AND SYNTHETIC RUBBER

Nineteen hundred and thirty-nine. Europe was on the edge of war. Tremors of apprehension reached the United States, creating some agitation for preparedness, some concern for the possible interruption of the supplies of vital materials imported from abroad. The most important and most vulnerable of these strategic imports was rubber. A small program to stockpile natural rubber had been started that year, but, in military and political circles, no thought, apparently, had been given or provisions made for producing in the United States an adequate (synthetic) rubber substitute. The notion that synthetic rubber had a place in American economic strategy was introduced, inauspiciously, into official consideration by an executive of the Standard Oil Company of New Jersey.

Thus, Mr. Frank Howard, of the Standard Oil Co. (New Jersey), writes:

> With the thought that we might be helpful, early in January 1939, I called on Mr. Johnson and on Col. Charles Hines, then secretary of the Army and Navy Munitions Board, to inquire as to their interest in rubber, and also talked to Col. H. K. Rutherford, the secretary's aide responsible for these studies. I was told that rubber was on their list of strategic materials and that they would be glad to have any information we could supply on producing it synthetically. I promised to have Dr. Frolich, director of Standard's chemical-research laboratories at Bayway, call on the Board. Dr. Frolich made his first visit a few days later, on January 12, 1939, and reviewed for the Munitions Board the three types of rubber on which Standard had special knowledge, Buna N, Buna S, and our butyl, which we were identifying at that time by the code name of Buna X.[1]

Mr. Howard could find—

> no indication that either the economic or military policy of the Nation as yet included any plan actually to prepare for the possibility that we might be cut off from our supply of natural rubber.[2]

But why was it that the Standard Oil Company of New Jersey, which neither produced rubber nor used it, but whose interests were in oil and oil products, first manifested concern for this aspect of strategic war planning, and first took the initiative in forwarding the possibilities of synthetic rubber? This is to be explained only by reference to patent-sharing arrangements between Standard and the German cartel, I. G. Farben Industries. Standard had been long

[1] Frank Howard, Buna Rubber, p. 73 (1947). Mr. Howard was, from the end of World War I until his retirement in 1945, the principal executive of the Standard Oil Company of New Jersey concerned with the direction of its research and development activities and with its international patent-exchange agreements.

[2] Id., p. 73.

interested in acquiring the rights to patents developed by German research, especially in the field of catalytic engineering, i. e., relating to the power to accelerate or control the reactions and to minimize those wastes and costs of conversion involved in the rearrangement of molecular structures—where the German had attained preeminence. Thus, by 1925, the parent company of what later became the I. G. Farben cartel was ready to produce synthetic gasoline (and other products, including alcohol and rubber) commercially from German deposits of low-grade coal. The German processes might enable Standard to convert crude oil into gasoline more economically, and, moreover, would provide that company with an alternative source of gasoline should the discovery of new oil reserves lag behind the demands of the expanding fuel market.

A series of agreements was concluded between the two corporate giants, the most important being signed in 1927 and 1929, wherein Standard undertook to invest in research on dehydrogenation and to share the results of that research with I. G. It transferred to I. G. 546,011 shares ($65 million worth) of Standard stock, and made available its full facilities for the distribution of I. G.'s synthetic fuel in Germany. I. G., in return, gave Standard control over its dehydrogenation process outside of Germany. Standard, presumably to induce the Germans to continue to make available the new research developments, extended a royalty share to the German company on all dehydrogenation licenses granted by Standard and gave I. G. also a substantial (20 percent) share in the control over the operations of a Standard subsidiary set up for patent licensing (the Standard-I. G. Co.). A joint development company (Jasco) was also formed under Standard's aegis as a vehicle for "commercial testing and licensing of new processes developed by either party for making chemical products from oil raw materials," the originating party to receive a five-eighths share and the other party a three-eighths share on each new process. I. G., however, received full German rights on all dehydrogenation developments made by Standard and on all processes developed by Jasco. Further, in the so-called division of fields agreement, the two companies agreed not to compete with each other, i. e., defined the chemicals and oil businesses as their respective lines of endeavor and agreed each to remain within its respective bailiwicks, except in Germany, where I. G. was now to produce oil products from coal.

It was through this agreement to share in all petrochemical processes that Standard came eventually to possess a minority share in the synthetic-rubber processes developed by I. G.

Synthetic rubber is a European development. In the middle of the 19th century, an Englishman, Grenville, discovered the molecular nature of natural rubber. Natural rubber is constituted out of the molecules of a substance called isoprene. These isoprenes are linked together in enormously long chains, which form coiled and tangled masses and, thereby, give to rubber its elastic or stretchy quality. The process of linking together single molecules into chains or globules is called polymerization, and, in the case of natural rubber, this process of polymerization is carried on by nature within the bark of the tree *Hevea brasilianus*. The rubber latex is tapped from the bark of the tree; the water is then dried out of this latex, and there is left the long, intertwined chains of isoprene molecules in the form of soft

plastic mass. For commercial use this rubber must be strengthened internally so that it will not lose shape under heat or pressure, and this internal strengthening is done through the process of vulcanization which, so to speak, cross-stitches the chains of isoprene with sulfur. Later in the 19th century, after Grenville's discovery, the Frenchman, Bouchard, succeeded in producing a laboratory synthetic rubber by polymerizing pure isoprene. Before World War I, in Russia, the Czar's Government, fearing the effects of a war blockade, offered a prize for the development of a commercially feasible substitute for natural rubber. To win this prize, a Russian named Lebedev developed a method for the low-cost production of butadiene, another molecule which, like isoprene, could be polymerized into elastic, rubbery masses. Both the Russians and the Germans, under the pressure of necessity, put Lebedev's discovery to use, each adapting its method to the available raw materials—grain in the case of Russia, and coal in Germany.

Prior to 1930, the German butadiene process, based on the use of coal and limestone, was considered to be outside the agreement with Standard. But with its new plans for the production of synthetic oil and oil gas, I. G. developed methods for the production of butadiene from these materials. This was within the scope of Jasco, and Standard undertook to share in the research. The goal was to break into the enormous United States market for natural rubber for use to fabricate tires. Standard attempted to develop a more economic method for the production of butadiene from natural gas or oil, but without much success.[3] However, that part of the joint research program, carried on by the Germans, that sought to reduce the costs of polymerization and develop a better rubber end product was more successful. It resulted in the development of Buna S (butadiene and styrene copolymerized), usable as a substitute for natural rubber in the production of tires, Buna N (butadiene and acrylonitrile), an oil-resistant rubber adopted for specialty uses, and new catalytic agents increasingly effective in accelerating reaction time. In Germany, with the advent of the Nazis and their increasing control over industrial planning, a plan was set in motion in 1934 to recreate the German economy in order to achieve a maximum degree of self-sufficiency. Synthetic rubber was to be "one of the pillars of this autarchy program * * * with the Government paying the cost and directing the procedure."[4]

In 1932, I. G. introduced to Standard a polymerized isobutylene useful in controlling the viscosity of motor fuels, and later marketed for that purpose under the names of Paratone and Vistanex. Standard then sought to develop the means of recovering and purifying isobutylene as a low-cost, large-scale byproduct of refinery operations. Isobutylene thus produced could be used to make Vistanex, or could be converted into di-isobutylene which was the primary ingredient in the production of high-octane fuel for military aviation, or possibly could be used to produce a new type of synthetic rubber (butyl) which

[3] Howard describes thusly the effort to develop a commercial method by the Baton Rouge group for the production of butadiene from natural gas or oil:
"Still working on the electric arc process and its related developments, the Joint Study Co. had found a workable but much too expensive process for obtaining butadiene from oil or natural gas. All along the line, we had attained a fair degree of technical success but commercially our efforts seemed to have ended in complete failure." Id., p. 39.

[4] Id., p. 40.

Standard was trying to develop. The technique for the commercial production of isobutylene and for its conversion into di-isobutylene and iso-octane was developed in 1935.

It is important to note for much of what will follow later that iso-octane was essential for the 100-octane fuel that was being made standard for American military aviation even in 1935. The production of iso-octane for aviation fuel, and of isobutylene for Vistanex (and later for butyl rubber) were alternative outputs, and in the particular process, increase in the output of one must necessarily reduce the possible output of the other.

In 1937, two Standard chemists, R. M. Thomas and W. J. Sparks, found that by introducing small portions of butadiene (later isoprene) into the isobutylene chain, a stable rubbery substance which Standard named butyl, could be produced. Standard sought vigorously to develop butyl's commercial potentialities. Research in the catalytic cracking field generally was accelerated in both Germany and the United States.

By 1938 the Germans had gone a considerable distance in the development and use of Buna S for tires. With the increasing threat of war and Government intervention, Standard and I. G. were anxious to establish a foothold for their synthetic product in the American mass market for general purpose rubber, i. e., for rubber used to produce tires. Foreseeable developments might after all, quite suddenly dissipate the fruits of a considerable investment and the dominating patent position which Standard had now acquired. Therefore, a campaign was organized to sell tire companies on the commercial use of the synthetic product. On a price-per-pound basis the synthetic rubber was more expensive, but it was the contention of Standard that the synthetic rubber was tougher, and that, even at a premium, it would pay for the tire companies to use the synthetic product in the fabrication of tire treads. Further, natural rubber prices were subject to erratic change, and production was in the hands of an international cartel which could victimize the rubber consumer. From 1938 through 1939 experts came from Germany with data on tire tests, with knowledge of compounding techniques, and with the synthetic rubber tires too, so that tests could be arranged by the leading tire producers themselves.

That pressure to acquire market advantage through patent pooling and exchange and through joint research, which brought together I. G. and Standard, was not confined to these companies alone. Howard tells that in the summer of 1939, he was involved in negotiating a vast, world-embracing patent combine known as Catalytic Research Associates.

This group included 3 foreign companies—I. G. Farben Industries, the British Anglo-Iranian Oil Co., and the British-Dutch Royal Dutch Shell Co.; 3 American oil companies—The Texas Co., Standard Oil Co. (Indiana), and our own company; and 2 American process development organizations operating in the oil industry—The M. W. Kellogg Co. and the Universal Oil Products Co. All were interested in the catalytic treatment of oils. Each had technical contributions to make. The group was trying to arrive at some workable arrangement under which they could exchange their knowledge and supplement one another's research efforts in catalytic refining, and each could secure the right to use or to license the processes resulting from the combined efforts.[5]

[5] Id., pp. 77–78.

This agreement was concluded in August 1939. A week later the Germans invaded Poland, and World War II began. The old relationship between I. G. and Standard could now no longer be maintained. In its dealings with France and England, and eventually with the American Government, Standard would be embarrassed by its German connection and by the dominant power possessed by the Germans in the licensing of patents and in the control over the development programs in vital industrial areas. It appears that the officials of I. G., who by now had virtually become agents of the Nazi government, were also embarrassed by some of the commitments they had previously entered into with Standard.[6] Therefore, an agreement was negotiated in September 1939, between Standard and I. G. dissolving the former relationship. Full rights to the jointly held patents were assigned to Standard for the United States and the French and British Empires, and to I. G. for the rest of the world.

Back in the United States, Standard officials reviewed their synthetic-rubber policy in the light of the following circumstances: Standard's patent supremacy; their interest in establishing a synthetic-rubber industry in the United States while they retained that supremacy; the possible importance of synthetic rubber to the security needs of the United States; the lack of any mechanism within the United States Government capable of comprehending the prerequisites or initiating the organization of a synthetic-rubber industry in response to this strategic need; and the possibility of securing public support or subsidy for the establishment of such an industry. Standard's officialdom formulated a plan for a cooperative synthetic-rubber company to be owned, operated, and, if necessary, financed by the industrial companies most interested in the production and consumption of synthetic rubber. Standard would hold 51 percent of the common stock, and the remainder would be offered to such tire companies as wished to participate. Standard might sell a share of its majority bloc to other oil or chemical companies, but on no account would control be allowed to pass into the hands of the rubber-product manufacturers, inasmuch as their interest in synthetic rubber as a bargaining weapon useful in holding down the price of natural rubber might preclude a concern with the long-run development of the new industry itself. On the other hand, the financial involvement of the tire companies would to some degree commit them to develop outlets for the new rubbers. Thus, a unified research and development company, controlling basic patents in the field, would be organized, and from that company there could eventually be developed a vast integrated industrial concern. Moreover, should this company be formed and should the Government decide that a great synthetic-rubber industry must be created quickly and at all costs, not only would this company then be ready to do the Government's bidding, but also it would be ready to receive the full benefits of Government support and subsidy.

On October 9, 1939, high officials of the Standard Oil Co. renewed their contacts with the Army and Navy Munitions Board. They came, not as supplicants or as mere well-wishers, but as men convinced that their organization held the key to the development of a general-

[6] Cf. conversations with Ter Meer and Ringer, id., pp. 62, 88.

purpose synthetic-rubber industry in the United States, and that such an industry (whether or not public officials were yet ready to recognize the fact) was vital to the national defense. On November 19, they broached the elements of their plan for a cooperative development of synthetic rubber. Standard's purpose was twofold. First, she wanted to explore the possibilities of getting for the cooperative program some sort of Government financial support, either a subsidy or a guaranteed outlet for products made with synthetic rubber. In this regard, the Munitions Board offered neither funds nor the hope of funds. Second, Standard wanted a suggestion, a request or directive from this the highest war mobilization authority which would, in effect, sanction, lend prestige to, and possibly protect against legal attack Standard's scheme of inducing, with the offer of Buna N licenses and by the other means, a jointly owned company for the development of general-purpose synthetic rubber. In this regard, the Munitions Board was pleased to oblige, and Standard was sent a suggested sanctioning letter which Standard was able to regard as its directive.

The full cooperative company plan was drawn up and put forward by Standard Oil (New Jersey) in January 1940. Three months later, the whole plan was discarded, ostensibly because of the fear that it could not survive an antitrust attack. Nor, indeed, is it difficult to imagine the reaction of Mr. Thurman Arnold to a plan which would seem to create a monopoly in the field of synthetic rubber dominated by Standard Oil.

After it had abandoned its cooperative company scheme, Standard tried to initiate a cross-licensing system in which royalties would have been shared by all patent holders, but with the major portion going to Standard. This approach was also put aside in favor of a Government-run program.

Standard's cooperative company plan, though it came to nothing, is worth attention because of its ingenuity; because it offered the only prospect which was ever to appear of a privately developed, general-purpose synthetic-rubber industry in the United States; and because the synthetic-rubber industry did, in fact, develop as a sort of producer's cooperative, financed and sponsored by the Government.

CHAPTER II

FIRST LESSONS

The experience of synthetic rubber was symptomatic of a general failure to fit the complex variables of science and technology into that conceptual framework in terms of which social policy was formed. There was a general lack of technical focus in government. The world of technological and scientific potentiality was evolving with great rapidity, but no instrument of government was attuned to these changes; characteristically, no awareness existed in government of the implications of such change for social and strategic policy. Thus, even at the very outset of the war, synthetic rubber was outside the orbit of political consideration. This lack, reflecting a lag in our culture where science and technology have become too suddenly of transcendent importance, went beyond the American Government to the American habit of thought, and beyond the American habit of thought to the approach that characterized many other societies, as well.

The experience with synthetic rubber illustrates another kind of lag, and lack. Our society has moved into a troubled era where it is no longer sufficient to rely on spontaneous individualism automatically coordinated through institutions designed to facilitate a competitive interaction. The public welfare required an unending sequence of deliberate and difficult decisions wherein society, as a collectivity, through its instruments of government, must engineer, restructure, and lead, rather than merely maintain the ramparts of safety and the parameters of individual choice. For this task, we have been, generally, ill prepared. We had neither the habit, the values, nor the competence for collective choice and action. Our ethic and philosophy of traditional liberalism had made us sensitive to the dangers of concentrated political power and had surrounded the prerogatives of individualism with an aura of sanctity. But social problems precede social philosophy, and the problems of the 20th century required a new level of deliberated social choice and action in politics, in economics, and now, inevitably, in science and technology. To resolve the problems of economic organization, we depended almost solely on the twin institutions of property and the free market, and on these we continue to depend. But these alone are not enough. Many basic problems are beyond the market function and must be resolved at the level of public action. Further, the market structure and the prerogatives of property must be kept under continuing surveillance and sometimes must be reshaped if their social purpose is to be served. Like property and the free market, the patent system is intended to harness free, self-interested choice to the social weal. This patent system was the sole and unique instrument of traditional liberalism, representing the totality of social intervention supposedly required to insure an optimum rate of tech-

nological advance and scientific development. But, like property and the free market, it does not suffice; the patent system cannot reach currently basic problems related to science and technology which must, hence, be resolved at the level of social choice and public action, such as the development of the synthetic-rubber technology. Further, the patent system must itself be kept under constant surveillance and be made subject to continuing alteration, as occasion demands, if it is best to assist in accelerating the pace of technological advance.

In the rest of this chapter, certain of the problems which inhere in the patent system will be examined in the light of the synthetic-rubber experience. The history of synthetic rubber gives evidence of some of the positive values of the patent system. Because invention could thus be commercialized, investment in synthetic-rubber research was probably stimulated. Because the patent system makes it consistent with the self-interest of those who possess an invention to use it without secrecy, and to package and sell the invention, as well as the product produced with the invented process, the spread of new knowledge may thereby be facilitated. In this instance, under the patent system, I. G. invested in research, produced inventions, and, through the purchase of the patents, Standard introduced a range of valuable products into the American market and important new processes into its refinery operations, thus raising the general level of productivity in the American economy.

Such arrangements, however, also pose social dangers. The patent (and related) arrangements between Standard and I. G. were attacked by the Antitrust Division of the Department of Justice under Thurman Arnold, not only in the courts (in an antitrust suit that ended in the consent decree of March 25, 1942), but, also, in the press and before various congressional committees and executive agencies.

Without attempting to choose between the arguments of those who would defend the oil companies and those who would condemn them, it suffices for our purpose to deduce from the arguments and from the facts the possible consequences, inimical to the national welfare, that might arise through such patent agreements.

The Standard-I. G. relationship, later enlarged to include other companies through the CRA (Catalytic Research Associates) was decried by the Department of Justice as an attempt, through the formation of a giant patent pool, to crush competition and dominate the world markets for petroleum.[7] "Such control" it was alleged "is a part of a settled and continuing policy of this group to monopolize the industry, control future production, and eliminate independent competition."[8]

Whatever the validity of such charges, it is clear that patent exchange arrangements can provide the basis for the monopoly control of an industrial market. Patents, being a limited grant of monopoly, are justified as providing incentive to invention. If, however, patents permit the achievement of an extensive industrial monopoly, then their use may frustrate the very incentive to invent which the patent is intended to insure, since monopoly eliminates a vital competitive

[7] Cf. Department of Justice, Memorandum on Synthetic Rubber Situation, July 18, 1942. U. S. Archives, Rubber Survey Committee files.
[8] Department of Justice, Memorandum for the Attorney General, July 21, 1942. Rubber Survey Committee files.

pressure to discover, to develop, to innovate in order to keep ahead or to stay in business. It might be contended that CRA's patent holdings provided the basis for an industry-wide monopoly, enabling this group to force competitors into the combine, and to foreclose incipient competitive lines of technological development, thus reducing the competitive pressure to invest in research. Through control of the basic technology, moreover, the market for new invention and new research might be restricted or "monopsonized." The market for new inventions relating to a wide range of technological advance would be limited to the few or possibly to the one corporate buyer who possessed the basic patents prerequisite to putting the new invention to use. That single buyer, or those few buyers, could fix the terms on which any invention could be sold and could narrow at their whim the avenues of research and technological advance which might arise outside the orbit of company operations. Thereby the range of subsequent exploration and development would be restricted. For these reasons it has been suggested that the law should deal differently with the patent pool or the massive patent portfolio than with the isolated patent, recognizing that when patents are grouped together beyond a certain magnitude the quality of that which is being dealt with undergoes a radical change. It might be questioned whether exclusive licensing should be allowed when the magnitude of patent holdings or the importance of a single patent enables a significant control over a broad sector of industrial technology. Thus, when dealing with other companies in the attempt to develop an expanding market for synthetic rubber as an outlet for her petroleum products, Standard refused to consider granting an exclusive license to any user, knowing that competition must be relied on to accelerate the most rapid extension and development of the new material in use. Mr. Howard stated it thus:

> Much as I was impressed by the force and sincerity of Mr. Litchfield (president of Goodyear), I felt that it would be a fatal mistake to grant an exclusive license to anyone of the great rubber companies. The effect would certainly be to alienate all the others * * * My own associates and the I. G. agreed when I reported this talk to them.[9]

But what is sauce for the Goodyear goose is sauce for the Standard gander. If an exclusive license was a danger in the hands of Goodyear, was this power of no danger in Standard's hands?

CRA exemplifies, also, a general problem in international social control. The United States Government could control the licensing policy of Standard, but could not effectively control the licensing policy of I. G., although that policy might vitally affect American economic development. Similarly, Germany could control I. G., though Standard's decisions escaped her net. Other countries, France, England, Canada, though deeply affected by international patent deals could not reach in to protect their interests either directly or indirectly. As a consequence of the international nature of the intra-corporate relationships, some aspects of the resultant transactions must escape scrutiny as well as control by governments whose interests were at stake. The essential problem is this: although the effects of these agreements and relationship are important to several national communities, they arise out of activities which transcend the bounda-

[9] Frank Howard, op. cit. supra, note 1, p. 64.

ries of any national sovereignty, and hence escape any effective political control. The dilemma is of international activity beyond the realm of national governments, of a business universe not coextensive with the mechanism of government to which it is supposedly subordinate.

In the Justice Department memorandum referred to above, evidence is offered of "the domination of I. G. and the German Government over the CRA agreement," and of the intent to retain this relationship in spite of the war.

In order to concede the possibility that the Nazis used I. G. connections with Standard (or other foreign companies) to further German war aims at the strategic disadvantage of the United States, it need not be assumed that there was any sympathy for the Nazis, or any consciousness of German strategic objectives on the part of the officials of the American company. It is probably reasonable to assume for the most part that these businessmen and engineers were wholly engrossed in the problems of business and technique. Thus, we would interpret Mr. Frank Howard's remark, that "technology has to carry on—war or not war—so we must find some solution" to the problem of keeping American and Dutch, British, and German interests lying "in the same bed." [10]

Aside from the intent of individuals, the circumstances of the patent arrangements may have been such as to jeopardize the strategic interests of the United States, inasmuch as there arose an imbalance in the manner of evaluating the strategic implications of patent and technological exchanges between the American and the German companies. From the beginning, the German company appears intimately linked to the German Government, with every critical decision referred to its demands. Even in 1926, at the initial meetings between the two companies when the idea of joint areas of enterprise was broached, the officials of the German company are reported to have become at once apprehensive that they might forfeit Government support if they dealt with the Americans.[11] In the September 1927 agreements, a series of letters was exchanged "at the request of the Germans" insisting again on the flexibility of company policy in its constant subordination to "governmental authority." [12] When the Nazis came to power, the Government became an active partner of big business in the direction of German enterprises. Thus:

> Under this program adopted in 1933 by the new National Socialist government, the German economy was to be rebuilt * * * under the leadership of Herman Goering * * * The synthetic oil-from-coal program, already well started, was to be greatly expanded and real efforts made to develop other synthetic industries.
>
> Because of its importance from a military and economic standpoint, synthetic rubber was to be one of the pillars of this autarchy program. * * * So the production of synthetic rubber became a part of the German autarchy program with the government paying the cost and directing the procedure.[13]

From then on, I. G. made it clear that "before I. G. could make any plans for a buna manufacturing industry in the United States, they would have to consult their government." [14]

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[10] Department of Justice, quoted from a note dated November 14, 1939, op. cit. supra, note 7, pp. 4, 5.
[11] Frank Howard, op. cit. supra, note 1, p. 19.
[12] Id., p. 25.
[13] Id., p. 40.
[14] Id., p. 61.

It thus appears that Standard, itself a commercial free agent, dealt freely and on a commercial basis with a company that had already become an instrument and agency for the policies of its Nazi government. It is not unreasonable to suppose that under such circumstances the Nazis would trade off commercial benefits for strategic advantage. In any case it does not appear that prior to Munich, for example, I. G. was stubbornly reluctant to permit the American licensing of its buna patents or even to permit the vigorous search for possible licensees in accordance with its agreements with Standard. In the 1939 patent exchange, the attempt was made to withhold or to delay the buna assignments.[15] While Standard was disclosing all the details of its independent research in butyl rubber, I. G. refused in 1940 to disclose to Standard any information on its buna rubber polymerization units.[16] In this light, it is significant that I. G. arranged its patent exchanges and joint research relationships in such a way that the American had no rights whatsoever over processes within Germany and that Americans were excluded from sharing in (or viewing except by specific permission) the research and development activities within Germany, whereas Germany shared in research, development, and control over licensing within the United States. This arrangement would seem to have had strategic implications for which there was no commercial equivalence.

It does not follow that Standard is to be condemned for the role it played. Under the special circumstance of international dealings, where strategic advantages are at stake and commercial criteria are not the primary guide to the public interest, it rests with the Government and not with private companies to make the public policy decisions. This brings us back to the dilemma noted previously. In order to formulate policy criteria suitable to the complexities of science and industrial technology, government must have the requisite competence. The competence it requires is not only such mastery of science and technology as might be provided by experts borrowed from industry or a university. It must, indeed, encompass this mastery; but it also must embody an understanding of the values of nation and community and of the processes of social evaluation, compromise and choice which are the very essence of governing. The United States Government had not this competence which would have been required to guide the relationships between Standard and I. G.

The technical relationships between nations which are today of strategic importance are not specifically those which may have been of national concern in the thirties. But the underlying problem of technical evaluation as a part of the process of governing remains.

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[15] Id., p. 88: "Ringer may, or may not, have known at the time, however, something I did not learn until the following year—the Nazi government had already made a synthetic rubber agreement of some kind with the Italian Government. Since Ringer had, during our first day together, mentioned that he expected soon to go to Moscow for technical discussions with the Russians, whom we both knew to be interested in Buna rubber, it is possible also that he foresaw the prospect of being required by his Government to make some arrangements with Russia concerning Buna. Ringer recognized that Standard's minority interest in the synthetic rubber process outside Germany was creating difficult problems for the I. G. with their own Government. Apparently because of this embarrassment, the I. G. had not yet asked its Government for permission to include these buna assignments in the batch he was delivering, although he freely acknowledged his obligation to do so * * *."

The quotation serves also to illustrate the manner in which I. G. officials acted as direct agents of the Nazi government in its dealings both with foreign governments, and with great foreign companies.

[16] Id., pp. 105, 108.

Indeed, as the technical issues proliferate, as they become increasingly complex, and as they assume greater strategic importance than ever before, it becomes increasingly urgent that our Government develop the special competence required for sound evaluation and effective control in this sphere. Recently, for example, there has been active intervention by the American Government in the control of trading relationships and technical exchanges between the West and the Soviet bloc. But while our Government chose to remain aloof in the twenties and thirties and intervenes with a heavy hand in the forties, the question remains as to whether it has yet acquired the special technical competence necessary to perform this task with understanding and effectiveness.

It was also charged by the Department of Justice and by the Truman committee that Standard and its CRA associates blocked the competitive development of the synthetic rubber technology (and other technologies) by means of the range of patent control acquired through the I. G. relationship and otherwise. This type of action, designed to check the development of competitive technologies, is part and parcel of the drive for monopoly power. The use of patents to block competitive technological developments, though related to the evil of monopoly, transcends that evil for there is implied not only a control over markets to the disadvantage of the consumer, but also a slowing down in the rate of productivity increase to the detriment of the entire community and to the disadvantage of the nation's military power.

That patents may be bought and sold by great companies for no other purpose than to block competition and prevent innovation and invention, is illustrated by an interesting event in the dealings between Standard and I. G. While this incident is not of great intrinsic importance, it is especially significant because it is not offered as a partisan argument by those intent on establishing the culpability of big business, but rather is described by Frank Howard himself, who carried on Standard's negotiations with I. G. Thus Mr. Howard describes a phase of these negotiations:

> Dr. Herman Schmitz, financial leader of the I. G., told me that one of their directors had conceived the idea that the most money with the least risk could be made out of the Buna development by selling it to the Dutch-British interests who dominated the rubber trade through the International Rubber Regulation Agreement. It was argued that these interests would be willing to buy the synthetic rubber development in order to hold up the price of their natural rubber. I opposed this suggestion at once as a shortsighted plan, probably impractical, and in any event out of line with the policies of my company * * *.[17]

In this instance, Standard is to be credited for not doing what I. G. would have liked to have done, that is, to have sold the synthetic rubber rights to the international natural rubber cartel, whose only purpose in buying those rights would have been to see that synthetic

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[17] Id., pp. 68–69. Cf. also the Extract From Executive Committee Memorandum, October 31, 1938, of Standard Oil (New Jersey):

"*Synthetic rubber.*—Negotiations indicate that the German Government will now permit discussions of details with, and revelation of technical processes to non-German parties in interest, so that within 1 or 2 months considerable progress ought to be made in these negotiations; *although the German interests hope to sell the process to the international rubber cartel that course would probably mean the process might be buried in the interest of maintaining a market for natural rubber. From our approach, the possibility of interesting some rubber interests in the United States in a mutualized company for the commercialization of the process would seem the more normal course.* * * *." Id., p. 264. [Italics are Mr. Howard's.]

The omnipresent influence of the German Government suggests that I. G.'s plan for barring the use of the buna process outside of the Reich, had strategic as well as commercial implications.

rubber was never produced outside of Germany. In this instance, Mr. Howard tells us, the sale of the patents to prevent their use would have been "shortsighted, probably impractical," and "out of line" with Standard's synthetic rubber policy. But the fact that this step was urged at the highest level of negotiation between two of the greatest industrial concerns in the world, indicates that what was proposed was not something outside the realm of regular business practice.

Our reading of the record indicates that Standard's general interest in purchasing the fruits of I. G. research was for the purpose of raising the level of its own refinery techniques and in order to add to the range of profitable byproducts of refinery operations; and that Standard's own investment in synthetic rubber research was motivated by the intention to establish an industry, based on the use of a petroleum derivative, that would mass produce a low-cost synthetic rubber for use in the manufacture of automobile tires. Yet, circumstances put into Standard's hands control over patents which that company was not interested in using or in developing, but which gave to Standard the power to block lines of development competitive with her own. Can it be doubted that Standard (or any company) would be tempted to use such a power to its own advantage, should a competitive line of development threaten? And may it not be supposed that the very existence of that power was a deterrent to any enterprise or researcher who might have been disposed to start a line of development competitive to Standard's?

Through the general strength of its patent position, it appears that Standard was able to determine the technological line of synthetic rubber development in the United States. Can it be assumed that Standard's "best choice" would necessarily also be the "best choice" from the standpoint of the economy of the Nation? There is, in fact, no necessary identity between the choice appropriate to this private company and that appropriate to the general interest. Standard was an oil company viewing synthetic rubber as a possible outlet for its oil products or, better still, its refinery wastes. It was not a synthetic rubber company researching toward the best synthetic rubber, or the most economical way of making a given rubber. It was interested, not in the best synthetic rubber or the most economical process, but in the synthetic rubber which would provide the most profitable outlet for its products. It was interested, not in the process best suited to war mobilization, but in that process which would provide the most convenient and profitable adjunct to its regular refinery operations. In business terms, this was quite appropriate and proper for an oil company. But these were not the criteria by which economic welfare or national power would best be maximized.

Specifically, Standard had acquired, in its huge deal with I. G., not only control over processes directly related to its own interests, but also control over processes only indirectly related to its research and business objectives. For example, it acquired the method in actual use by I. G. Farben for producing butadeine from coal, a method closely related to that used in producing butadeine from alcohol and related substances. But Standard had no interest in the use, evaluation, development, or promotion of this method. On the contrary, it might well have had an interest in its suppression, since this would have created a line of development competitive with Standard's own petroleum-based techniques. Standard, no more than other compa-

nies, would be inclined to encourage competition against itself. There is evidence of this in the very field under discussion, i. e., synthetic rubber. Here, Standard did not hesitate to protect her property rights, and thereby crush the incipient competition of possibly competitive lines of synthetic rubber development by Goodyear and Goodrich Tire Cos., by serving formal notice of patent infringement even during the emergency period of 1941.

Even assuming that Standard never used its control over the I. G. butadiene process deliberately to halt a line of competitive development, and that licenses under this patent were never requested, let alone withheld, it is a matter of social concern that a company should control a process, possibly of great importance to commercial development and national security, which it did not itself develop, in whose development it was itself disinterested, but which might be used to block technical developments competitive with its own. The very fact that Standard held these patents may well have deterred others from considering the use of techniques related to the patented processes, thus foreclosing other possible lines of technical development.

In 1942, under the severe public pressure of the alcohol-petroleum butadiene crisis, Standard Oil did offer to the Secretary of Agriculture the I. G. process for possible use in the production of butadiene from grain alcohol.

Thus:

HON. CLAUDE WICKARD, MAY 8, 1942.
Secretary of Agriculture,
Washington, D. C.

MY DEAR MR. SECRETARY: In view of your statement today, I am writing to inquire whether this company can be of assistance to you in your consideration of the use of agricultural alcohol as a raw material for the manufacture of butadiene for rubber production. I am advised by our technical organization that we have processes for the production of butadiene from alcohol through the aldehyde-aldol-butylene glycol route. Although we have no commercial experience with this process our commercial people are confident that it is a sound operation. Our own estimate of about 2.2 pounds of butadiene per gallon of alcohol seem to be about the same as those which have been published in relation to the Carbon & Carbide Co.'s process and the process of the Publicker Co.; but more detailed examination and comparison would be necessary to determine the relative merits of the three processes. The other two processes are certainly more modern and perhaps cheaper than our own but under present conditions the most important point is not the exact cost but the time required to obtain the production and the amount of critical materials required for the plants. This is a complicated question which only the Government authorities could pass on intelligently after a full review of all the facts. If it should appear that our process above referred to, or any other process, would be of value in the program of immediate production of synthetic rubber from agricultural alcohol they will be available, royalty free, for the duration of the war, and we will render all possible technical assistance in connection with the program.

Very truly yours,

(Signed) W. S. FARISH.[18]

From the words of this letter it would appear that the process developed by (possibly) the world's leading technical organization in the field of synthetics and primarily relied upon for the world's production of synthetic rubber, had not even been thoroughly tested and commercially evaluated at that time, let alone adapted and developed in the light of American needs, by the Government, by the

[18] Id., p. 296, appendix.

company owning the patent, or by any other American firm or organization.

In short, it becomes clear that under the structure of existing law, a private company controlling a wide range of patents may shelve them, neither developing nor putting them to use, and by so doing block lines of development important to national security and the general economic welfare, even though the company may be operating within the contexts of accepted business ethics, law, and commercial goals. This becomes all the more likely when control over patents is not the result of the company's pursuit of particular scientific or technical objectives but represents rather a grab bag acquisition as the result of a wide-ranging patent deal.

Nor should it be supposed it will necessarily suffice to prevent the deliberate blocking of potential lines of technological development. Because knowledge and invention is not kept out of use, does not mean that it will be put to use. The traditional assumption that save only for the pernicious meddling of monopoly, the clockwork of competition will serve all social ends, is an assumption that does not conform to experience. Indeed, even in that stronghold of pure competition, the agricultural sector, technology would stagnate except for the socialization of research and development. But if competition cannot be relied on to fully exploit the potentialities of discovery and invention, neither can oligopoly. It may be the social task, not merely to prevent barriers to the use of discovery and invention, but in a more positive sense to see that the values of such discovery and invention are most fully exploited.

In sum, research and technological development has been, and for the most part remains in the hands of private business, and especially of large corporations. This vital function, which includes the allocation of funds between alternative research outlets, the sale or use of inventions, and the introduction of new products and techniques, is carried on through the instrumentality of the patent system. On its proper operation every aspect of our future depends. But it is not a function which can fully and properly be performed by private business operating in the context of the patent system. First, because there are tasks of technological development, important for society, to which private business, operating in the quest for profits through patents, will not address itself. Second, because, as has been shown in this chapter, conflicts in this sphere may arise between private and social interest in matters of concern to consumer welfare, strategic power, and economic growth. It is possible to suggest modifications of the law which would mitigate against these conflicts, but the divergencies of interest are so manifold and so variegated in form that it is most unlikely that any formula of law will ever be devised which will itself create a sufficient harmony in the sphere of technological development, between social values and private goals. Hence, Government must (and eventually will) assume a new role. No longer limited to its role of mere financial angel, occasional trust-buster, and guarantor of the legal parameters of private choice, Government will be obliged (and is being obliged) to participate over the whole range of technological choice, to undertake independent research and development, to juxtapose social values to private goals and to impose the general and public interest when in contravention

to the particular or commercial interest. The change is already upon us. Each day new, ever more urgent, demands relating to the processes of creative scientific and technological development are added to the responsibilities of Government. But if the task is with us, the consciousness of the nature of the task and its prerequisites is not. For the new task we continue to rely on competencies, attitudes, and organizations that are inappropriate or obsolete. The consequence of a failure to develop the prerequisite competence in government to deal with this task will be illustrated in the chapters which follow.

CHAPTER III

THE SEARCH FOR A POLICY

It was May 1940. With incredible rapidity the Germans had conquered Western Europe and destroyed the expeditionary force of Great Britain. Under the impact of this catastrophe, on May 28, 1940, an agency was created, the National Defense Advisory Committee (NDAC), to give some kind of focus to American mobilization. Under NDAC, the so-called Francis committee was formed to formulate a policy for synthetic rubber.

Looking into the past the statisticians found that there had been great variations in the United States consumption of rubber. In the previous 4-year period, for example, 437,000 long tons had been used in 1938, 592,000 tons in 1939, 648,500 tons in 1940, and 775,000 tons in 1941. Should annual consumption be averaged or should the trend be projected? Or should a vastly accelerated increase in demands be predicted as a function of the expanded activities of the economy under the needs of war? Or should a sizable proportion of current demand be discounted as "panic buying" or (more important) as nonessential? Clearly the facts offered a wide range of possible and reasonable estimates as to future need. The statistician could, and did, "reasonably" estimate rubber demand in the United States, under the impact of mobilization, at between 500,000 and 1 million tons per annum. But this was for civilian needs alone.

Further, there were the needs of the Military Establishment. These were necessarily most uncertain. To this must be added the military and civilian requirements of foreign nations that the United States might wish or need to support. A characteristic estimate of combined military and civilian needs during the projected period of mobilization was for 900,000 annual tons. Should things remain as they were, that quantity of rubber would continue to be supplied through ordinary commercial channels. But things might not remain as they were. Rubber was brought from the East Indies, and there might be interruptions in the passage of ships by submarine warfare, by a sheer shortage of available ship bottoms and/or by the conquest of those areas where rubber was grown. But how to measure and quantify such risks? Reclaimed rubber might to some degree be used instead of natural. But it was not then known to what degree reclaimed rubber could be substituted for natural rubber or the level to which the rate of rubber reclamation could be pushed.

Thus, faced with need for a million annual tons of rubber, and the possibility of a sudden (or gradual) and complete (or partial) cessation of supplies—and assuming that an adequate synthetic substitute for natural rubber could be put into production, officials might either suggest that an industry be built sufficient fully to meet all possible requirements or, alternatively, suggest a smaller investment

intended to provide (1) a "nucleus" of plant and operating organization as a basis for the rapid expansion of the industry and (2) a margin of safety in the form of a natural rubber stockpile and/or operating synthetic-rubber capacity, sufficient to satisfy essential needs while the requisite building program (should such a program prove necessary) was brought to completion. Nor could responsible public officials lightly approve the building of a new synthetic-rubber industry. Such a program would require a large expenditure of public funds. The basic processes were untried and unevaluated. The degree of substitutability of the synthetic for the natural product was not known. Some foresaw in the establishment of such an industry the continuing prospect of new tariffs and subsidies, resulting in both a higher cost and perhaps inferior articles being forced upon the American consumer, and a grave blow to the post-war economies of our British and Dutch friends to whom the sale of natural rubber was a major source of dollar earnings. Nor could the fact be ignored that those who pushed for a new synthetic-rubber industry, had a commercial self-interest in its establishment, so that skeptics might discern a scheme to foist off on the Government the whole vast risk of establishing a synthetic-rubber industry, the profits and control of which would eventually revert to a few great companies.

On June 5, 1940, the president of the Rubber Manufacturers Association forwarded to NDAC a memorandum based on a poll of industry opinion, recommending an annual synthetic-rubber-making capacity of 25,000 tons.

On June 14, 1940, Mr. Collyer of Goodrich Tire Co., testifying before the Senate Military Affairs Committee, suggested an immediate production of 100 tons of synthetic per day.

In an early June meeting of the Francis committee, the representative of Standard Oil took vigorous exception to limiting the synthetic-rubber program to the suggested 25,000 tons of annual capacity, arguing that a Government program of this magnitude would be worse than nothing for it would—

> tend to saturate the market for synthetic rubber as a specialty product and thus drive out of commercial production all the companies on whose initiative and development work the progress of general purpose synthetic rubber would depend.[19]

By July 17, 1940, the Francis committee had settled on a plan for the immediate construction of an annual feedstock and synthetic rubber-making capacity of 100,000 tons.

It appears that the committee arrived at this figure by a rather simple and direct route. The committee, convinced that a substantial production was called for, requested the companies which had been brought into the discussion to indicate the capacity which they would like to engineer. The figures which were then voluntarily submitted totaled 108,000 tons. Thus later, when Firestone and United States Rubber came forward with an offer to engineer a 20,000 and a 25,000 Buna S plant respectively, the committee obligingly increased the planned capacity to 150,000 tons. When Standard Oil asked the committee to hold in abeyance the 30,000 tons of butyl capacity which Standard had previously offered to build (on account of difficulties

[19] Id., p. 120.

that Standard was evidently running into in developing an adequate technology), the committee lowered its sights accordingly. In other words, it appears that the Francis committee formalized the views of the private firms commercially interested in synthetic rubber, and forwarded these views to the NDAC, which gave them the stamp of high national policy. While this accomplishment may not be quite in accord with the highest conceptions of government, in this instance America had reason to be grateful. At least, the committee was there to channelize the proposals of interested companies. No group other than these private firms displayed any initiative in getting under way a program which was to prove vital to national survival.

The NDAC had no means of implementing its recommendations. The program must be financed, and for this it was needful to go to those who held the strings of the Government purse. To this end, in late September 1940, Mr. Stettinius and Mr. Batt contacted the Federal Loan Administrator, Mr. Jesse Jones. Jones made two points clear: first, he was himself skeptical of the need for the recommended level of synthetic-rubber-making capacity and he had enlisted the support of the President to his views; second, if the RFC were to lend financial support to the program, then the whole problem and the whole responsibility would have to be turned over to Mr. Jones and his associates.

Subsequently, in November 1940, Jones threw out the NADC plan to build synthetic rubber capacity to a level of something more than 100,000 tons. As he relates in his book,[20] he was willing to concede that "inasmuch as we in this country had not perfected the making of synthetic rubber we should at least learn the know-how." Let the boys have a little cash to play with, to have their little experiment. When Jesse Jones met Howard of Standard Oil, Wiess of Humble Oil, and Harvey Firestone, he wasted no time reviewing the recommendations of the NDAC committees.

> Mr. Jones opened the discussion with characteristic directness: "What do you think can be done for about $30 million?" This figure of $30 million was in subsequent discussions reduced to $25 million, and Mr. Jones had stated that this was the one that he recommended to the President at the time.[21]

Thus, the Government banker, abruptly and without explanation, cut the laboriously evolved program from a 100,000 to only 40,000 tons of integrated capacity.

In retrospect, this delay and this reconsideration by a new set of officials and then the drastic scaling down of the NDAC's plan to less than half of its original dimensions may be counted as tragic. With the advantage of hindsight, the 100,000-ton plan was clearly a better plan than the 40,000-ton plan (for that matter, a planned 200,000 tons would have been better than the planned 100,000 tons, and a plan for 500,000 tons would have been better still). But in the context of the time it is difficult to prove one a wiser or more reasoned judgment than the other. For Mr. Francis, "a capacity of 100,000 tons per year is as good a figure as can be named." For Mr. Jones, an investment of $25 million was as good a figure as could be named. On such judgments, the fate of nations hang.

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[20] Jesse Jones, Fifty Billion Dollars, My Thirteen Years With the RFC, p. 404 (1951).
[21] Frank Howard, op. cit. supra, note 1, p. 131.

In these early November meetings the program took much of its essential future shape. Polymerization plants were to be built and operated separately by each of the Big Four tire manufacturers (Goodyear, Goodrich, United States Rubber, and Firestone). Each company would make whatever sort of tire rubber it chose to make, and would produce that rubber for its own use. Each company would arrange for its own feedstock supplies. The scheme called for 75 percent Government and 25 percent private financing of direct cost.

This arrangement, which in effect left the shaping of the program to the major tire companies, appeals to one's commonsense, especially since the Government possessed no organization capable of making an independent evaluation of products and processes or of formulating a technological plan; nor was the RFC interested in recruiting such an organization.

It would be expected that this arrangement would lead to the production of a synthetic rubber suitable for fabrication into tires since the companies responsible for its production would be obliged to use that rubber in the manufacture of their tires. Moreover, these companies, in line with their own self-interests, would presumably select satisfactory processes and suppliers, would coordinate the production of feedstocks with the production of rubber and would adapt the copolymerization to the needs of tiremaking. But the arrangement also had its drawbacks. Even theoretically (as was noted above) there was no assurance that the technicians of a private company would refer, in evaluations of this sort, to the criteria proper to the strategic or national interest (nor indeed, with Government financing, with the guaranty against any operating loss, was there any need for the company technicians even to refer to proper commercial criteria). Further, while the research staffs of the tire companies had already devoted some time and effort to the problems of synthetic rubber, they were not likely to have access to the wide range of ideas, invention, and development in Europe as well as in America which might have been made available to a national scientific agency. In point of fact, moreover, the choice of synthetic product and process was largely predetermined. Firestone and United States Rubber were already licensed by Standard to produce Buna S and were committed to Standard (and its process) as their source of butadiene. Goodrich and Goodyear were initially committed to the production of their own rubbers Ameripol and Chemigum which, according to Standard, were modifications of its own Buna N. By a flanking movement of patent infringement suits and the offer of Buna S licenses, Standard could pressure these companies into the use of Buna S. Eventually all companies accepted Buna S. For a part of their supplies of butadiene, the companies were apparently steered into negotiations with the Carbon & Carbide Corp., a chemical company affiliated with Mellon interests. Goodrich was tied to Phillips Petroleum Co. in their joint ownership of the Hycar Chemical Co., and Phillips had chosen as its process one that would be appropriate to the butane available in its abundant supplies of natural gas.

This working plan matured in the early November meetings. On December 9, 1940, the RFC formally requested proposals for the specific projects, these to be submitted by January 15, 1941. By January

15, 1941, proposals and building plans were in the hands of the Rubber Reserve Company, a subsidiary set up under the RFC.

From January 1939 until June 1940, the problem of a synthetic-rubber industry had been under consideration by the Army-Navy Munitions Board; from June 1940 until October 1940, it had been under consideration of the NDAC. At last a plan had been evolved only promptly to be discarded. From October 1940 until January 1941, the problem was under consideration by the RFC. Now, finally, a general plan was settled. The construction proposals were in. The agency in charge had the power to act. At last a synthetic program was to come into being—so it seemed.

But there was no action. No authorization. The Government banker had chosen to reconsider.

On February 21, 1941, Mr. Frank Howard wrote to the executive committee of the Standard Oil Co.:

> Mr. Schram admitted last Tuesday that the rubber program of the RFC is in a state of suspended animation and that it is impossible to say when any action might be taken.[22]

What has happened? The pros and the cons of the case seemed just as before. All the disadvantages of the move were just as great, the advantages were no less. Then why? Mr. Jones and his colleagues never explained. Something may perhaps be understood, however, from a glance at the course of world events.

When, in May 1940, the "mighty" army of France, and the armies of England, Belgium, and Holland collapsed and disintegrated in a fortnight, then the Nation was fear stricken. Against this background of dread urgency, the NDAC's considerations of the synthetic rubber problem began and its recommendations emerged. But our world did not turn topsy-turvy. Britain repulsed the air onslaught of the Luftwaffe. The German invasion threat did not materialize. Churchill continued his defiant speeches. In the United States things moved on an even keel. Business was good. In Washington day followed day, just as before. The Wehrmacht was quiescent. There was room for invincible complacency to return and spread itself. Mr. Jones, who did not believe that any investment in "expensive plants" was warranted in view of the technological uncertainty, "except in an extraordinary emergency" might, under these circumstances, have reconsidered and concluded that there was no "extraordinary emergency" sufficient to warrant throwing away the taxpayers' good money.

Mr. Howard was handed a memorandum by Mr. Clayton on February 26, 1941. The essence of this memorandum was expressed in this conclusion:

> It may be safely assumed, therefore, that we have in sight now even if cut off at once from any further supply, a sufficient supply of rubber to carry us for 3 years.[23]

Having thus reasoned America out of all danger, there remained no justification for an emergency synthetic rubber program. Among the interested companies it was now assumed that the 40,000-ton program was definitely abandoned, and that there was little likelihood that the RFC would do anything about synthetic rubber at all. These companies, and other perhaps, did, however, continue to exert such

[22] Id., p. 139.
[23] Id., p. 143.

pressures as they were able to muster to resist the complete abandonment of the synthetic-rubber program. On March 28, 1941, the RFC proposed what appears to have been a sop to appease those exerting pressure. This was the so-called "shadow-plant plan," a plan which, it has been remarked, certainly reduced the program until only its shadow remained.

The shadow plan proposed no construction of feedstock plants, though the development of workable processes and the provision of a suitable supply of butadiene was, as was then foreseen, the crux of the technological problem. It proposed the construction for Government account of four copolymerization plants of 2,500 tons annual capacity each, for a total annual capacity of 10,000 tons. Each plant would be required to produce a mere 625 tons of synthetic rubber a year for a national grand total of 2,500 tons, of which only half need be tire rubber.

The interested companies were not appeased by the gesture. They reappealed to the officials of RFC. More particularly, they took their case to the new Office of Production Management (OPM), which had recently emerged from the NDAC. They attacked as illusory the supposition that a synthetic-rubber industry could be brought quickly and easily into being after a rubber shortage had actually developed, contending that from 2 years to 30 months would be required in order to achieve a substantial production, and that no amount of preliminary engineering would appreciably shorten this period of gestation. As mobilization cumulatively increased the competing demands for resources, the difficulties of creating the industry would become more severe. Thus, in a letter from Mr. Howard to Mr. Deupree of OPM, dated April 10, 1941:

> * * * If we are to meet an emergency the four large companies must know in advance how to provide synthetic rubber successfully and continuously on a large scale, and how to produce tires from this rubber * * * At least three processes of butadiene manufacture should be developed * * * At least two processes of styrene manufacture * * *
>
> No amount of preliminary "preparation" by way of paper designs or erection of empty shadow plants can completely meet these problems. If we spend the next 6 months working out a preliminary engineering and experimentation program at least 3 months out of the 6 months will be net lost time, and the ultimate delay may be even worse than 6 months because of the possibility of cumulative difficulties of all kinds which may come upon us in increasing numbers when we are trying to carry out an emergency rubber production program under conditions which will upset the normal production in this country in countless ways.
>
> * * * we have incurred the danger of a real shortage of rubber * * * and have also handicapped ourselves by pushing the rubber program along until it conflicts even more seriously than it would have with the ship program, the plane program, and the general preparedness program.[24]

But more important than the pleas of individuals was the pressure of events. From March 1941 onward, the Nazi armies resumed the offensive with uninterrupted success in North Africa, Yugoslavia, and Greece. Submarine sinkings reached a new peak. On May 20, the German air and seaborne attack on Crete began—a perfect model of an island invasion. It was against this background of defeat and disaster with all the implicit threat to the security of America, that OPM

[24] Id., pp. 150–151.

reacted in favor of the plea for a renewed synthetic rubber program.

On May 9, 1941, Mr. Knudsen wrote to Mr. Jones:

> * * * we should immediately make the decision to erect plants capable of producing 40,000 tons of synthetic rubber and holding our minds open for a few months until we have a better knowledge of engineering plans, with the idea that we may want to multiply this production to 100,000 or 200,000 tons of synthetic rubber.

The RFC accepted this decisive recommendation. On May 21, 1941, the interested companies [25] were called together to settle technical details. At this meeting the suggestion was made of bringing in a top engineer as technical consultant or to supervise, coordinate, or run the program. The suggestion was seed thrown on barren ground. The program was to remain in the hands of the Government bankers. It also emerged at this meeting that a main objective of the immediate program would be merely to test and choose between available products and processes as a basis for a major expansion (time, however, was not to indulge us with this further opportunity for experimental evaluation). All plants were to be wholly financed and owned by the Government through the Defense Plants Corporation. All plants were to be built by private companies and operated by those private companies on a cost-plus-fee basis.

On June 22, 1941, Germany invaded Russia. Through the summer months the Germans destroyed Russian armies and advanced through the Russian lands. And in their islands the Japanese were preparing a surprise of their own.

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[25] Standard Oil (New Jersey), Firestone, United States Rubber, Goodyear, Goodrich, Du Pont, and Union Carbon & Carbide.

CHAPTER IV

CRISIS

Thus by the summer of 1941, the synthetic-rubber policy had taken a definite shape, and had become a program in action. It was a policy and a program now that derived from certain settled technological conceptions; with operative responsibilities divided between particular industries and even particular companies; a program which relied for its drive, incentive, technical judgments, and energies on a group of private concerns; a program that was to be financed in a settled fashion and to be supervised and held in check by the views of a particular Government agency. Subsequently this program was to be expanded, blown indeed into vast proportions. It was to be battered and it was to be modified, but it was not to be replaced. This basic pattern, assumed as a reflex to the pressures of a set of particular industrial companies, was to remain the core of all that followed.

Through the summer and fall of 1941 the Russians were pushed to the verge of defeat. The German offensive in North Africa moved forward. The Japanese threatened war. On December 7 the Japanese struck at Pearl Harbor, crippling and immobilizing the American fleet. Rapidly, Japanese sea and air power seized control of the Western Pacific. Now at war with Japan, Germany, and Italy, it was the task of the United States to create a military force and to supply the people and the armies of Great Britain and Russia so as to sustain their fighting power. Insofar as rubber was concerned, the worst had happened. The whole Far Eastern supply was about to be cut off. In that crucial December, construction had started on not a single one of the essential butadiene plants.

On January 3, 1942, the War Production Board was established with Donald Nelson as top industrial mobilizer. In the flurry of adjustments then taking place, one small item appeared which was to be of consequence to the synthetic-rubber operation. On January 7 the whisky-distilling industry was ordered to divert 60 percent of its capacity to the production of industrial alcohol. On January 12 a planned 400,000 tons of synthetic-rubber output capacity was announced. In this expanded building program, authorizations to those already in the group were increased, and other "reputable" firms were brought in. As before, these firms were allowed to choose their own processes. Thus Koppers Co., with an assigned capacity of 40,000 tons of butadiene, chose a benzol-based process. Benzol was in very short supply. Because of this shortage, 5 months later Koppers' authorization was canceled entirely.

Alcohol-based butadiene capacity was increased to only 40,000 tons of a projected 288,000 tons of butadiene, the entire 40,000 tons to be built by the Carbon & Carbide Co. At that time George Johnson, a public power engineer and leader of a Nebraska group, was making

the rounds of the Washington agencies trying to interest someone in his group's plan for converting the great grain surpluses then held by the Government into industrial alcohol and high-protein cattle feed. He could find no one in the war agencies to examine his plan or evaluate his claims. His Senator, George Norris, however, was interested in hearing him out.

For the great bulk of the required butadiene capacity, Rubber Reserve turned to the petroleum industry.

The whole petroleum industry was, at the time, tightly organized through a war agency known as OPC or Office of the Petroleum Coordinator. Harold Ickes was the Petroleum Coordinator. Although Rubber Reserve made requests and contacts through OPC, it continued to negotiate with individual companies and delegated to OPC none of its power to select, or to control and shape, the petroleum-based synthetic rubber program.

Planned styrene capacity required for the output goal of 400,000 tons of synthetic rubber, was initially raised by bringing Koppers Co. into that program. Contracted-out copolymer capacity was raised to the projected level by increasing the assignments of the Big Four tire companies.

On January 12, 1942, in a meeting of OPC, there was aired an intra-industry controversy on the technical approach to the production of butadiene which was later to be fought out in the press and before congressional committees and in a Presidential committee, and which was never quite to be resolved. Certain companies maintained that there was an insufficient supply of butylene for the projected production of high-octane gasoline for aircraft and that, therefore, rather than adding to this demand, butadiene should be made by the dehydrogenation of butane which was admittedly in plentiful supply. To this argument, Standard and its associates replied that while the butylene supply was certainly short at that time, it would be preferable to invest in new refinery techniques, such as Standard's new "fluid catalyst process" cracking units, which would increase the butylene supply, rather than invest in the equipment required for butane dehydrogenation. Thus the whole war program would be given a greater flexibility, for the aviation fuel program could be increased, if this became necessary, at the expense of the synthetic rubber program and vice versa. There were no disinterested parties in this dispute. Both sides had large patent royalties, industry influence, and byproduct markets at stake. There was no Government agency competent to review and to evaluate the dispute from the criterion of effective mobilization policy. The later dispute over the Houdry process, is related to this original controversy over the preferability of a butylene-to-butadiene as against a butane-to-butadiene route. What Houdry did was to propose an easier and cheaper process for the production of butadeine from butane. Insofar as rubber was concerned, Standard carried the day. The Jersey method became the process basic to the production of butadiene from petroleum.

In February 1942, the Russian Government, its armies locked in death struggle with the Nazis, suggested to the American Government a full interchange of information on synthetic rubber production. The Russians had been engaged in the large-scale production of

synthetic rubber for 10 years. They offered to send experts, blueprints and production data for use in our initial planning. The Russian offer was forwarded to the Rubber Reserve, who turned it over to their technical adviser, Dr. Weidlein, who shelved it. For awhile, the offer was forgotten. The Russians did ship seeds of their Kok-saghiz, as a possible source of natural rubber.

In early February, OPC officials claimed to foresee a critical shortage in butadiene supply for the year 1943, and to meet this shortage they formulated what was to be known as the quickie butadiene program. The quickie program was intended to produce at a high cost, but in a short time and with a minimal addition of new equipment, a large quantity of butadiene and simultaneously other critical chemical substances such as benzol, toluol, xylol, and isobutylene. It contemplated use of a "thermal cracking" process which was uneconomic in terms of money cost, but which was the method by which butadiene had hitherto been produced in America.

The quickie plan contemplated an operation which would no longer assign tasks to firms as though each firm were a segregated and indivisible entity. Instead, it would treat the industry as a whole complex of specialized and standardized equipment, and specialized and standardized manpower—one which could be reassorted and rationalized under OPC direction to the end of meeting the specific and special demands of the war effort. Equipment would be rented or purchased from certain refineries, dismantled, moved and reintegrated into the production scheme elsewhere. The whole work flow would be broken down with specific tasks allotted to the operating units having the ability or specific equipment to handle those tasks. Raw and semi-processed material would move from plant to plant under a central plan. Thus it would be possible to bring the small and medium-sized independents into the synthetic rubber program as, it was said, they had already been brought into the aviation fuel program. It was contemplated that, as the regular synthetic rubber plants were brought into production, the quickie plants would resume their regular refinery operations and the program would be liquidated. OPC claimed that the program could produce about 200,000 tons of butadiene, 100,000 tons of butylene, and 40,000 tons of isobutylene per annum.

About this program a number of points should be made. First, it demanded a high degree of centralized control and planning by a technologically competent body: the kind of control and planning that Rubber Reserve was in no sense competent to exercise. It was a program that could not be carried out by individual negotiations with particular firms alone, no matter how sharp were the Government bankers and no matter how statesmanlike they were in their dealings. Since Rubber Reserve was not itself able to plan for or control the petroleum (or any) industry, if a job which required such planning and control were to be done, then the job and the prerequisite powers would have to be turned over to a technologically competent agency, presumably the OPC. But Rubber Reserve was not inclined to relinquish any of its powers.

Secondly, the plan proposed that the Government offer to purchase the whole output of the individual firm, including many joint products, rather than negotiate piecemeal for segments of that output, e. g., for butadiene alone (the butadiene yield running from 2 to 5 percent

of the total). It was argued that the small refinery could not be induced to embark on the direct thermal cracking of light petroleum distillates unless an outlet were provided for all the joint products of that process. With small quantities of numerous items involved (though each was in short supply) it would be too costly and risky for the small firm to undertake the separate marketing of these individual items separately. The RFC, however, did not look with favor on such package buying and it was another 6 months before it would allow such purchases.

Thirdly, the OPC plan demanded quick action and quick acceptance, not only because the program was intended for a delimited period whose dimensions grew narrower with the passing of each day, but also because the acceptability of the program to the individual companies and the enthusiasm with which it was likely to be pushed depended upon the existence of excess refinery capacity. Once the production slack, which transportation bottlenecks and tire rationing had caused, began to be taken up and technical staffs became otherwise occupied, then the moment appropriate for launching the quickie scheme would have passed.

The quickie program was never accepted and never quite rejected. In the months that followed it continued to be one of the points at issue between OPC and Rubber Reserve.

On February 20, 1942, Senator Guy Gillette of Iowa, as a member of the Committee on Forestry and Agriculture, addressed a report to the Senate in which he accused the United States Industrial Alcohol Corp. of blocking the expansion of needed alcohol-producing facilities through its power in the WPB and elsewhere. To this blocking scheme Senator Gillette linked the Standard Oil Co. which, he claimed, controlled the industrial alcohol industry in the United States besides controlling patents for the conversion of alcohol to rubber. A committee of the Senate was set up to investigate these charges.

In March the planned synthetic rubber program was raised toward the 700,000-ton level. For this, eight new oil companies were brought into the program. Dow Chemical became the third company in the styrene program. Copolymerization capacity, still in the hands of the four large tire companies, was correspondingly increased. Not until the summer of 1942 were other tire companies to be brought into the copolymerization program.

Then General Tire & Rubber Co., large but not in the same giant class as the so-called Big Four, Copolymer Corp., and National Synthetic Rubber Corp, two cooperative companies consisting of a number of small and medium sized rubber firms, were each authorized to construct and to operate a 30,000-ton copolymerization plant.

Hitherto copolymerization plants had been built in the vicinity of tire-manufacturing facilities. This had the advantage of facilitating supervision by the central management of the tire companies. It also allowed an easy liaison between technicians concerned with the making and the blending and fabricating of synthetic rubber. For the second and third round of increases in copolymerization capacity, the value of building in proximity to tire-fabricating centers was no longer so great, for the construction plans had now been completed, the organizational plans had been worked through, the operational know-how could be further developed in liaison with the original nearby copoly-

merization plants. On the other hand as the program assumed its gigantic proportions, the economics of transportation costs became an increasingly decisive element in the location of new capacity. And it was cheaper to ship the finished synthetic rubber than to ship the raw materials required in producing it. Therefore, from the February-March authorizations onward, copolymerization capacity was scheduled to be built in the vicinity of the butadeine-producing centers.[26]

And now the investigatory committees of Congress bestirred themselves. In March 1942, testifying before the Truman committee, Thurman Arnold for the Justice Department blasted Standard Oil and its subsidiaries. He blamed the rubber shortage on the IG Farben-Standard Oil cartel. He charged that Standard Oil having developed a superior and lower cost synthetic rubber, namely, butyl-rubber, had withheld information on that rubber from the military authorities and had, by various evasive tactics, sought to keep the butyl rubber out of the Government's program so as to reserve this rubber for its own control and profit. Mr. Farish and Mr. Howard for Standard denied all. On top of the charge of blocking the rubber program, Mr. Arnold heaped the charge of blocking the high octane gasoline program, and the charge of dealings with Japan, Italy, and occupied France.

The investigations of the Gillette committee had also started and continued from March through July 1942. Their stated intention was to uncover a "plot," a "conspiracy of the monopolists," to prevent the needed expansion of alcohol-producing facilities and the "dispersion" of such facilities into the surplus-grain areas of the United States. The committee's first witness was Mr. George Johnson of Nebraska who described at length the frustration of his efforts to have the war agencies consider his plan for a synthetic-rubber program based upon grain alcohol.

The Gillette hearings provide insights into the processes of public policy formulation and decision making by the officials of war agencies. Thus, Mr. Jesse Jones, who retreated under pressure to the position that the "RFC only carries out policies and does not formulate them," was asked by Senator Gillette how and by whom the then-planned level of synthetic-rubber capacity had been set. Mr. Jones replied "I don't know that I can tell you, Senator." But when pressed by the Committee, Mr. Jones described the process of formulating this high and vital policy as follows:

> We worked out the original 400,000-ton program and kept working, and when we saw the need for more, I think I suggested that we increase it to 600,000 tons. That was adopted, approved by the WPB. Then I suggested that we go to 700,000 tons and the WPB approved that. Then I suggested 800,000 tons and they approved that, if I remembered correctly; and now I have suggested for consideration another 200,000. That has not been acted upon * * *. I will take the responsibiiity. I probably had some people with me, but I will take the responsibility.

In the course of the hearings it emerged that a number of new processes and technological suggestions had been offered to the Government, but that there was no effective instrumentality or technique for the objective consideration or impartial evaluation of these proc-

[26] Comparative transportation costs under the various location combinations are given as a part of the model cost study made on the synthetic rubber industry by E. R. Gilliland and H. H. Lavender and published August 31, 1944, in the Special Report of the Office of the Rubber Director.

esses or suggestions. The important processes which were brought to the attention of the committee were chiefly for the production of butadiene. Among these was the butylene-glycol method based on the processing of grains which had been developed by Department of Agriculture scientists at Peoria, Ill. Considerable economies were claimed for this method but it was clear that the high officials of the Department of Agriculture had not and were not urging it or pushing forward its development with any vigor.

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The role of the Department of Agriculture in this crisis is a good example of the difference between technical competence in Government, and technically competent Government. There was a high degree of technical competence in this agency, and this technical competence was employed in the provision of certain useful services. But it was not a technical competence which, wedded to the special value-structure of public choice and to the know-how of politics, could provide a basis for decisive policy formulation, for public choice, public planning, public action. Department of Agriculture scientists knew a great deal about the problems and processes of butadiene production. No mechanism existed for turning their knowledge to account in the formulation of public policy; their work and knowledge and competence were not incorporated into the function of government. In their long experiments at Peoria they had developed new processes, but they were not called upon to develop these processes in the context of the special needs and scarcities of war planning, nor were these processes tested and evaluated by any agency in the light of these needs and scarcities. Very late in the day, the then Secretary of Agriculture, Mr. Claude Wickard, submitted a report on the research of the Department covering the production of synethetic rubber from plant products including (1) the butylene glycol process, (2) an ethyl alcohol process, (3) a butyl alcohol (butanol) process, (4) an isoprene from grain via acetone process, (5) a methyl-pentadiene from grain via acetone process, (6) a norepol from soybean and other domestic vegetable oils via linoleic and lineolenic acid process, (7) a methyl acrylate from milk whey or grain via lactic-acid process, (8) and isoprene from turpentine process, and (9) a myrcene from turpentine via b-pinene process. But there is no evidence that the value of these was weighed at any stage in the formulation of policy in the context of the special needs of Government. A summary of the processes was transmitted to the Baruch committee on August 31, 1942. In a letter to Mr. Crossland, a copy of which was forwarded to Mr. Baruch, Secretary Wickard suggested that certain of these processes ought "not be overlooked." Mr. Wickard's efforts were not welcomed. Mr. Baruch wrote in reply:

SEPTEMBER 3, 1942.

DEAR MR. SECRETARY: Thank you very much for your letter of September 2, enclosing a copy of the report on butylene glycol and your letter to Mr. Crossland.

You, of course, will remember that in your testimony before the committee, you said, "The Department of Agriculture is not in a position to make recommendations as to what kind of methods should be used," and "Now, I want to make it very clear, however, that I am not recommending that you use grain exclusively or in any part for production of synthetic rubber."

Since I am sure you would not use the method of a letter to Mr. Crossland merely to make a record, we assume you want the committee to consider it as a definite recommendation.

May I add, also, my dear Mr. Secretary, that this constant shifting in position among all the agencies dealing even remotely with rubber may result in a better process—but only after the war has been lost.

Sincerely yours,

(Signed) BERNARD M. BARUCH, *Chairman.*

Mr. Wickard replied.

DEAR MR. BARUCH: This is in reply to your letter of September 4, in which you express the feeling that remarks which I made when testifying before your committee were inconsistent with statements which my letter of September 2 to Mr. Crossland contained. You refer to my statements regarding the production of butadiene from 2, 3, butylene glycol. I want to state categorically that we have not shifted our position, as you indicate we have in your letter, nor do I think that my statements before your committee are inconsistent with my letter to Mr. Crossland. I am sorry if they seem that way to you.

The Department of Agriculture is not in a position to make recommendations as to the kind of methods which should be used in the production of synthetic rubber, and I have not recommended the use of grain exclusively, or in any part, for the production of synthetic rubber unless grain offers definite advantages over other processes and raw materials from the standpoint of the speed of production and the use of critical materials. Those responsible for the synthetic-rubber program can alone make a decision on those matters and we have not knowingly ever attempted to influence their decisions.

To me it does not seem that expressing "the opinion that the 2, 3, butylene glycol should definitely not be overlooked in any consideration of the development of increased or alternative supplies of butadiene" is inconsistent with the above principles as stated in our hearing before your committee.

You realize, I am sure, that our letter to Mr. Crossland transmitting a report on the butylene glycol process was in response to a request from him of July 20. Since the establishment of your committee it has been our policy to provide you with copies of all information on synthetic rubber which we have supplied to any other agency of the Government. If this policy is not in accord with your wishes, we shall be glad to hear from you.

Sincerely yours,

CLAUDE R. WICKARD, *Secretary.*

And so was ended the meager and abortive attempt to use Government science as it should be used.

Returning to our consideration of the hearings before the Gillette committee: the Senators were informed of the so-called Polish process for the production of butadiene from alcohol; a process which, it was claimed, had been operated on a commercial scale for a number of years in Poland. The inventor, one Szukiwicz, had escaped to America and his process was now being sponsored by the Publicker Co., a large independent producer of alcohol in Philadelphia. Another was a one-step process for the production of butadiene from butane, developed by the renowned catalytic engineer, Eugene Houdry, and sponsored by the Sun Oil Co. Publicker and Houdry made striking claims for their processes and both told a tale of frustration and "brushoff" by key officialdom. Similar were the complaints of others who had come forward with technological suggestions (e. g., Fred Willkie of Seagrams Distilleries with an early plan for the conversion of industrial alcohol plants using molasses to the use of grains), and of those who had come to the war agencies in an attempt to gain a share in the alcohol or synthetic-rubber programs.

The reaction of the committee is typified by a passing remark of one of the Senators who said in exasperation and puzzlement, "They come with their organizations. They come in with their engineering plans completed. They come in with the financing. They come in with the most part of the material, but they are blocked right here."

The Senators were inclined to explain this "blocking" as due to (*a*) the favoritism of Government officials with private company connections, (*b*) vested interests intent on keeping out potential competition, and (*c*) big industry's fear of excess peacetime capacity which might bring the threat of "cutthroat competition."

It is also possible, however, to explain what appeared as "blocking and brushoff" as the result of technical incompetence—the incompetence of governing agencies which did not evaluate proffered processes or technological suggestions because they had not developed the capacity for so doing. Thus, when Houdry offered his process to Rubber Reserve, Mr. Crossland for Rubber Reserve was able only to suggest to the Phillips Petroleum Co., which he knew to be interested in making butadiene out of butane, that it might like to look into Houdry's process, impervious to the fact that the standards of company choice are not the same as the criteria appropriate to war mobilization.

This imperviousness even to the need to consider, test, and evaluate proffered processes and suggestions of a complex technological nature is epitomized in the incident in which the Gillette committee members asked Jesse Jones what he would do if or when the Publicker Co. came to him with its process and its claims for this process of quick construction time, minimum use of critical materials, and low-cost operation. To their questions, Mr. Jones replied simply, "I would not believe it."

The unquestionable contribution of the Gillette investigation had to do with the production of industrial alcohol. There were three important sources of industrial alcohol. As of 1940, most of it was made from molasses (88 million gallons), a substantial proportion was derived synthetically from petroleum (33 million gallons), and a relatively small quantity was converted from grain (17 million gallons). As for the first, sugar and molasses are imports and, hence, the supply was limited by the shortage of available shipping tonnage. The second type synthetic alcohol, is made from ethylene, a byproduct of refinery operations. To expand the production of the synthetic alcohol required complex engineering and the use of many critical materials. Nevertheless, the WPB authorized new plants to raise output from this source to 60 million gallons, which approached the practical limit of an expansion based on byproduct ethylene.

The third recognized source of alcohol was via the distillation of grains. There was an enormous grain surplus, a quantity approaching a billion and a quarter tons of wheat in Government granaries and on the farms. It was claimed, moreover, that new distilling capacity required to convert this grain into ethyl alcohol could be made quickly available with only a minimal expenditure of critical materials or high-priority equipment; that the plant used to distill alcohol from molasses could, with minor modifications, be used to distill alcohol from grain; and that the alcoholic-beverage industry had an enormous unutilized capacity for the production of grain alcohol. Thus, that industry had produced 276 million tax gallons of distilled spirits in 1936; yet, in spite of the influx of new firms and the building of new distilling capacity, it was producing only at the rate of 164 million tax gallons in 1940. It was contended that the capacity of the beverage industry available for the production of ethyl alcohol could be greatly expanded (*a*) by introducing into this industry, which was recognized

as being in large part technologically backward, more efficient operating procedures and the widespread use of new production techniques, e. g., flash distillation; (*b*) by slight changes in the Internal Revenue Code such as would, for example, permit continuous distillation or would allow the shipment of low-proof alcohol from distilleries without rectifying equipment to distilleries with the equipment required to further rectify that alcohol; and (*c*) by the installation of small increments of equipment.

Even recognizing that grain was the obvious source for a large increase in the output of industrial alcohol, there remained the question how much this ethyl-alcohol output should be increased. The answer to this question depended on the degree to which the new synthetic-rubber industry was to be based on butadiene made from alcohol rather than petroleum.

At the time of the Gillette committee, those who argued for a greater (or a total) reliance on alcohol rather than petroleum as the source of butadiene contended that the processes for the production of butadiene from alcohol were tested and proven, having been practiced on a commercial scale in Russia, Poland, and Germany for many years. In contrast, they charged that the methods planned for processing butane or butene were unproven, and represented a gamble which a nation in grave peril had not the right to take.

That the petroleum-based processes were untried and full of risk and uncertainty is undoubtedly true, although the agencies of Government may have taken small cognizance of this fact. Thus, Mr. Howard relates:

> In synthetic rubber, these first months of the war had brought all of the processes for which Standard was responsible to a crisis at once. The Buna S itself had to be turned out in the largest possible quantity as soon as possible in our small Baton Rouge plant to provide enough materials for the fabricating tests needed to help the tire plants prepare for synthetic rubber. The new butadiene process, which was to form the principal basis for the oil industry's butadiene program, was being engineered on the slimmest possible basis of laboratory tests, and we were trying hard to get better checks on these data. The butyl pilot plant, on which all Standard's hopes for the development of an immediately successful manufacturing process for this new rubber depended, was not behaving consistently. Sundays usually found a tired group of chemists, engineers, and executives from New York assembled in the Bayway refinery for a post mortem study of the records of pilot-plant runs that had come to a premature end during the preceding week.[27]

It was further argued that, since the alcohol-based process was less complex and required more easily available materials, the plants could probably be built more quickly, more cheaply, and with a lesser diversion of critical equipment and resources. This claim was to be verified by events.

Against the use of alcohol as the basic source of butadiene, it could be maintained that the money costs of the raw material in the case of petroleum-based butadiene would be less and, therefore, that the synthetic rubber could be produced at a substantially lower dollar price. If the objective had been to build a new industry for normal peacetime production in competition with natural rubber, this argument might have been decisive. As it was, it provided a full and sufficient reason for the concentration of research by Standard Oil

[27] Frank Howard, op. cit. supra, note 1, pp. 191, 192.

on this process and for the interest of the tire companies in a petroleum-based butadiene. But, in the circumstances of a war emergency, these normal economic criteria no longer held. And, particularly in this instance, relative money costs were without significance. Regardless of its market price, the surplus grain stocks in Government hands represented "sunk" costs, and any use that could be gotten from them must be counted as a net gain. Moreover, the greater utilization of whisky-making capacity for the production of industrial alcohol was hardly to be counted as a diversion of equipment skill or manpower likely to be critical, whereas, alternatively, it was probable that new demands upon the petroleum industry wold represent just such a diversion.

Clearly, in this time of great crisis, where speed of construction, assurance of output with the least technological risk, and minimum competition with other war demands were all of the essence, the argument for basing the new synthetic-rubber program on grain alcohol was a very strong one, and one, moreover, which would naturally coincide with the bias of farm-State Senators.

Nevertheless, in April 1942, nearly the entire 700,000 ton (GR–S) synthetic-rubber program was based on butadiene made from petroleum or natural-gas derivatives, with only 40,000 tons to be made from alcohol, and that to be produced synthetically from petroleum. But now the pressures of the Gillette investigation began to take effect. WPB performed a sort of miracle. In early May 1942, the Chemicals Branch found that, instead of the severe shortage of alcohol which it had previously put forward to explain its policy, there was, instead, a huge surplus. Rather than a 280-million-gallon-per-year capacity, it appeared, overnight as it were, that there was actually an annual capacity of 540 million gallons.

How this vast capacity happened to be so suddenly discovered, or, even more intriguing, how it managed to be kept out of sight so long, is a puzzle which we must leave for others to solve. In any case, on May 24, 1942, a new alcohol allocation was made to Rubber Reserve, and the share of the synthetic-rubber program based on alcohol-butadiene was increased to 220,000 tons per annum. The new alcohol capacity was in large part a substitution for the butane-to-butadiene capacity which was planned or in construction.

That month, a world-famous industrial chemist especially known for his contributions to the allied victory in World War I, Dr. Chaim Weizmann, later President of Israel, was put in touch with the synthetic-rubber authorities. Dr. Weizmann, who had been associated with research into synthetic rubber since 1910, had been sent from England by Prime Minister Churchill with the idea that he might help in planning a synthetic-rubber program here.

Weizmann had developed a new process for making grain into butadiene. In this process, the grain was converted first into acetone and butyl alcohol, and the butyl alcohol was then converted into a highly pure form of butadiene. With his byproduct acetone he proposed to make the chemical substance isoprene, which is the basic building block of natural rubber. His process condensed acetone and acetylene—

producing thereby isoprene, which is polymerized into isoprene rubber and gives a soft, malleable product which blends well with the butadiene rubber so one could use the pure butadiene for the hard tube and a combination of the two rubbers for the soft inner tube.

On May 15 Weizmann met with a technical committee including Messrs. Weidlein and Reid, who dealt with his suggestions and claims rather cavalierly. He was told then that there was no particular problem in butadiene purification, though in fact purification was to be a major problem throughout the war. He was told that there was no need for his byproduct acetone. He was told that there was no capacity available to produce butyl alcohol. Later, he insisted that existing capacity could easily be used for this purpose.[28] In his autobiography he writes bitterly of his experience:

> My first lead was a letter from Mr. Roosevelt to Mr. Vannevar Bush, then the head of War Research. I am afraid that it did not do me much good, for I soon discovered that if I was going to do effective work I would have to play the politician more than the scientist, a prospect which I found repugnant. The main question was not going to be one of processes and production, but of overcoming the vested interests of the great firms—particularly the oil firms * * * to initiate a process which had not the approval of the oil companies was almost too much of a task for any human being * * * the struggle was long and tiring * * * the vested interests were too powerful to permit a quick breakthrough.[29]

Whether one accepts or rejects Dr. Weizmann's explanation as to the reasons why his recommendations were not fairly considered, there is indeed no indication that his proposals were ever subjected to a competent technical evaluation.

The time now seemed close at hand when American armies must come to grips with those of the Axis Powers. In May 1942, American military demands were for a minimum of 400,000 tons of rubber in 1943. Civilians began to feel the pinch. Sugar and gasoline rationing began. On May 26, Senator Harry S. Truman estimated that there would be no automobile tires for civilian use during the next 3 years. Nationwide gasoline rationing as a means of conserving tire rubber was scheduled for July. Yet synthetic rubber was not forthcoming. The program had bogged down, or had failed to start. These were days of fear and tension, of frustration and suspicion, of feverish and too long delayed preparation. All this was reflected and focused in the national attitude toward rubber. Here there had been a failure of anticipation, of preparation, of organization. Who was responsible; who should be blamed? There was evidence of stupidity, of incompetence, of brushoff and blocking, of favoritism, and of injustice. Private firms, e. g., Seagrams and Houdry, which felt that their proposals or processes had been slighted by Rubber Reserve, now advertised their complaints in the public press. The Rubber Reserve was attacked by the Truman committee, the Gillette committee, and other spokesmen for Congress. Congress rose in full revolt. Under the urging of its key committees, it decided to take the rubber program into its own hands. On July 22, by a decisive vote, both Houses passed the Rubber Supply Act of 1942, setting up an agency independent of all other executive branches, and directed to increase the production of synthetic rubber from alcohol "produced from agricultural or forest products." This agency was given the power to exercise an absolute priority in obtain-

[28] The difficulty seems to have been not so much in the use of basic equipment but rather in the fact that the enzymes corresponding to the yeast used in the production of ethyl alcohol are, unlike yeast, very delicate organisms which must be treated with special care. Thus what was called for was the introduction of special fermentation techniques and purification equipment.

[29] Chaim Weizmann, Trial and Error, pp. 428–430 (1949).

ing the plants, equipment, machinery, materials, and supplies required to produce the rubber to satisfy the military and civilian needs of the United States.

This would have created, in a word, a separate executive supreme within its own sphere and answerable only to the Congress. The President vetoed the bill. In his long veto message, he pointed out that the bill would subvert the whole concept of materials allocation according to their relative essentiality in the prosecution of the war. But the President did not defend the then-existing program. He took cognizance of the "many conflicting statements of fact" and conceded that there may have been—

> serious mistakes * * * made in the past, based either on misinformation, misconception, or even partiality * * *. It may be that the present program of the War Production Board is not the best solution. If so, the facts should be ascertained and made public.

To this end and in answer to the congressional revolt, he set up a three-man committee to review the whole program and to recommend an overall rubber policy as a basis for future action. The Committee consisted of the Honorable Bernard M. Baruch, Chairman; Dr. James B. Conant, president of Harvard University; and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

The message was dated August 6, 1942.

CHAPTER V

PATENT CLAIMS AND THE INTERCHANGE OF TECHNICAL INFORMATION

After Pearl Harbor, the Government and the private participants in the synthetic-rubber program turned to the task of settling patent claims, and providing for the exchange of technical information between companies. Both were prerequisite to the creation of the new industry. A vast industrial complex must be organized, using untried techniques to produce a new product. The plant would belong to the Government. The product would be paid for by the Government. But it would be private companies that would devise the processes, build the factories, and carry on the operations. Those processes, built into Government facilities, were patented, and those who owned the rights to those patents would have a continuing claim on a share of the value of the synthetic-rubber output of Government plants. The extent of that claim must be settled. Moreover, it could not be assumed that those called upon to build and operate Government plants would themselves possess the patents or the knowledge necessary or useful in carrying out their assigned task. Consequently, it was necessary that the knowledge held by many companies should be made available to those selected to participate in the Government's program. It was not possible, however, to determine beforehand what knowledge and invention would be necessary or useful for this purpose. Some of the required knowledge and technique was not patentable but was secret, e. g., rubber-compounding formula. And the patented invention and the secret knowledge (if it was to be paid for) was not only of an indeterminate value to the yet unshaped synthetic-rubber program, but had an unknown value also outside of that program. The question was: How was the Government to acquire and make available to the participants of the program the patent rights and information that would aid them in their tasks, and how might it protect the taxpayer from excessive liability in so doing?

Conceivably, the Government could have seized the pertinent patents, leaving the companies to make claims for recompense later before the courts. This would have been strongly resisted.[30] Alternatively, the Government might have dealt with its patent problem by requiring the participants to pool their patents, with royalties to be fixed by arbitration later after subsequent developments in the in-

[30] True, the Alien Property Custodian did seize German patents, including I. G. buna rights, which Standard continued to claim as her own. An examination of this seizure of enemy patent rights might, incidentally, provide useful insights into the operation of the patent system. To what extent were German patents actually available, to what extent were they used, and what impact did this have on the level of American technology? Answers to these questions might provide us with a clue as to the part played by "promotion," salesmanship, and development in the incorporation of the patented invention into the system of technological operations. It might suggest some measure of the value of patented information itself, without the know-how and abstracted from the concreteness of working operations, as a basis for spontaneous industrial development.

dustry clarified the value of the various contributions.[31] This approach was opposed on account of the extreme insecurity which would exist as to the value of particular patents on the one hand, and as to the extent of the Government's obligations on the other.

The Government chose a simpler expedient. Agreements were negotiated with participating companies and with certain others thought to control important patents. These agreements had the following primary objectives:

(*a*) minimizing and limiting the Government's liability, and ostensibly of

(*b*) preserving the sales value of the Government-owned plant, e. g., by securing an agreement to the effect that the patents and know-how necessary to operate these plants would be passed on to postwar purchasers, and

(*c*) of insuring that the Government would have the ultimate rights to the results of the private research which was financed by the Government.

The Government arranged with these companies to pay a flat royalty for all past and future inventions that might be incorporated into the processes used in Government plants. It left it to the companies to divide up that royalty payment amongst themselves. Similarly, it left it up to the participants to arrange for the interchange of technical information between themselves. It assumed the role only of an occasional mediator.

While these patent agreements were lengthy and became highly complex, their general form was as follows: The private companies in a specified field who had patents to offer and/or who would participate in the operation of the Government-financed plants, either (1) made their patents available to the Rubber Reserve Company until some specified "cutoff" point, with the Rubber Reserve Company entitled to license these patents to its agents, i. e., to those companies who participated in the Government-financed program, or (2) the agreement simply sanctioned a series of private interchange agreements between participants with some provision that newcomers must also be made party to licensing agreements without specific discrimination against them.

It was ordinarily provided that some fixed royalty be paid by the Rubber Reserve which, when there were several patent owners, would be divided between them according to some formula. This limited the Government's liability.

A method was generally provided for the exchange of technical information, by setting up technical committees with the companies exchanging information between themselves, or through a technical adviser to whom information was to be made available on request and who, in turn, was able, at his discretion, to re-channel that information to other interested parties.

There were also vague provisions for licensing private operators who might purchase Government-owned plants, when these plants were offered for sale after the war. This was intended to preserve the sales value of the facilities.

[31] Frank Howard, op. cit. supra, note 1, p. 232.

Also, to cover inventions made under Government-financed research, it was required that—

> each operating company requesting approval and reimbursement for research to execute as a condition precedent to reimbursement, a "patent agreement relating to research work," which * * * contains a grant to Rubber Reserve Company of an extendible patent immunity under all inventions made in the course of research or development work financed by the Rubber Reserve Company within the "synthetic-rubber field." [32]

This was intended to insure that the Government would have ultimate rights to the results of private research financed by the Government.

The specific agreements may briefly be summarized.

(1) With regard to the "manufacture, use, and sale of 'synthetic rubber,'" i. e., the polymerization and compounding phase, Standard had held the key Buna S patents. These patents were seized by the Alien Property Custodian as I. G. property. Standard, however, never relinquished its claim. In 1943, however, the impasse was resolved when Standard granted to Rubber Reserve a free license for the life of its Buna S patents, with the right to "issue perpetual free licenses to everyone who cooperates with the Government in its war program and reciprocates with similar licenses under its own patents." [33]

(2) Subsequently Rubber Reserve entered into a large number of direct agreements with participating companies "undertaking to render technical assistance to the Government" wherein each company extended a general grant under its patents relating to the manufacture of general purpose buna rubber, and received in return a royalty-free license under the buna patents held or subject to licensing by Rubber Reserve. It was also required that each company entering into this agreement "give its technical information * * * under a uniform system for the collection and exchange of such information." [34] An agreement made previously for the general royalty-free grant of Buna S licenses had provided for the formation of a committee for the exchange of technical information on synthetic rubber among the parties thereto, which consisted of the Big Four tire companies and Standard. Rubber Reserve held the right to "transmit such information to other parties conducting operations for Rubber Reserve Company on a reciprocal basis." [35]

Special agreements were concluded—

(3) between Rubber Reserve and the du Pont Co. for the manufacture of neoprene;

(4) between Rubber Reserve Company and Thiokol Corp. for the manufacture of thiokol; and

(5) between Rubber Reserve Company and Standard Oil for the manufacture of butyl.

In view of subsequent developments in the synthetic-rubber program only the butyl agreement need concern us. The Rubber Reserve and its agents were licensed under all of Standard's patented inventions made prior to 6 months after the termination of hostilities. All licenses were royalty-free for the duration.

> Royalties payable thereafter * * * are on a sliding scale, dependent upon the cumulative total of butyl rubber theretofore manufactured by Standard Oil * * *

[32] Rubber Reserve Company, Report on the Rubber Program, 1940–45, p. 33.
[33] Frank Howard, op. cit. supra, note 1, p. 235.
[34] Rubber Reserve Company, op. cit. supra, note 32, p. 73.
[35] Id., p. 71.

and licensees, such royalties being 5 percent of net sales until such total exceeds 100,000 long tons, 4 percent thereafter until such total exceeds 200,000 long tons, and 3 percent thereafter * * *.[36]

Provision is made for extending to licensees—

technical information * * * upon payment of reasonable compensation.

(6) On September 5, 1942, a general agreement was completed between the Rubber Reserve Company and a number of oil and chemical companies, pertaining to the manufacture of butadiene. Here, neither direct licensing to Rubber Reserve nor any system of general licensing was provided for. The parties each agreed to accept a ceiling royalty out of which their claims would be settled, and agreed to offer to each other and to newcomers information or patents on nondiscriminatory terms. Technical information was to be obtained through the medium of a technical adviser who could transfer or withhold such information as was "in his opinion * * * necessary or desirable." As Rubber Reserve described the agreement:

No direct licenses to Rubber Reserve are provided, the purpose of the agreement being to effect interchange of technical information and to provide for a system of interparty claims for use of technical information and patents under a ceiling royalty * * *. The agreement provides for licensing new operators of Government-built plants on reasonable terms and conditions not less favorable than those being offered to others * * * the agreement makes general provision for separate licensing to cover incidental products at reasonable royalties.

* * * Rubber Reserve agrees to pay each butadiene supplier one-eighth of 1 cent per pound of butadiene supplied under any agreement providing for payments specifically based on cost of production, the purpose of such payment being to provide a limited fund available for settlement of interparty claims * * *. These provisions remain in effect until the end of the national emergency * * *.

The parties are required to submit their technical information to a technical adviser * * * having the right to transfer any portion of such technical information to another party as in his opinion is necessary or desirable.[37]

(7) This general butadiene agreement was supplemented by a—

substitute agreement regarding exchanges and use of technical information and patent rights under oil industry processes for production of butadiene—

the parties to this agreement being Standard, Shell Oil (and M. W. Kellogg Co.), Phillips Petroleum (and the Lummus Co.), Universal Oil Products, and Rubber Reserve. The agreement covered catalytic dehydrogenization and other processes. It provided for no direct licenses to the Rubber Reserve Company. Exchange of licenses between oil-company parties under this agreement were to be royalty-free. New suppliers and new operators of Government plants would be licensed at the request of Rubber Reserve. New licenses would pay—

one-eighth of 1 cent per pound of butadiene manufactured for Rubber Reserve during the term of the general butadiene agreement; three-sixteenths of 1 cent per pound of butadiene manufactured for Rubber Reserve Company thereafter; three-eighths of 1 cent per pound of butadiene manufactured by licensee for its own use or sold or delivered to others than the Rubber Reserve Company or its nominees.[38]

The agreement provided for the direct interchange of information between licensors and licensees.

[36] Id., p. 77.
[37] Id., pp. 78, 79.
[38] Id., p. 80.

(8) An agreement pertaining to the exchange and use of technical information relating to the manufacture of styrene was concluded on March 4, 1942, between a number of oil and chemical companies and the Rubber Reserve. As under the general butadiene agreement, no direct license to the Rubber Reserve was provided for, but a ceiling royalty was agreed upon to be divided among private company participants according to a system for the settlement of interparty claims.

The system for settling interparty claims in both styrene and butadiene production followed the same general pattern. A set payment was made by the Rubber Reserve to each producer of styrene or butadiene, per pound of material produced, to cover all royalty on inventions pertaining to the production of those materials. Companies might then institute claims against each other for the sharing of this quantum of royalty payments. Settlement of these claims was to be facilitated through the mediations of the technical adviser and, if that did not work, through formal arbitration under an arbitrator agreed upon by both parties or selected by the senior judge of the District of Columbia Court of Appeals. The pattern of settlement thus arrived at was not to carry beyond the period of the agreement.

As for styrene for the account of Rubber Reserve, the ceiling royalty was set at one-eighth of 1 cent, and when produced for others at 5 percent of the actual sale price of the styrene so produced. The agreement was not to extend beyond the period of national emergency. New operators of Government-built plants were to be licensed at one-eighth of 1 cent per pound of styrene produced for the account of Rubber Reserve during the term of the agreement and 2½ percent of the cost or sale price of such styrene manufactured thereafter, and 5 percent of the sale price of styrene produced for other purposes at any time. Technical information was interchanged via the medium of a technical adviser.

(9) On July 3, 1942, an agreement was reached between Rubber Reserve and the four largest tire producers, pertaining to the exchange of technical information and patent rights relating to the compounding of synthetic rubber. Patents were licensed to Rubber Reserve which in turn licensed each of the other parties. Licenses and immunities were to be royalty-free. A technical committee was set up to exchange technical information and "to advise the Rubber Reserve Company in respect thereto."

(10) Other special agreements covering specific patents or materials, and providing for royalty payments, were developed with Goodyear Rubber & Tire, United States Rubber Co., and du Pont Co.

(11) A series of agreements was also developed covering inventions in synthetic rubber made in the course of subsidized research conducted by companies and universities. The purpose was to secure free patent rights, in return for such research subsidies.

So much for the terms of the patent agreements. They did afford a basis for some technical interchange. They defined the Government's obligations to private parties, and minimized the area of subsequent patent conflicts and possible litigation during the term of Government ownership of the synthetic-rubber industry. They did provide a quick means for new operators to take over complex operations for Rubber Reserve without protracted negotiations with private patent holders.

On the other hand the nature of the agreements reflect the essential technical incompetence of the Government agency, and its indifference to the problems of economic organization and technical choice. That agency was primarily concerned with the Government's royalty obligations during the period of emergency operations, and left it to the (generally) small clique of large firms composing the inner circle of the controlling group to deal with other aspects of the problem.

Whether Rubber Reserve succeeded in minimizing the royalty obligations of the Government is not easily determinable, since neither it, the companies involved, nor anyone else has explained the criteria used in determining the adequacy and reasonableness of royalty payments.

The provisions made for turning over techniques and patents to private operators upon sale of the plants were vague to the extreme. The guaranties to assure the vaunted "reasonableness," in terms offered to those who might purchase Government plants, were virtually nonexistent. This indifference to future disposal problems may be understandable and excusable in the light of the extreme emergency conditions under which the agreements were formulated. Less understandable was the failure subsequently to clear the decks of patent claims so as to facilitate the ultimate sale of the Government plants. On the contrary, each fabricator was able to change his techniques, operations, and the organization of the plant which he operated, incorporating into operations the patented modifications which would enable him to retain a favored position with regard to the purchase of that plant.

Similar indifference on the part of the Government agency was evidenced in the arrangements made for the interchange of technical information. This also was virtually left to the private operators. Where there were a few big companies, they set up a technical committee to interchange information between themselves. As long as only they themselves were concerned, this worked well enough. But when larger numbers were involved, and especially where outsiders moved into the circle of the synthetic-rubber operation, the system for the interchange of information through the medium of the technical adviser proved utterly inadequate. Data in possession of a given company, and which might be used to raise the level of the operating efficiency of others participating in the program, could not be searched through. One company had to know of the existence of particular data in the possession of another, before that information could be requested. Each request must be specifically justified. The newcomer into the orbit of the Government operation was especially disadvantaged. But more, the idea of pooling knowledge as a part of a conscious and positive effort to facilitate efficient operations in a period of crisis was set to naught. The inherently inoperative nature of the system is further attested by the fact that all requests must be processed, all demands on companies made, all the mountains of technical information that might conceivably be interchanged must be channeled through, and at the discretion of a single technical adviser, the same one for each of the agreements—a man who must also act as arbitrator in all patent disputes and who simultaneously, was also part-time director of the Mellon Institute in Pittsburgh and part-time technical consultant (and one-man technical staff) of the Rubber Re-

serve. Obviously, little time could be spent wearing the hat of technical adviser.

During the months of crisis, this system for interchanging information was to be subjected to severe attack by critics of the program, and by firms that considered themselves shut out from the inner circles of control.

The butadiene and styrene agreements not only did not encourage the interchange of information for the mutual improvement of processes; they actually created a positive financial disincentive to such an interchange, and to the consequent development of the most efficient unified process. These agreements provided for the payment by the Government of the manufacturing costs plus a flat royalty fee for each pound of rubber produced. The royalty paid by the Government was to be divided up between the companies by an agreed-upon formula. This division was intended to reflect the relative use made by the participants in the program of the patented processes owned by the various companies at the time of the agreement. It was, for example, the intent of the agreement that if Company A used processes owned and patented by Company B exclusively, then the royalty received from Rubber Reserve by A, for each pound of rubber produced, would be turned over to B. Hence the more that a company used the patented processes of others, the larger the proportion of the royalty fee received by it from the Government which it must share with others. The more that it relied on its own processes, the less was it liable to share its royalty income from the Government. If, subsequent to the agreement, one company switched to the use of processes patented by another, the latter could then claim an increased share of the former's royalty fee from Rubber Reserve. Therefore any adoption by a given operator for his own use of the processes of other operators involving patented techniques would jeopardize his share of the royalty fee. The operator, in other words, had no financial incentive to adopt better processes patented by others, even though this might lower his costs (since Government payments covered his costs), but had a financial incentive to avoid their adoption since to adopt them would threaten his settled royalty share.

More serious than the inadequacy of the system for the interchange of information was the failure to provide stimulus and direction to the future progressive development of the synthetic-rubber technology. This was a double-headed failure. First, the Government agency in charge failed to recognize the need to choose between alternative directions of research and to evaluate the results of research on grounds other than those dictated by private company self-interest. Therefore the Government did not evolve the criteria nor develop the special competence required for this sort of cognition and choice at the level of national planning. Without this competence (and indeed without even recognizing the need for it), the agency in charge could not organize research on its own account nor could it direct and evaluate private company research by reference to the criteria appropriate to strategic planning. The Government relied on private-company research, plus smaller projects carried on in universities and some research institutions. The Government paid, but it was not equipped to judge the value of that for which it paid. Second, relying on undirected private research, the Government failed to impose a system

of incentives, with a sting or with a promise, that might spur the progressive development of the synthetic-rubber technology. Research contracts were made and the payments may be presumed to have been adequate. But payments were tied into efforts measured by costs and not to results. There was no financial premium on accomplishment, no financial loss through failure. Aside from the specific research contracts, the general royalty payments were tantamount to a research subsidy since they were conceived of, not only as a payment for the right to existing patented inventions, but also as a payment for the right to future developments patented and incorporated into the processes of the companies operating for the Government. Thus, the companies received a flat payment covering royalties on past and subsidies on future research; that payment remaining the same whether the individual company subsequently developed new rubbers, improved existing rubbers, developed cost-reducing techniques, or did nothing at all. After the patent agreements were signed, no way existed for the private company to benefit from its contributions to cost-saving or new-product development, whether such contributions were developed under research contracts with the Government or by its own research under its own initiative.

There was evidently a fundamental misconception which underlay from the beginning the organization of synthetic-rubber research by the Government, and which persists today in the relationships of Government to the organization of research under private agencies. Incentive was confused with payoff. It was implicitly assumed that if private agencies or individuals were sufficiently subsidized, creative development would be forthcoming. The objective was taken as that of satisfying the demands of private parties. What ought to have been at issue was, not whether private companies were satisfied by a system of payments, but whether that system would drive them to a greater technological endeavor. Creative achievement and significant technological advance, the processes that go by the names of invention, discovery, and innovation, are never a simple function of laboratory time or the number of doctors of philosophy assembled in the same building, and certainly not a mere function of Government subsidy.

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CHAPTER VI

THE RUBBER SURVEY COMMITTEE

The three-man Rubber Survey Committee (sometimes called the Baruch committee) set up by the President on August 6, 1942, in response to high national crisis, started work at once. A staff was brought together; a field survey was organized; hearings were held, sometimes several simultaneously before subcommittees separately chaired by Mr. Baruch, Dr. Compton, or Dr. Conant. Reports were submitted from all sides.

The Attorney General's brief included a memorandum from Mr. Thurman Arnold dated July 1942, which summarized its findings and conclusions as follows:

1. There is danger that under the present program rubber production in 1943 will fall short of 400,000 tons. If *so, it will be due to the shortage of butadiene.* For example, *because of this shortage, the completed plants of Goodyear and Goodrich today are able to operate at only 10 percent capacity.*
2. Buna rubber now being produced is of inferior quality, and has been rejected for military purposes.
3. The methods adopted for production of the principal supply of butadiene are entirely untested.
4. Alternative methods proposed by corporations outside the Standard Oil group are being rejected even though they require less critical materials.
5. These decisions are influenced by individuals in key positions in the Government who were connected with the CRA patent pool, which, in turn, was a part of the I. G. Farben cartel. This cartel had a settled policy of preventing outsiders from producing rubber. Today they have every interest to acquire domination of rubber production for the CRA group for the following reasons: (1) Such control would enable them to cover up their past sabotage of rubber production and their misrepresentation to the Government; (2) such control is part of a settled and continuing policy of this group to monopolize the industry, control future production, and eliminate independent competition. The names and connections of these individuals are given in the memorandum.
6. All decisions of this group where experts differed have been in favor of the dominating position of Standard Oil Co. (New Jersey).
7. No contracts have been made not in the interest of this group except after public pressure—as for example the alcohol program.
8. No independent check by experts in a disinterested position has ever been made for the guidance of the nonexpert Government officials who make the decisions.

CONCLUSION

At the very least there is the *appearance* that former CRA officials influence the decisions relating to the rubber program in spite of unimpeachable evidence that they misled the Government in the past. Charges made by responsible persons go much further than that. They claim CRA has established air-tight control and that pressure is being exercised to keep outsiders from taking part in the rubber program. These charges are supported by a substantial amount of circumstantial evidence. It would be inappropriate to investigate this evidence by the usual grand jury procedure. Nevertheless, it is not safe to ignore it.

Many responsible complainants who have come to the Antitrust Division have urged the need for a check on the rubber program by experts without any entangling connections with the Standard Oil group. Such a suggestion has the

following reasons to support it, even though the conclusions stated in this memorandum prove to be wrong:

(1) It would remove the present basis for the charges that the rubber program is dominated by an interested group.

(2) It would relieve the present bitterness of responsible business men who now sincerely believe that their claims are being rejected by a thoroughly partisan set of experts.

(3) It would be a defense against attacks by congressional committees who justly feel a lack of confidence in the CRA group after the disclosure of documentary evidence showing that they had been working against our national interest.

Whatever the cause, the facts were that styrene contracts had been let to only a few great firms; that copolymerization capacity was concentrated in the hands of the Big Four tire companies; that the so-called CRA group held a perhaps dominating position on the petroleum side of synthetic-rubber production; and that officials of this group held positions of power in the war agencies.

The record, as we read it, does not indicate that the great companies took over the synthetic-rubber program in a conspiracy to further their self-interests. They dominated the program because they had created it. No agency in Government had taken the initiative or had been capable of so doing—or was now capable of truly evaluating that program or of truly reshaping it. To the companies should go credit, not blame; yet, there were great dangers inherent in this surrender of the essential war function of centralized social planning to the interplay of corporate pressures.

Technical competence is not abstract but is always rooted in a complexity of values, objectives, and points of views. The technical competence of the company engineer is deeply rooted in the objectives of his company and the universe of value relationships which is characteristic of his industry, and that competence cannot be relied upon for evaluation that stands on criteria of social weal and strategic strength. Nor can that competence be easily and quickly transformed into the competence appropriate to the processes of government.

The constant conflict, even at the simplest level, between the values of private and public evaluation is evidenced in the following portion of a memorandum, dated August 17, 1942, written by Mr. Lubell for the Rubber Survey Committee:

> Mr. Madigan, who is apparently in charge of constructing the butadiene and polymerization plants, raised the question whether the plants are to be constructed with postwar industrial use in mind or are to be built with the idea that they may have to be replaced in 7 or 8 years. He said that the decision of this question was of great importance in determining the amounts of materials which would be needed. * * *
>
> Madigan's question led to a general discussion as to the designing of the plants. Newhall suggested that the degree of elaborateness of the designs frequently was directly related to the capital structure of the company which was to operate the plant. The engineering is being done by large engineering firms which have for years worked for the oil industry, and Mr. Gary pointed out that those firms do not wish to displease their clients. They expect future employment from the oil companies while they anticipate doing only one job for the Government. Gary said that the engineers for the oil companies had been educated over a long period of years to build for the future with ample safety allowances, and that it was very difficult to reeducate them to build quickly and cut corners on required materials. Eberstadt remarked that the Army and Navy Munitions Board would revoke priorities for any excessive use of materials when such excessive use were pointed out, but that unless a project were constantly followed, the engineering would progress so far along a particular line that any change designed to accomplish a reduction in material requirements would involve prohibitive delay.

The fact that private technological competence is not abstract, not objective, but shaped by the special point of view of the company and the industry is evidenced by the conflicts already witnessed between companies, within the synthetic-rubber program. The engineers of Publicker, Seagram, Standard Oil of New Jersey, Standard Oil of California, Sun Oil Co., and Phillips Petroleum Co. were all competent engineers, but they did not agree on complex "scientific" technical questions. They disagreed, not as individuals, but as company representatives. Their disagreement was not random but arose strictly on company lines. We have seen no instance, for example, where the competent Standard Oil (New Jersey) engineers, after a judicious weighing of the pros and cons, came out favoring the Houdry process for the synthetic-rubber program, or where one of the competent engineers from Sun Oil opined that the Standard Oil processes were to be preferred for the Government plants.

Moreover, where procedure or settled standards for technical evaluation do not exist, it is difficult to suppose that industrialists drawn into the Government would not, to some degree, favor those with whom they had been or hoped to be affiliated, if only because they felt they could deal more expeditiously and safely with old associates and organizations in which they had personal confidence.

To admit that such dangers existed is not a reflection on anyone. They are dangers inherent in the participation of private interest groups in a Government program—and the participation of such groups in the synthetic-rubber program was essential. The question was not whether pressures that could distort the program were there. They certainly were. The question was, rather, by what means and in terms of what standards or objectives ought such pressures be checked, channelized, and controlled. But these questions can hardly be meaningfully asked about the rubber program since the administering agency did not even possess the technological competence to evaluate alternatives.

Where it was a matter of prices, fees, royalties, or ownership rights, no one, least of all the Reconstruction Finance Corporation, thought it sufficient to rely on the patriotism of the participating companies. In such matters the RFC acted rigorously to protect the Government's interest. To judge from the absence of criticism on this score the RFC and Rubber Reserve must have done the job well. Nor should we deny that the economical use of public funds is a worthwhile objective, though never a sufficient criterion for public action.[39]

But in the matter of technical evaluation and choice, the policy of the Government bankers was, simply, to leave it to "the boys." Thus, Mr. Jones summed up his views before the Rubber Survey Committee:

> We have been leaning heavily on the rubber industry and they are, of course, the people who have to do the work. When we started our rubber program, when we were asked to create a stockpile, we immediately called in the in-

[39] It was this very emphasis on money costs, this willingness to save money at the expense of the program, rather than emphasis upon getting the best program and the biggest research yield with the available funds, which accounts in part for our pre-Pearl Harbor failure to initiate a substantial construction or research program. Thus, the strange boast made by Dr. Weidlein when testifying before the Baruch committee:

"We felt rather safe with that interesting [pre-Pearl Harbor] program. At that particular time I was trying to save money for the Government. There had been an appropriation made of $50 million for that program.

"After we got through setting up that program, the total cost of the program was only $19 million. We saved $31 million * * *."

dustry and went partners with the industry and they have worked with us, had offices in our building over there, and been right with us ever since July 1940. Viles has been there all the time and we have seen the principals in the industry very, very often. We found this, that any of them will do anything that you tell them to do, but they are all interested in their business, interested in how they are going to come out when it is over; and if you find that you have got a contract that isn't clear, there is nothing dangerous about it because you ask them to correct it and they will correct it. Anybody will, because nobody is going to buck the Government; nobody with any intelligence.[40]

It was precisely in the field from which the administering agency held itself aloof and gave full rein to the discretion of private companies, namely, the field of technological evaluation and choice, that personal honesty and patriotism could least be relied on to get the desired results. The businessman knows when he is or is not giving the Government a square deal financially. But the businessman by himself does not know, for he has no way of knowing, the overall real cost of his operation in terms proper to a war economy, the relative reliability of his innovative process or the probable time required to bring it into full production as compared to other processes, the prospective conflicts with other projects or programs for equipment or raw material or the relative importance of timing, reliability, real cost, program conflicts, and so forth, in the general objective of economic mobilization.

The incident of the sidetracked Russian offer to exchange technical information, which had leaked to the press, now came to the attention of the Survey Committee. Further, it was charged that the Houdry process had been withheld from the Russians who wanted to buy it. Thus, from the brief of the Justice Department:

6. At the request of the War Production Board, the officials of Lease-Lend requested the Russian Government for information on their butadiene-rubber processes. When the Russians stated they would agree to an exchange of information, this was taken up with Mr. Weidlein of Rubber Reserve, who refused to allow any exchange for the reason that the rubber program at that time was formulated and fixed, no deviations were possible, and the Russian information therefore would be of no value to us. Mr. Weidlein, thereupon, refused to allow any information to be transmitted to the Russians.

Mr. Jesse Jones summarily dismissed the whole question of an interchange of technical information with the Russians. On August 19, 1942, he testified before the Committee as follows:

Dr. CONANT. I am wondering if I could ask you about this whole question of the Russian process. I take it that when you decided to expand your program, you decided not to go into the Russian rubber because it was different from the Buna S. Is that correct?

Mr. JONES. I never heard a great deal about the Russian problem. There was a suggestion that we exchange processes or technical advice. I think that it was finally decided to exchange tires, 50 tires each, and then if either one wanted to get any technical information, it would follow that, after experience with the tires. I think the tires that have been sent have been sunk and I don't think we have gotten any. I don't think they have had any from us.

Dr. CONANT. As one looks at it now, one would think that possibly you would have turned to the Russians after Pearl Harbor or Singapore since they had been making synthetic, and imported and developed the industry. Do you know whether that was considered?

Mr. JONES. I never heard of it.

Dr. CONANT. It wasn't in your plans?

[40] Verbatim transcript of proceedings, August 19, 1942, p. 38. This transcript is hereinafter cited as "Proceedings," with the chairman as of that time indicated where appropriate.

Mr. JONES. Not discussed.

Dr. CONANT. If it had been discussed, do you suppose it would have been Newhall, or Weidlein, or Crossland?

Mr. JONES. I suppose probably Weidlein and Newhall or Weidlein and Crossland. All I know about it is just what I have seen.

When Dr. Weidlein was questioned on the incident, he gave no clear-cut answer to the question why he refused or neglected the Russian offer to exchange experts and information. He offered the opinion that we were far ahead of the Russians in the blending of rubber and made better natural-rubber tires than the Russians did, and that the people in industry—

were a little dubious * * * might have made it harder to get industry to cooperate.

Rubber being of crucial importance, we could ill afford to refuse an offer of cooperative assistance. Moreover it was reasonable to assume that the Russians, with their long experience in the field, would have had something to teach us in our initial and basic planning—if at the Government level there had been any initial and basic planning, or if at the Government level there had been any instrument for evaluating the technological suggestions, plans, and processes which might have been offered by the Russians or of incorporating such plans, processes, and suggestions into the program.

The Baruch report made a major point of the fact that "Russian help not asked." It found the "failure to obtain detailed technical information concerning the experience of Soviet Russia in making synthetic rubber" an "example of inexplicable administration," and suggested that "every effort ought to be made to obtain this information." [41]

Under this directive a mission was sent to Russia in December 1942 to gather information on Russian experience. By that date, whatever chance there may initially have been, the opportunity for a fruitful interchange had gone by. We are told that by now there was deep bitterness, tension, and suspicion between the allies on the issue of a delayed second front. Dealings were at arms length and negotiations were carried on with difficulty. The matter, now at the tertiary level, was left to the obtuse and regulation-bound handling of the lower bureaucracy.[42] In any case the mission could hardly have been

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[41] Report of the Rubber Survey Committee, September 10, 1942, pp. 13, 50–51 (hereinafter cited as "Rubber Report").

[42] This is illustrated by an incident on our side related by Mr. Frank Howard in his book, Buna Rubber, op. cit. supra, note 1:

"* * * the first Russian inspection party headed by Mr. P. S. Makeev, Vice Peoples Commissar and Chief, Rubber Mission U. S. S. R., arrived in Baton Rouge on October 27, 1943. Colonel Dewey, who had now succeeded Mr. Jeffers as Rubber Director, had proposed that, while in Baton Rouge, the Russian mission be given the opportunity of seeing something of the rubber plants there. This courtesy was intended by the Rubber Director to be in the nature of a return for the limited privileges extended to the American mission and to aid in his negotiation for a more complete exchange of reports on synthetic rubber. It required an authorization from the U. S. Army Intelligence, which he was to obtain and which Mr. Makeev, before leaving Washington, understood would be waiting his arrival at Baton Rouge. Due to some new general regulation by the Army on 'courtesy visits' to war plants by allied missions, the Rubber Director was unable, however, to obtain clearance from the Army for the visit to any other plant than the alcohol plant, which was covered in the detailed agreement. The result was that Mr. Makeev and the members of his mission were already in Baton Rouge expecting to see the rubber plants and Standard's local management was not authorized to permit the visit" (pp. 228–229).

By long-distance telephone to Mr. Stettinius, the Under Secretary of State, and through him exerting pressure at the highest military level, Mr. Howard was able to get the Russian mission permission to make that "courtesy" tour.

"The incident suggested," Mr. Howard concludes, "that perhaps a part of the difficulty which the American mission had experienced in Russia might have been the result of tangles within the Russian bureaucracy * * *" (p. 230).

much more than a token gesture. For by this time, a full year after the offer, our technology had advanced far on its own route, our program was fixed and our processes were frozen. The mission returned in March 1943. Rubber Reserve reports that the—

information obtained as a result of the trip has made no material contribution to the synthetic-rubber program in the United States.[43]

The Office of the Petroleum Coordinator aired its grievances before the Survey Committee and asked again for a greater share in the control over the general organization of the petroleum processing side of the new industry. Judging from the testimony of OPC members, Messrs. Gary, Brown, Davies, and Wilson, the crux of the conflict was the alleged technical incompetence of the RFC as the agency governing the synthetic-rubber program:

DR. CONANT. If I may ask this question—I may ask questions, by the way, which you don't want to answer or you might want it off the record, so feel free to—do you feel that on the whole the organization between the OPC on the one hand and Rubber Reserve on the other has been as satisfactory as it could be?

MR. GARY. Candidly, no—primarily for the reason that our activity has been one of a technical nature while theirs has been one more of a banking nature.

DR. CONANT. There hasn't been any overlapping of technical staff but it has rather been, then, a deficiency of technical staff on the part of Rubber Reserve?

MR. BROWN. Overlapping. We haven't been in the banking business but they have gone in the technical business.

DR. CONANT. They haven't got a big technical staff, have they?

MR. BROWN. They have done an awful lot of work in dealing directly with refiners.

DR. CONANT. Who are the technical men there?

MR. BROWN. Until March there weren't any that I ever saw.

MR. GARY. With the exception of Dr. Weidlein himself.

MR. BROWN. Of course, he was there in a general capacity. In March Mr. Dearborn of Texaco came there. Shortly after that he brought Fred Pyzel and Rufus Savage. They have some supernumeraries over there in the office. I think as far as the technical staff is concerned, those are the only three.

* * * * * * *

MR. DAVIES. I would like to add to that, this: that whether Rubber Reserve did or did not have a technical force, it has been my observation that they pass technical judgment. They pass judgment on technical questions and to the extent that that has been so there has been conflict. To the extent that it continues to be so, there will be conflict, delay, and generally unsatisfactory operating arrangements from the standpoint of the agency that is attempting to direct the operations of the refineries and the other units of the industry. I think you mention there something that we should frankly say is definitely serious in terms of the rubber program.[44]

But if Rubber Reserve was without technical competence, the technical competence of OPC also had serious shortcomings. Theirs was the competence of the oil producers, not a competence based on the values of Government and integrated into the processes of Government. Thus, when Dr. Conant asked the vital question in terms of which the choice between alcohol and petroleum must ultimately be made, concerning the danger of "conflict between the present Rubber Reserve program and the high octane gasoline program," he received a reply in technical double-talk that contained no answer, but revealed

[43] Rubber Reserve Company, op. cit. supra, note 33, p. 36.
[44] Proceedings (Dr. Conant, Chairman), August 29, 1942, pp. 4, 5.

the stubborn drive of the oilman to keep activities within his own bailiwick and to protect his markets:

Dr. CONANT. * * * Now if I may jump to a problem which has come to our attention—alleged conflict between the present Rubber Reserve program and the high-octane aviation gasoline program. Do you feel there is any danger of a conflict there?

Mr. BROWN. I would like to start to answer that but would like to call on my associates here to augment what I may say.

As the program is now laid out in Rubber Reserve, skipping what might have been if they had done something else, talking about it as it is now, they are only going to use butylenes as a raw material at Port Neches, Sinclair, Houston; Cities Service, Lake Charles; and on the coast, Shell, Los Angeles. At Port Neches there are 5 refineries involved; at the other points only 1.

Mr. WILSON. At Sinclair, Houston, there are 3.

Dr. CONANT. How about Standard Oil of Louisiana?

Mr. BROWN. That is Standard Oil of Louisiana at Baytown. So any conflict that would exist could only exist with respect to those certain refineries.

Now we can cut down some more, because two rubber people who are going to supply Port Neches with butylenes are going to put in equipment specially to make butylenes. I don't know whether you can call that a conflict or not. We have a shortage of hundred octane. If we had the equipment to alkylate those butylenes and had the butylenes, then we would have some more hundred octane. On the direct-approach basis, those people are putting in equipment specially to make butylenes; they are not reducing their hundred octane nor changing hundred octane. So it gets down to a very small invasion, if any, on butanol—not talking about Buna rubber. I think our people estimated a total possible 2,000 barrels a day.

Mr. WILSON. Exclusive of Standard of Louisiana at Baton Rouge and exclusive of Humble Oil, of which we did not have information, but including the 8 companies—3, Sinclair, Houston; and 5, Port Neches—we estimated 2,000 to 3,000 barrels per day.

Mr. BROWN. That would be about 1 percent conflict.

Mr. WILSON. It seems to us quite small.

Dr. CONANT. We have heard that the Army might greatly increase both the quantities of the high-octane aviation gas and their specifications which bring it into a new area. Would that open up any possibilities of conflict?

Mr. BROWN. I don't think it could, because whatever the rubber program had stolen, as it were, is all that would have to be replaced. The fact that you needed, say a hundred thousand barrels more a day—which we believe we do—that is just a factor that would have to be provided through the refinery conversion program or new equipment. It doesn't have much to do with the little stealing taking place on the gulf coast.

Dr. CONANT. In terms of the whole high-octane aviation gasoline program, it is your feeling that the butadiene is so small that it couldn't conflict?

Mr. BROWN. As the program is today, we are satisfied. One of the reasons we are satisfied is not a technical reason; that is, that we have to build hundred-octane plants where we have got refineries and oil. True. But we want to build hundred-octane plants where the Army and the Navy want the product. In the first blush of this thing last fall we felt rather desperate about being able to get the requirements in a hurry. In heading up our program as best we could, we headed it up with about half as much production on the east coast as the Army and Navy want on the east coast; about half as much on the west coast as they want; 2 or 3 times as much in the Middle West as they are going to use there, that is on a winning-the-war basis, assuming they shipped the product away from the country; and quite a little more on the gulf coast than we are going to use there.

This is big-volume stuff; several hundred thousand barrels a day to be moving around—quite a transportation problem. So, from the standpoint of the ultimate program, if there is to be a big increase—and I think it has to be—the site selected would probably not be the gulf coast except to the extent that the refinery-conversion program would enable people to get very cheap construction materials to make it worthwhile to move it. If we want to build any more, build in the West where we are fighting the war. That is the merits of the use of butylenes on the gulf coast to make rubber.[45]

[45] Id., pp. 5, 6, 7.

The Survey Committee did not examine the structure of patent agreements. The royalty bill was being paid by the Government, and there were no complaints from private parties. Further, the Committee's interest was in the immediate production of synthetic rubber whereas the patent structure was significant chiefly for its long-range effects in terms of the incentive given participating companies within the program to develop, innovate, and discover new products or processes—and for its relevance to the problem of a final disposition of the plants so as to form a competitive new American synthetic-rubber industry.

But while there was not occasion then for complaints about the patent structure, there were serious complaints about the functioning of the system for the exchange of technical information. As usual, the information sought by outsiders was to be obtained through Dr. Weidlein, in his role as technical adviser. It tended to be obtainable only with great difficulty. Dr. Rogers, of the WPB Rubber Branch, described the situation as follows: [46]

Dr. COMPTON. May I ask a question * * *? The only group that we have run across in our study that is officially concerning itself with the development of compounding procedures by the industry, is the Technical Compounding Committee set up under the Rubber Reserve Company. This committee was set up under a contract between the four major rubber companies and the Rubber Reserve Company in such manner as to make possible free exchange of information between those companies on the subject of compounding of synthetic rubbers, making that available to Rubber Reserve, but binding the companies not to disclose information which they received under that contract to any outside source.

The release of that information was, under the contract, left within the jurisdiction of the Rubber Reserve Company, which could release it at its discretion to any rubber manufacturer to the extent which he may need it for the manufacture of goods containing synthetic rubbers manufactured in Government-owned plants, and providing that in exchange for that release of information secured under the contract, the manufacturer to whom the information was released should throw into the pool all of his information on that same article.

Dr. ROGERS. * * * As I briefly stated this afternoon, we, in the Rubber Branch, thought a program of this kind would have to be carried out, although it has only been within the past few days that we appreciated the very vital importance of it, and how it is related to the carryover of rubber and the compounding during next year.

So, on June 12, in collaboration with Mr. Carman, of the Chemical Branch, then in charge of synthetic rubber, and myself and Mr. Newhall, we called a group of the compounders together for the purpose of discussing an educational program. We had representatives from Du Pont and Goodrich, United States War Production Board, Goodyear, Standard Oil, and Firestone. We had Simmons there, President Simmons of Akron University, as an observer * * *.

We were unable to start our program then because we couldn't get the people that we needed, and it was some time before synthetics were coming into the Rubber Branch, but shortly thereafter we got Dr. Simmons and we got Mr. J. M. Bell, from the Vanderbilt Co., a dollar-a-year man, a very excellent chemist, and we began to prepare a preliminary release on compounding and the use of butadiene, styrene, and copolymer rubber. We were finding out in the meantime about this secrecy order. * * *

So we got ahold of Mr. Newhall, and he has been helpful in this. His thinking has gone along with ours, and we have not asked anything of him that he hasn't given us. We went over to see Mr. Klossner, President of Rubber Reserve, and we got him to write a letter, while we were there, to the presidents of Goodrich, Goodyear, the Firestone, and the vice president of the United States Rubber Co., in which he said that Rubber Reserve Company has been informed that the War Production Board intends to conduct a general survey of the technical survey in the use of compounding of synthetic rubber manufactured in Government-owned plants [reading]:

[46] Proceedings (Mr. Baruch, Chairman), August 27, 1942, pp. 30–43.

"In this connection Rubber Reserve Company wishes to call attention to the fact that although the agreement on exchange of technical information and patent rights relating to compounding of synthetic rubber entered into by and between Rubber Reserve Company and the four rubber manufacturing companies named therein under date of July 3, 1942, contained in paragraph 6, article III thereof, a requirement for maintaining the secrecy of technical information from the committee, such agreement contains no restriction or inhibition against the release or disclosure of such technical information as each such party may independently own or control relating to the compounding and use of synthetic rubber. Accordingly Rubber Reserve Company hereby approves the disclosure by each of said parties of technical information which it may independently own or control relating to the foregoing subject for the purpose of such release or disclosure as may be required by the representatives of the War Production Board from time to time."

After that letter had gone out, John Ball went into the field again and visited three companies, and on August 4 he ran into obstacles with United States and wired Simmons: "Temple and Cuthbertson"—they are United States men—"advise they saw Weidlein and Palmer today in Akron, that those men know nothing whatever of our plans. United States Rubber cannot release information until the situation is cleared. Leaving for Washington tonight, arrive Tuesday afternoon. See you for dinner."

It was the feeling of these men—Mr. Klossner's letter of August 4, 1942, did not give them the right to consent to release, because (*a*) no one could separate out of his material that which sole ownership could be claimed, and (*b*) there was no method suggested for material coming back from those who requested. It was agreed that we discuss the report and hold it until authority for its release might be obtained.

So we went back to Rubber Reserve and we asked for an assignment of that contract to the War Production Board. Mr. Newhall, Dr. Simmons, and I went over to see Klossner, and Klossner agreed to assign the contract to the War Production Board. * * *

We went over there—Dr. Simmons and Mr. Lynch and myself—for the purpose of discussing it with the rubber people, and we found that they had sent over four patent lawyers, Statford of United States, one from Goodrich, O'Brien, and Fraser. We discussed it from 10 in the morning until 6 at night. We carried along with us a contract which, in the place of the four companies, listed all of the tire manufacturers as participants of the contract. * * *

The two points of discussion throughout the day were the inclusion of all tire people in it, and their enlargement of the Committee. Since that seemed to be an obstacle, we came down to the decision that we were willing to trade for less, and about 10 minutes to 6—in order to leave ourselves the driver's seat—we asked the lawyers to go out and write the assignments. * * *

They left the room at 6 o'clock and we sat there until about 7:30. * * * Mr. Johnson, the lawyer for Rubber Reserve, came in and said they would like to have a conference with us down in Klossner's office. We went down to Klossner's office—Klossner, Crossland, and Johnson. Crossland said that they could not assign a contract to us, using as his argument that the Committee had been developed for the purpose of considering the problems of compounding as they were related to the problems of manufacturing. * * *

* * * Now, the next day we took that old problem up with Mr. Newhall and went over to his office, and Mr. Lynch and Dr. Simmons, and we discussed it with him. He said, "What do you want to do?"

"Well," we said, "let's initiate a program of education and development ourselves. We will invite all of the tire companies into a program, and we will ask everyone to disclose what they are doing and to exchange information on it, and we will make a condition on that, that those who are willing to do something will get Buna S for experimental purpose, and if they get it for experimental programs, they will have to report back to us what they do with it and what they find out, and we will start that ourselves."

Mr. Newhall went away with the assumption that that was what we wanted to do. That was what we were willing to do because of an obstacle. It wasn't what we judged should be done as a part of a policy of a national government meeting an emergency such as is existing today, but it was all that was open to us; but we are proceeding upon that basis. * * *

Mr. Ball then sent out a letter to the industry in which he asked for a release of this material.

Dr. COMPTON. That is the material that you had collected for the primer?

Dr. ROGERS. Yes.

Dr. ROGERS. On Monday of this week we got from Babcock, Firestone:

"I have called Mr. Vogt of Goodyear and Mr. Loomis of Goodrich, in reference to the information that we discussed in the memorandum submitted to Mr. Torrance with Mr. John M. Ball's letter of August 14. This will not include the technical information specific to tires and tubes.

"It is understood that no detailed questions relating to this subject will be answered, nor will any further detailed technical papers on synthetic rubber compounding be printed, until a definite plan for the dissemination of technical information has been decided. Very truly yours."

Those letters are quite specific. They were received this week.

Dr. COMPTON. Can that be summarized by saying that there was no objection to your releasing to other manufacturers the general information of the type which does not refer to the manufacture of tubes and tires and which was generally available in the literature anyway, but did object to release of the type of information which has been developed during, and discussed under, the terms of the secret agreement?

Dr. ROGERS. That is right. * * *

Now, it may be said that in initiating a new program like this, where there are overlapping jurisdictions, and the minds are set in one direction, that it is expected that time is to be consumed, in getting the adjustment and in getting authorizations. I submit, however, that it is so disastrous to approach situations that confront this country today, when it takes us weeks to get this far in this kind of a program. It is utterly disastrous, with only a few months ahead of us, and we have been working on this a month and a half; 25 percent of our time going for fighting that kind of thing.

Dr. COMPTON. Let me ask you two questions relating to this. Was there not, in the interval, a suggestion given to you that the matter be handled by your having two representatives to sit with this Committee so that you would get the information, but, at the same time, binding you along with the others against disclosing that information?

Dr. ROGERS. Generally, that is right; Mr. Crossland made that recommendation.

Dr. COMPTON. Why did you not accept it?

Dr. ROGERS. Because we felt it tied our hands. We couldn't do anything with this information after we got it; and that the initiative of the program was absolutely throttled, and we thought it was better to tackle the problem as we are tackling it, and either break this thing or give up the job and turn it over to somebody else.

Dr. COMPTON. One other question with regard to the release of the primer, about which you have written today. Had you discussed that primer previously with Mr. Crossland verbally?

Dr. ROGERS. I don't think so. We had very few discussions with Mr. Crossland. I presume that was so, because our people felt there was little to get from him. They were after technical information, and we had no idea that Mr. Crossland would upset the even tenor of our operations. We had got our release in systematic sequence from Mr. Klossner; first, when we asked that he write a letter telling the rubber companies that they were free to give it, and when that blocked us—each step took about a week or so—when that blocked us—then we got his consent to turn the agreement over to us, and then that was blocked a week ago Monday by Mr. Crossland.

Mr. HANCOCK. My impression from the Crossland testimony, supported by his counsel, was that, from the start, the purpose of these provisions related to the secrecy agreement was to protect the companies against the provisions of the patent law, and the prohibition of revealing secret information without adequate disclosure to the Patent Office and consent from the Patent Office; the Patent Office having assigned to the Rubber Reserve the right to grant that release insofar as the product made under these contracts was concerned. Mr. Crossland also testified, as I recall, that it would take him a very short time to put into type the agreements which have been arrived at, because he used the expression, as I recall, "He had an agreement—a contract—and he relied on the good faith of the men, and he could put it into writing in the course of an hour or so." * * *

Dr. ROGERS. There has been no time when Crossland has refused to approve the release of any information by us, because we have not submitted any information to him asking for its release. Our whole plan in all our operations is to get control of this into our hands, so the initiative could be with those who were going to operate, and so that we won't constantly be going back and asking, "May we do this?" and "May we do that?" When these compounders

come together, they are going to have to talk; they are going to have to exchange information freely, and it can't be carried out under this: "I don't know whether I can tell you this" or "I don't know whether I can tell you that." It can't be done that way, and it would be my guess that 99 percent of it has nothing to do with patents at all.

The bulk of the hearings before the Committee had to do with the choice of a process for the production of butadiene. There were many challenges, but the principal point of contention, i. e., whether butadiene should be produced from petroleum or from alcohol made out of the surplus grain, remained unresolved. George Johnson, the person who, more than anyone else, forced into the light the significance of this choice, appeared and testified again. The insight his testimony provides into the events of the time and into the problems that confront an outsider seeking to persuade a Government official, who is unable to evaluate his claims and annoyed by his unsettling proposals, justifies quoting him at some lengths:[47]

Mr. JOHNSON. * * * In the first place, we people in the Midwest, * * * if we can do it better and more economically than anyone else, we should be allowed to contribute, especially something that will fit into our economy later. I do not think that we should be placed in the position during the war where we would not be on equal economic terms with the rest of the United States if in so doing it takes more material and costs more money to carry on the war.

That is really the basis of what we have been fighting for and the things we have been considering in connection with this alcohol and rubber program, which is something that dates over a long period. We have been experimenting with the making of rubber through the butylene glycol process and the development of a more economical production of alcohol for more than 10 years, and it fits in, we feel, with our final economic program for the agricultural sections of this country. * * *

That, generally, is the plan we have been working toward, and Dr. Christianson and others have been carrying on experiments and doing work for more than 10 years to find better and cheaper ways and means of getting that job done. So, we came down here especially on this alcohol and rubber program the first week in January, and we began working with the Chemical Division of what was OPM at that time. We immediately met considerable opposition and were told that they would not allocate any material or equipment to build a new plant.

I went out and went through some of the closed textile industries up around the New England coast, and we found that the equipment was almost double of what we needed for cookers, and that those pieces of equipment could be assembled and placed into alcohol plants with very little difficulty—securing all the equipment necessary, except about 10 percent, which would be mostly reinforcing. Then they told us they would not approve any plants if we needed more than 2 percent of the material.

Well, the showing we made at that time was that, if they went ahead on their program, if they followed that program and equipped these plants for grain, they would use a considerable larger amount of material to make the conversion than we would require to put in our alcohol plants in the Middle West where the grain is grown; also, that it would take several times the amount of critical material used in transportation in transporting that grain to these plants after they were converted than would be required in the alcohol plants that we would need to use the grain in the Middle West, and, in addition, the loss of money to the Government supplying the grain would be several times the cost in cash of constructing these alcohol plants.

None of these things was given any consideration when they went into their conversion program. * * * any consideration by the Alcohol Division of WPB. * * *

And we had in mind to build these alcohol plants so that we could produce alcohol or butylene glycol and make rubber. We have been working along with the Federal Department of Agriculture. We were satisfied that our processes

[47] Proceedings (Dr. Conant, Chairman), August 20, 1942, pp. 2–20, 31–43.

were far enough along with the butylene glycol to say that it was more economical than alcohol, although we didn't want to go ahead and advocate that as our principal effort in making rubber because it was a new process, and the alcohol process was something that we had had considerable information about. It has been carried on in Russia for a great many years. We had all the details regarding the process. And, also, the Poles had developed a separate process of making rubber from alcohol, and that was fairly well known in this country, and people were here that had carried on the manufacture of rubber in Poland, and we had had conferences with them.

We felt that the manufacturing of rubber from alcohol was an old, proven, tried process and was sound, and we offered considerable criticism at the time they adopted the oil process over alcohol because we felt that no one knew where they were coming out on those processes and, also, that it would take a great deal more critical material and cost a great deal more money to construct plants and make rubber from oil as compared to alcohol.

Finally, after not getting any place from the War Production Board, that is, the representatives of the War Production Board, we contacted Mr. Stanley Crossland, of the Rubber Reserve Company, in April. He told us there wasn't any place in the rubber program for agriculture and, first, tried to make us believe that it was unpatriotic to use or consider using grain for the manufacture of rubber because our grain would be needed to feed the people during and after the war. We had about an hour's conference with him. I left a copy of the application that we had filed with the War Production Board on our plans with him, which he promised to have examined.

I said to him at that time: "Mr. Crossland, you people should know that we people out in the short-grass country know that you never will be able to get the equipment to build these plants on the program you are following; there is not manufacturing capacity enough in the United States to build the compressors you need for this program if you devote the entire capacity of the plants to nothing but your work for 1 year, and those same plants have orders now for approximately 3 years of work."

I also told him that the boilers' requirements would be such that it would take 72 million pounds of water and to attempt to get those boilers would take the entire production of those factories over a long period of time, and that it would interfere with shipbuilding and other war programs in the United States. He said it would be necessary for them to shut down other work and give us the material.

Well, in about 2 weeks after that conference, we had completed our investigations. Mr. Newhall testified—you will find his testimony in the Gillette hearings—that they were putting all of their contracts, on the making of butadiene, with the oil people, and at that time had changed all of their contracts except with Phillips. And later on, I understand, the Phillips was changed.

The PD-200 forms that were filed with the War Production Board requesting materials showed that they needed about 21 times as much steel and about 3½ times as much copper and about 100 times as much stainless steel for the processes under the contracts they had awarded as was necessary for the alcohol process. That information was secured by taking the records of the War Production Board for some of the contracts. The principal one, I think, was the Humble Oil Co. They were building two plants with the Polish process. The plans had been filed with the Rubber Reserve Company by Publicker in Philadelphia.

There were 5,853 tons of copper per 100,000 plant capacity per year for the year; 1,712 tons of copper for the alcohol process; 121,763 tons of steel, that is, carbon steel; alcohol process, 5,120 tons; stainless steel, 3,568 tons for the oil process and 25 tons for the alcohol process.

The horsepower of compressors and blowers was 58,633 horsepower, against 4,000 for the alcohol process. * * *

* * * What I am leading up to is this: You have a group of men over there that, before you get through with your investigation, you will find that, regardless of what the costs are or what the delays in the time are, their whole ambition is to have a certain group of people do this work, and I am certain that, if you go far enough in the investigation, you will find that this thing will not be worked out satisfactorily unless somebody else does it. That is the reason we came to that conclusion—the Senate committee came to that conclusion. That is the reason the Gillette bill was introduced—a group that would go in and set up this rubber program and get it done quickly. * * *

Dr. CONANT. Taking the program as it now stands and leaving aside those questions you have been speaking to, as to management of the enterprise, how do you think the program should be modified, if at all?

Mr. JOHNSON. I think the economical way of setting up this job now is to make rubber from the butylene glycol process. We went into that in considerable detail with the Department of Agriculture back in January. They have put in a great deal of time on it. The Seagram Co., under Mr. Fred Willkie, has spent a considerable amount of money and has had a large force of chemists and technicians working on it, and Dr. Christianson here has spent a lot of time on it, with others, in connection with his work, and we are satisfied that that process is complete and is the most economical method of making rubber today, as well as the quickest method of making rubber today.

In the conference I had with Mr. Nelson about 3 days before the veto message came out on the Gillette bill, he told me that if Dr. May would approve the butylene glycol process he would approve the building of some plants on the process. We immediately went back and started preparing an application. The day before yesterday, I left copies of that application with Mr. Nelson. I left them with him, personally, because I was almost certain that, instead of taking that through the usual course of applications, he would file that with the applications of Dr. May and have them examined and secure a report before it went any further. * * *

Dr. CONANT. How long do you think it would take to erect such a plant?

Mr. JOHNSON. We could have it going in 6 months. We have the boilers. In Nebraska, we have a large public-power system that we have constructed, a hydro system, $60 million. I have charge of that. Then, we bought all the power companies in the State except one, and we are negotiating to buy that now. Those companies cost $40 million. We have the spare boiler capacity in these plants. That runs about 300,000 pounds of steam an hour, both at Omaha and at Lincoln. These two plants, each of them, are capable of taking care of the manufacture of 20,000 tons of butadiene per year.

And another proposition that ties into this is the meat production. That is being affected by the shipping of all this grain down the east coast and dumping feed in the ocean. About 31 percent of all grain used for alcohol can be developed into a high-protein feed. That feed has been selling at about $40 a ton, 2 cents a pound. * * *

If we had plants where we could get this high-protein feed, and had plants in the section where the grain is grown and where we do our feeding, which is on the road between the pastures and the stockyards, this feeding program would be going on today, and you would not have this meat shortage. So, that whole thing ties in together.

We feel that, for economic reasons all the way around, these plants should be constructed where the grain is grown and where we have steam and power and at least 25 percent of the material and cost of plant already installed.

Dr. CONANT. Is it your proposal to construct three 20,000-ton plants?

Mr. JOHNSON. Two plants, one at Omaha and one at Lincoln, although there is about the same amount of steam at Des Moines, Iowa, and at Fort Dodge, Sioux City, and Topeka, Kans. So that this whole program, whatever is needed to finish out this rubber program, could be completed without putting in one single horsepower boiler capacity; and that could be done in the grain areas, without shipping any grain across State lines.

Dr. CONANT. Where could we get a copy of those complete proposals for the plant?

Mr. JOHNSON. I have it here. * * *

Dr. CONANT. You say you think those could be built in 6 months?

Mr. JOHNSON. I know they could. They can be built in 6 months from the date of the shipment of the necessary equipment.

Dr. CONANT. Well, how about the fabrication of the converters and so on?

Mr. JOHNSON. That will include the time for that. Most of that work we will do on the ground. The greater part of that will be welding, which we will do.

Dr. CONANT. Does that plan include the whole thing, starting from the grain?

Mr. JOHNSON. Yes. Taking the grain off the cars and furnishing the butadiene.

The discussion later turned to the relative merits of the butylene glycol and the alcohol processes. In this connection the following exchange occurred:

Dr. CONANT. I take it you have decided that if you were to put the rubber industry into your State you would rather do it through butylene glycol than through an alcohol plant because you think it is more economical in the long run?

Mr. JOHNSON. Yes. While Seagram's shooting for 7½ pounds of butadiene per bushel of grain, Dr. Christianson here has developed 19 pounds of butylene glycol per bushel of grain, and the conversion of that by Dr. Miller has run up to 9 pounds of butylene glycol through a separate process than being used here.

The reason we are filing this process is because we are satisfied it has been tried out and is ready to go, although if these plans were put in we would continue to work on the plan produced by Dr. Miller which we are satisfied will produce a much higher yield than this process.

* * * * * * *

Dr. CONANT. You said you wouldn't want to do it yourself, under the present arrangement?

Mr. JOHNSON. I don't believe it would be practical; I don't believe it would be safe to take private financing and go in and have to deal with men like Mr. Crossland, and those men in the Rubber Reserve Co., and have them pass on what you do. They could crucify you on your operations and your construction if you had to do that.

Mr. HANCOCK. I don't see why. I can see where the War Production Board might crucify you by not giving you material.

Mr. JOHNSON. They are in a position to change your contracts and do most anything they want to. They are also in a position to change your allocation. That is, if you start tapering off on your program, or you run into a condition where you don't need the total output of the plant. If you finance this thing privately every month or 6 months it will be necessary to make payments on that money, and if they reduce your quotas or your allotment of material you are not going to be able to do it, you are through.

Mr. Johnson was followed as a witness by his colleague, Dr. Christianson:

Dr. CHRISTIANSON. On the matter of alcohol production for alcohol as such or for synthetic rubber, we have been doing quite a lot of research in the last 10 years, particularly in Iowa State College, University of Idaho, University of Nebraska, looking toward improvements in alcohol yields, and that research has now reached a successful conclusion. We have been able to improve the economy of producing alcohol from grains.

* * * * * * *

Dr. CONANT. And you have a glycol process. If you were the dictator and you were going to make it from grain tomorrow, would you make it through the known alcohol process, or would you go through the glycol process? * * *

Dr. CHRISTIANSON. If I were dictating a policy, deciding on a program, I would use, I believe, the Polish process; and I would plan to go ahead on that basis, and I would build the alcohol plants and I would operate through converting the alcohol to butadiene by the Polish method. * * *

Dr. CONANT. How about time of construction of plants?

Dr. CHRISTIANSON. They are, after all, the same plant. Still pretty much the same operation.

Dr. CONANT. You wouldn't think there would be any appreciable difference in the time of construction of the two types of plants?

Dr. CHRISTIANSON. I think not. There is this difference in the glycol process. As I understand it: There is a great deal less copper required; steel tubes being used. I know this much, that the Department of Agriculture at Peoria could move a great deal faster if they had available equipment to go ahead with this pilot plant. They have to borrow equipment to continue their operation. It seems to me that a great deal could be done to facilitate their operation if we could make available to them the equipment necessary. I think this process, such as Harry Miller developed—he has been fighting for months to find a way to get this into pilot operation. So, your committee could do good in making available to these people some pilot plant equipment.

* * * * * * *

Mr. JOHNSON. I would like to make one statement. We have been advocating alcohol all the time, the alcohol process, until we went into it thoroughly with Seagrams as to what they had done. I am satisfied they have gone into this thing sufficiently and made sufficient development to show that the glycol process is safe and there is a considerable amount less critical material. For instance, your converters with the Polish process will need about 1,700 tons of copper, and for this process you use steel tubes.

Dr. COMPTON. Stainless or ordinary steel?

Mr. JOHNSON. Ordinary steel. And when you go into the Carbide process you use a lot of compressors, and use heat changers and a considerable amount of equipment and material that is hard to get today. I would think, if we were going to continue with the alcohol process it would be a vast mistake to expand any more on the Carbide and Carbon process because of the materials they use. And when you go through the process that is used by the Polish process, it is so simple.

Now, there is one thing Mr. Crossland has been talking about a great deal, and that is the purity of the butadiene. Now, from the Russian or Polish process, it would be very easy to get a butadiene that has less than one-half of 1 percent of acetanilide, and that seems to be the only impurity that interferes. * * *

Mr. George Johnson was as much of an outsider to the Rubber Survey Committee as he had been earlier with the Rubber Reserve and WPB officialdom. This time, he was at least listened to, for behind him stood the explosive political power of the farm bloc. The Survey Committee, in Dr. Conant's words, had to face up to the "political implications" of the alcohol program. The Committee recommended that possibly later there should be built an additional alcohol-butadiene plant (27,000 tons) and a matching copolymerization plant near the center of grain production, stating its views as follows:

The Committee recommends that the Rubber Administrator, about 6 months hence, in the light of the situation which exists regarding the best technical process then proven for the production of butadiene from grain and in the light of the need for additional Buna S then estimated, proceed with the erection of the 27,000-ton butadiene plant from grain and the associated polymerization plant. * * * If the needs for synthetic rubber and the production program are in balance, making due allowance for civilian driving, he may then cancel the erection of this additional 30,000 tons of Buna S capacity.

The Secretary of Agriculture has assured the Committee that no concern need be felt that the expansion of butadiene from grain program will interfere with our food supplies * * *.

By delaying the construction of the extra polymerization facilities for 6 months, in all probability we shall prevent a serious conflict between this eventual expansion of the Buna S program and other aspects of the war program. There is reason to believe that the shortage of critical materials will be less acute 6 to 8 months from now. This will certainly be true in regard to facilities for fabricating special chemical equipment * * *.

We recommend that these facilities be erected on sites near the grain-producing States and located on water transportation.

* * * such units should if possible be operated under the control of an independent local group.[48]

The Committee's expectation that "the shortage of critical materials will be less acute 6 to 8 months from now," turned out to be ill-founded. Public interest and congressional ire did, however, subside and, in "6 to 8 months from now," it was no longer necessary to appease angry farmers and their Congressmen. George Johnson was never given the chance to prove his vision. The Rubber Administrator duly threw the token project out of the program.

[48] Rubber Report, pp. 43–44.

The committee also heard Chaim Weizmann, who foresaw clearly the conflict between petroleum-based synthetic rubber and the high-octane fuel programs. Dr. Weizmann's testimony underlines the fact that the technical evaluation and policy decisions had to be made in the context of a strategic table of values wholly different from the table of values appropriate to commercial choice and business planning.[49]

Dr. WEIZMANN. There are two people who have been doing it, that is, the Russians and the Germans. * * *

Now, when I came here I heard that there is a Polish process. * * *

Then, since I have been here I have heard and have seen something of the butylene dry coke process, and all I have seen of it is really excellent. That is my opinion. It is very impressive. It is apparently a fermentation process. Whether you can make thousands of tons thereby as easily in a vat where they have 500, well, that is fairly certain. * * *

Then comes the isolation of butylene alcohol which I understand also is quite easy. Then comes the split, the removal of dehydration. If you get a dry acetone, then there is a split. I have seen the acetalization. The yields are good and the products are pure. Whether you have to pulverize thousands of tons of acid, whether there wouldn't arise a question of the materials out of which you have to make the vessels in order to resist acetic acid, that I don't know. But in peacetime, I would certainly go for it. It is a beautiful reaction. Perhaps I am biased. Perhaps I am biased because it is based on fermentation. But certainly it is an elegant method. The butadiene is pure, and I understand from Dr. May that it is something like over 95 percent pure. That is as good as pure. So, you have to pass judgment. I can only say that it is beautifully worked out on a small scale. But the last two operations, the circulation and the paralysis, are more sticky.

Now we come to the oil question. Here I am not on safe ground—not as safe as I was on the alcohol. I hope you will ask me all the questions you want to. I was biased, and I admit I was biased simply because I couldn't understand one thing. I thought that they had one thing to do, and that was to produce aviation fuel. They have one task. I don't know what the production of aviation fuel is today in this country, but judging by the information which I had at home before I left—and I was sent by Geoffrey Lloyd to find out the information here—the American production was something in the neighborhood of 3 to 4 million tons a year. Beaverbrook mentioned a figure but I attach very little value to Beaverbrook's figure. He doesn't distinguish between gallons and tons—but Beaverbrook's figure was something like 3 or 4 or 5 million tons a year. I assume that he meant really tons. But I do know as a fact that we were informed in London that the aim is 10 million tons, and I was further informed that that wouldn't really be enough, that eventually we will have to get up to 20 million.

Now, my brain reels when it comes to these millions, but I believe it is a formidable task in itself. It is a task which is essential for the conduct of the war.

There is another form which is not so well explored as the alcohol. The alcohol people are making it. Well, they do the pioneering and the producing at the same time, while the enemy bombs us. I thought that logically they would say, from a national point of view, that there are people who can make alcohol, and we have got plenty of alcohol in this country, so let us do that. Why do I feel so strongly about it? Not that I have any prejudice—I say at the outset that I am sure that the oil people will do it and can do it. There is no question about it. It is not a question of technical ability, but I think that it is a question of putting all of one's eggs in one basket. They have to make aviation fuel. They have to make toluol-benzol. Well, why load this rubber question on the back, however great the back may be? Moreover, from the literature that I have, the work on butadiene is not so much as in the case of alcohol. You had the jumping process there. The laboratory process on that was very well known. I don't know how far the technical points went. Why pioneer and produce at the

[49] Proceedings (Dr. Conant, Chairman), August 13, 1942, pp. 14–22, 30–32.

same time while you have your hands full with a formidable program which would tax the energies of an organization like the oil people? That was my prejudice from the beginning. It is not a personal prejudice, but purely a matter of logic. However, here they are. They have taken it on. We have passed anybody's opinion, so we have got to make ourselves at home.

Now, I don't know what the present production of high-octane fuel is in this country. I don't want to ask, if it is a military secret. But I am raising this point because they are cojoined products. Aviation fuel and rubber production are now married, I should say. One is a function of the other.

Now, first of all, about the quality side of the problem. I hope I am not tiring you gentlemen.

Dr. CONANT. It is very interesting. Go on, please.

Dr. WEIZMANN. First of all, about the quality—it was obvious that we should begin from butane. There is plenty of butane. There is butane in the form of natural gas. There is butane as a byproduct in cracking.

One thing which gave me a real shock was that after having gone the butane road of using this material—because I have no better term at the moment—they suddenly changed their policy and found that it was much better to abandon butane and to start from butylene. We should have known that before, 6 months ago. Six months is a terrible thing, I contend, and I am sure that most of you gentlemen present will agree that the only advantage of value is time. The price of grain doesn't matter. The cost of oil doesn't matter. The only thing which matters is time. It is the most precious article, and if you can make rubber which will cost you 50 cents, but in a short time against rubber which will cost you 20 cents within a long time, I would rather take the first. I am sure everybody else will do it also in the present contingency.

Therefore, starting the butane and abandoning it, and starting from the butylene, points to one thing, that this whole problem, as far as the oil people are concerned, is in an experimental state. They haven't got a set program that we could go along with. * * *

I saw [Dr. Weidlein] and he told me very eloquently, I admit, that on butane we've got any quantity of it. It is not easy to make butylene from butane, but we are doing it. I asked him then, "Why don't you start from butylene directly?" After all, what we are doing is taking the butylene and converting it into butadiene. I asked him why they don't try butylene directly. Here I was biased because I thought I could produce pure butylene from butyl alcohol. Well, he dismissed it, and when I was there—this meeting took place in his office, and I will just pick out the date here.

When I left I told them that "this is the 15th of May." I said, "remember, I am telling you that in a few weeks we will abandon this." I do not want to emphasize my qualities, which I have not, but it was perfectly obvious.

Dr. CONANT. That is, that row being the butane row?

Dr. WEIZMANN. Yes. And a few weeks after we had an equally eloquent statement that "Now we are in clover. We have any quantity of butylene. We can convert it into butadiene." * * *

Now, what is the new technique? All the plants are being revamped, and we are going to work from the beginning. Where does butylene come from? It comes from butane. It therefore had to undergo all the complex processes of purifications which it has not. It is "starved," so to say, at the source, tainted, I mean, at the source. * * *

If I may enlarge a little more on what happened. What is the new technique? I do not know whether anyone here understands it. I tried my level best to understand it. I think I understand it about 50 percent now. The new technique consists of the fact that you discard butane; you take out the butylene; we purify them. It may be complicated but we do that. Now, when you are taking the butylenes away, you are taking away something which is the basis—a valuable basis for high octane fuel. In other words, you have taken away something which belongs to Peter and given it to Paul. In order to fill this gap they say, "all right, instead of polymerizing butylene to octanes we shall polymerize amylene." Of course it is not a high octane fuel then. It may be a high nonane or decane, but it will do—and it does—it does with a lower octane with these butylenes being used up.

Now, let us attack this problem a little differently. There are four butylenes—isobutylene, alpha butylene, beta butylene, and cistrane configuration. Let me say three, for the argument's sake. Of these three butylenes, the iso is useless from the point of making rubber, but extremely useful in the making of high

octane fuel, because it is the one butylene which gives the 100 octane, hydrocarbon. So then there are two which are left. Of these two, the alpha is the best. The beta can also be used, but it is less easy to use. I mean, it is not very serious. I assume they both are good, but I would prefer the one which is the starting material.

This is all taken out, converted into rubber, and the high octane fuel—the gap is filled up by the amylenes, which obviously give you an octane number which is different in number from the real octane. It is to weigh up what is more important—all the rubber to be made out of that, or have a real fine, safe supply of high octane fuel. The gap is filled up by the amylenes, which obviously gives you an octane number which is different in number from the real octane.

Suppose you get an octane fuel—80 percent or 85 percent. When you make it up it is lead. I am not so sure whether the constant increase of the lead which is being admitted or allowed by the specification, is such a desirable thing, but from the view of the health of the aviator it is not desirable. I am speaking feelingly about it because my son is an aviator, and he always complained of large quantities of lead which is being allowed in the fuel.

Is it necessary to take away the butylenes if you can make rubber out of something else?

Now again, gentlemen, I would not like you for 1 minute to think I have anything of interest in either way. I want to see rubber, but I also want to see aviation fuel. And as these points are linked together, I am emphasizing a point that perhaps some of it is unnecessary. Then, let us push the question a little further, and this applies to all rubber. When you have your butadiene—whether you got it out of one source or out of another—we are not at home yet. We don't know. Whenever I raise the question of styrene the answer would always be "We are rolling in styrene." We are not. How do you make your styrene? "Oh benzine, ethylene, or anything."

I hear now we have to take something like 40 million gallons of alcohol, and instead of making it from methane we are going to make it out of benzine. I know the ethylene is somehow discarded. Why? Because it is impure. The ethylene comes from the same source. The ethylene has got to be pure just as the butylene has to be pure, but I assume we shall have styrene. * * * I think it will come your way. * * * We have butadiene and styrene but we do not have tires.

You know, better than I do, this problem has not been solved—that the jobbers have to mix the Buna S with a considerable quantity of natural rubber, to make pliable, soft rubber, particularly for the tires.

This brings me to the problem in which I am to some extent interested. When I advocated butyl alcohol, I did not do it in order to add another trouble to the ones that are fixed. It had one virtue and only one. It gives pure—chemically pure—butylene. It happens to be alpha butylene. That is all I claim for it. And what I suggest is, to take these butylenes and send them into the oil catalyst, and instead of them catalyzing impure butylene, see what will happen if you catalyze pure butylene. That is all I am interested in. I am not entering into a fight.

Well, it was given a considerable amount of attention, and then I was told there was not butyl alcohol, but one of the reasons was that even if you would have enough, you would produce a lot of acetones. Acetones are a drug on the market. We are swimming in acetone. We have not a drop of butylene. We do not know what to do with acetone, therefore, it is no good. You can make out of acetone, and here I emphasize the point which probably has not been brought to your attention—you can make out of acetone the one thing which will solve the problem of softness and hardness of the rubber, and that is isoprene. We are all polarized on butadiene, because butadiene is easily accessible. Supposing we could make isoprene. Well, I contend that you can make isoprene out of acetone. There are 40,000 or 50,000 tons of acetone at present in the country in storage going begging. It is a drug on the market. I would like to see your committee ordering somebody to take their coats off and convert this acetone to isoprene, whatever else happens. You will then cure your butadiene, because you do not need to have it absolutely pure. * * *

* * * It can be done and it can be done of an article which is a drug on the market. That was the second reason why I advocated the butyl alcohol. It happens to be that there is plenty of acetone, and we do not know what to do with it.

Well, one last word about how far this program of getting the butadiene progressed. What is the yield of butadiene out of butylene? I have heard of

4 yields: 50, 60, 65, and 75. This again points to the fact that the thing is not stable yet, and again you have to purify your butadiene. * * *

Again, a rough calculation would show you that a ton of oil would give about 3.5 percent of rubber. Well, it is easy to calculate how many tons of oil have to be processed in order to get the required quantity of rubber, assuming 600,000 tons—I understand the target is 800,000—200 by alcohol and 600 out of oil. It would roughly require something like the processing of 25 million tons of oil.

Now, this is not a very staggering figure for the oil companies. I may be wrong by a million or two, but that does not matter. For the sake of argument, how long will it take? It is quite true that simultaneously we make high-octane fuel—not as high as we would like, but octane fuel which can be doctored up with lead to produce 100 octane. It is quite true, but in order to determine the time lag—few know how much octane fuel is made now—the one is the function of the other—you could determine the time when really large quantities of rubber would be forthcoming such as to satisfy the supply of the United Nations—not only this country, but my country, China, Russia, or whatever it may be.

I believe it is not too pessimistic in the fact that Mr. Newhall made the statement to me—I have the record—that the real production will not be ready until 1944.

Dr. CONANT. Until 1944?

Dr. WEIZMANN. Here is the statement that was made at the Office of the British War Material Commission, to which I am more or less attached. Mr. Newhall spoke of the difficulties with which the oil process has met in the last 6 months, and has admitted that the use of butane as starting material, which we have now available in very large quantities, is fraught with so many technical difficulties that recently—that happened June 17—that as recently as a few months ago this idea had to be abandoned and all the plants for the manufacture of butadiene redesigned and changed. He then spoke of a new technique, which consists in using primarily butylene as starting material, and converting it into butadiene. At this stage I remarked that judging from articles published in Brest, and what one hears generally, the new technique consists of using butylene for making high-octane fuel. The count has been great. This apparently means, by using a C–5 cut, which is amolene and by aromatics to the high-octane fuel. Mr. Newhall said that is a fair presentation of the case, and remarked that the specifications for the high-octane fuel has been changed so as to allow an additional 20 percent for that. Mr. Pittman then remarked that having large quantities of aromatics must be required, and that is also important in relation to rubber and fuel.

At that stage I asked the following two questions: It seems to be distinctly a difficult problem in the use of butylene. The butylene is probably derived from butane. Therefore, it is tainted with the same impurities as those obtained from cracking butane directly. This was admitted as being the case. It would, therefore, seem desirable to open a new source of perfect pure butylene. Here I expressed my own point, which is easily derived from butyl alcohol by simple methods which have been practiced on a large scale. This could be converted into butadiene by any of the well-known methods, and this might constitute the quick and rational way of getting butadiene quickly. Dr. May, who was present, expressed his agreement with this view. Now Mr. Newhall said—this is another point I want to make—"This calls for a total production of 800,000 long tons of rubber."

He made, at that meeting, the remark—oh yes, here it is. "Mr. Newhall," I asked, "supposing the butyl-alcohol processes prove to be satisfactory, would there be a niche for it in the program?" Mr. Newhall did not give a definite reply, saying 'that would depend on many factors." At one stage of the conversation Mr. Newhall remarked that under the present program, considerable quantities of rubber would be forthcoming in 1944. * * *

Now, then, I admit that in 1944 to me it is unreal. I do not know what it will be like in 1944. * * *

Dr. CONANT. Your doubts are about the purity, perhaps, and the economic wisdom of the oil program. I am trying to sum up, in a few words, what you have said.

Dr. WEIZMANN. Yes, but it is too late in the day, I think, to be harsh on it.

Dr. CONANT. Oh, yes; quite.

Dr. WEIZMANN. I would say it is probably not too late to give the alcohol people a greater chance than they have had hitherto, and to have a little grace.

Dr. CONANT. That is, if I understand your judgment correctly, you think perhaps that on the program it might be wise, from your point of view, to have reversed the balance?

Dr. WEIZMANN. Perhaps it is not saying too much, but give the alcohol people another 150,000 tons. That would be, in my humble opinion, a safety measure. I am perfectly sure they can do it. * * * Well, perhaps it is wiser to consider the solution of the problem in this manner. I believe natural rubber is doomed. It is going through the same history as other things, under stress, under which we are all working, and the result will be that we shall all learn how to make good rubber, and even when the war is over, whenever it will be, and we survive it, the plantations will not come into full operation after a good many years. Perhaps they will be destroyed. It will be a rather different world after this war. Therefore, synthetic rubber will have a good chance, and the industry will be a great industry in this country, and that is perhaps the incentive for the oil people to have their hands in it, which is perfectly natural. * * *

Dr. COMPTON. The point you had made; the point Dr. Weizmann has made, first, that we would have a safety factor by shifting some of the present program over to alcohol by that process.

Dr. WEIZMANN. Yes.

Dr. COMPTON. The second point, by getting some of our supply of butylene through the buta-alcohol process, we would perhaps get a better rubber, and we would, at the same time, save something for the aviation gasoline?

Dr. WEIZMANN. I believe so. I have seen some lists of the various methods of the various distribution between aviation fuel and rubber, made up by the oil companies. I probably should not have seen them, but I have seen them, and all of the isobutylene which I would keep as the "apple of my eye" for aviation fuel, is converted into so-called butyl rubber.

Dr. CONANT. Yes; I was going to ask you—we have not talked about butylene for this type of rubber.

Dr. WEIZMANN. It may have its uses, but it is not anything like butadiene for rubber. Am I right? Am I speaking correctly? It is third class.

Dr. SHEPARD. You say it is third class?

Dr. WEIZMANN. Yes. Butadiene is second, and this would take third place. It still has its very important uses, but I am asking myself "Is it worthwhile to forego the 100-octane hydrocarbon and replace it by a rubber which is certainly not as good in quality as it should be?

Dr. CONANT. On the other hand, the proponents of the butyl rubber would say, would they not, that as a temporary, 43 stop gap, it apparently can be gotten into production much quicker and I think from that point of view it would be correct?

Dr. WEIZMANN. Again, from the safety point—instead of making 40,000 tons of butyl rubber, or whatever the program is, I would only make 20,000 and leave still a good deal of aviation fuel, because I feel very strongly on the question of aviation fuel. Gentlemen, I believe it is much easier to make 3,000 planes than to fuel them. We talk glibly, all of us. We read, "we shall send 3,000 planes over Germany." I wish we could. We would finish the war. If we could send 3,000 planes for a period of months—but to fuel 3,000 planes, in the present state of our production, is something which we cannot do.

Dr. CONANT. Well, now we could get—I suppose the Office of Oil Coordinator here must have the whole story on the aviation gasoline.

Dr. WEIZMANN. I hope so. I have tried to find something out. They either talk in millions or talk in grams. There is no middle course. I am not saying this in a facetious way, because it worries me a great deal—it really does.

When Mr. Churchill was here, he was asked by Mr. Ickes, and this story I have from Mr. Ickes himself, "How much high-octane fuel has England got?" Mr. Churchill said, "Enough for the next 2 years."

Now this answer, in itself, is stupid, although it is from my Prime Minister. It depends on how much you are going to use. If you are not bombing, it may last for 5 years. If you are going to send 5,000 bombers, say 3 times a week, it may not last long. I do not know what it meant. It was most unscientifically planned.

Then Mr. Ickes reads out from a letter where a person is worried about the quantity of fuel we have in England. Then I asked Mr. Ickes, "Mr. Ickes, have you any idea how much we have?" He said, "Yes; I have quite a good idea." That was the beginning of July. "You have fuel until July 15." I said, "Do you mean 1942 or 1943? He said, "1942".

There must be a middle way between Mr. Churchill's optimism and Mr. Icke's pessimism.

Mr. Ickes pressed a button and in comes Mr. Ickes' adviser on fuel, and he hemmed and hawed about it, and said that they might have something like half a million tons. Now assuming half a million tons—in the Cologne raid, which

lasted 3½ hours, we used up 5,000 tons of high octane. Assuming we should not go to Cologne, or not to Berlin—say we go to Hanover, which is 6 hours—we would need 10,000. Assuming we shall do it 3 times a week, we need 30,000 tons a week, 130,000 a month, and if there is going to be this problematical second front, we shall have to bomb the places where the landing is going to be for at least 1 month, with at least 1,500 bombers * * *

But the fact remains that the attention which the Survey Committee gave to Weizmann, Houdry, and others was more in the nature of a ritualistic gesture than of a realistic analysis of the alternative processes offered for consideration. The Committee showed little disposition to disentangle and resolve the conflicting claims and arguments. Following the advice of Mr. Nelson, Chairman of the War Production Board, and of Mr. Eberstadt, Chairman of the Army and Navy Munitions Board, it took the position that it was too late to contemplate any radical change in the program as then organized, the processes chosen, or the processors selected. Good program or bad, the wisest course would be to "bull it through" as it was.

Thus, the advice of Mr. Nelson: [50]

* * * I cannot overstress to you things which, I am sure, you see; that is, regardless what is eventually the best process of making rubber, and I am convinced there will be many better processes than we are now using. Many, I will point out to you now, which we have under consideration will eventually, perhaps, greatly outstrip the present program, but I can't stress too strongly the fact that something had to be done and it had to be put in operation, and we had to have rubber and we couldn't afford to take chances on new processes which had not been proved. That was my position and it is still my position.

There are still a number of things that I am sure could greatly improve this program if we had time to wait.

Dr. Conant, himself, in briefing the members of his staff as to the essential position and recommendations of the Survey Committee, prior to the staff's putting together the first draft of the Committee's report, put it this way: [51]

Dr. CONANT. Well, that is it. You see if you can figure on that, if those quick programs can really be quick and really at tremendously less cost in critical material, then you have got the upsetting of the whole engineering program.

You are going to have people like Madigan, Eberstadt, Patterson—all of whom have made up their minds and have said "What ever you do, don't make changes. This program has been bedeviled by changes." That is the banker's point of view.

Mr. MCCABE. They have just made a change.

Dr. CONANT. We can say "It has been bedeviled by changes. We can't very well go ahead and suggest queering it" and so on. I will give you that for background. It is very much in people's minds, I think.

This "banker's point of view," as Dr. Conant put it, which ultimately became the Survey Committee's position, was stated in a memorandum to Mr. Baruch from Mr. Eberstadt: [52]

"Bathtub butyl," cheap in capital investment, quick to get, should, it seems to me, be encouraged at once and vigorously. *It promises a fair tire promptly* and in reasonable quantities. The present butyl program, as recently increased by the War Production Board, appears to be in good shape, reasonable in demands on raw materials, progressing satisfactorily, and promising in its returns. I will not comment on the neoprene, thiokol, koroseal, etc., as their contributions are in special fields and not large.

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[50] Proceedings (Mr. Baruch, Chairman), August 20, 1942, p. 20.
[51] Proceedings, August 27, 1942 (briefing of staff).
[52] Memorandum dated August 9, 1942. Italics that of the Rubber Survey Committee.

Buna S: The present authorized 800,000 tons, from all indications, *will be substantially exceeded in actual production.* It is not unreasonable to anticipate at least a million tons.

The division of the Buna-S program—600,000 tons, roughly, on the petroleum base and 200,000 tons on an alcohol base—may appear somewhat out of balance. The cause is largely historical. No one seems to have realized in good time how much alcohol could be made available. It is to be borne in mind that while the capital investment and time involved in an alcohol installation are less than in a petroleum installation, from all present indications the cost of the product is very much higher in the former than in the latter. This may not necessarily always be so, if, and when, after the war, substantial amounts of cheap synthetic alcohol are made from a petroleum base.

But whether or not the amount from petroleum and alcohol, respectively, are out of balance is not the important question—the vital thing is that *we have rubber*, not necessarily by the best method or the cheapest method, *but that we actually have it in the quantities that we need it when we must have it.* Any substantial change now of important elements of the present Buna-S program cannot help but result in considerable delays and confusion and jeopardize the main objective. *The die has been cast.*

The Carbide alcohol process for butadiene seems well proven. A second alcohol process, generally known as the *Publicker process*, based on a Polish patent, appears to be operable, and it would seem to be good insurance *to give them a portion of the program*, which has not yet been done, but is, I understand, under contemplation.

There is a third process from grain, often discussed with the alcohol processes, but essentially different. This is based on butylene glycol. Experiments on this appear still to be in too early a stage to indicate what results are to be expected.

The processes for producing butadiene from petroleum, whether from butane or butylene feed stock, whether by the accepted method or the *Houdry process*, seem surrounded with a good many technical problems, but the process which has been selected for the principal petroleum butadiene plants appears to be farther advanced than the Houdry process and, therefore, its adoption seems justified. On the other hand, it would appear wise *to have the Phillips butadiene project operate on the Houdry plan, thus affording two strings to the bow.*

The main risk in the Buna S program, as I see it, is that through chasing some rainbow or other *interruptions or delays may be caused in the present program, even though every one of the Buna S plants presently being built may be out of date before going on stream.* Adherence to the present program is justified by the necessity of having the amount of synthetic required when we want it, irrespective of whether it has been produced by the most efficient and economical process then known. * * *

Butadiene has long been made from a petroleum base by the Hi-Car Chemical Co. with joint operation of Phillips Petroleum and Goodrich Rubber. None of the new plants, however, is yet in full operation. The *most advanced seems to be the Standard of Louisiana project at Baton Rouge* and that of *Humble Oil.* These are said to be coming along very rapidly.

The synthetic-rubber projects enjoy the highest priorities presently available to any construction projects. As far as I know, they are moving along up to schedule. There would, I am sure, be no objection to such further priority assistance as they might need to meet the program dates.

3. To sum up, it seems important that the approach to the problem be conservative; i. e., that *we should strictly conserve our stockpiled rubber, our reclaim, and our rubber on the road in such degree as to overlap, rather than to meet or fall short of fruition of the synthetic-rubber program. The risks of any other course might be disastrous.* The American public, in my opinion, will not hesitate in choosing between discomfort and defeat.

The Survey Committee was ready to accept the view that "any substantial change now of important elements of the present Buna S program cannot help but result in considerable delays and confusion and jeopardize the main objective," that "the die has been cast."

Thus, in the report the Committee recommended:

No changes in processes now. * * * A number of these processes have promise, but it does not believe that any one of them gives sufficient certainty of producing

more rubber quickly enough to warrant substituting it for processes already in the program.

In war one cannot wait perfection. Any weapon on the battlefield is better than the best weapon on a blueprint. The Committee recommends that the present program be pushed forward with the greatest possible speed, without further change, except that if new projects are adopted they be made additions to the present program.

* * * * * * *

The Committee recognizes that there still is room for reasonable scientific disagreement over many of the processes for making rubber that are being developed. It is quite possible, even likely, that before much of the synthetic rubber now planned is produced better processes will have proven themselves. In any new industry the processes of today are outmoded by the processes of tomorrow, and tomorrow's by those of the next day. However, our need for rubber quickly is too great to wait upon perfection; and if this Committee were to advise the newly appointed Rubber Administrator, it would say, "Bull the present program through."[53]

In the course of the testimony the technological incompetence of Government in the area of social and strategic choice was everywhere evident. It cannot be too much emphasized that incompetence implies not only a lack of knowledgeable men in the echelons of power, but, more essentially, it implies a failure to develop a special kind of knowledge; not only the lack of system or capacity to deal with highly complex technical choice, but the failure to evolve the basis, the value-criteria upon which such a choice could be made.

This failing appears in the testimony of Mr. Donald Nelson, speaking from the very pinnacle of strategic planning, who wonders himself why certain processes were chosen; who describes the accepted processes as "tested," though in fact they were the most untried, presumably because they had been brought forward by big companies; who reflects on the confused panorama of claim and counterclaim without perceiving the need for the systematic resolution of such conflicts; who tells of a course of drift guided by intuition, and of expediency built upon expediency. This is reflected in his testimony before the Committee.[54]

Mr. BARUCH. Mr. Nelson, knowing how important this rubber problem is to the whole program, we know you are giving it a great deal of thought. I wish you would tell us how it lies in your own mind.

Mr. NELSON. Be glad to do it.

I will try not to cover much of the territory that I know you have already covered from the standpoint of technical details, but we will try to hit the high spots in the picture as I have seen it from the start. This is, as you say, the No. 1 problem in our whole war production effort, * * *

* * * It was in 1940 when the Defense Commission was first established that rubber began to be a subject of consideration. The Defense Commission felt that we should be experimenting on synthetic rubber, on the production of synthetic rubber, on the compounding of synthetic rubber, so we would render ourselves impregnable as far as rubber was concerned.

After surveying—this came directly under Mr. Stettinius' jurisdiction—the situation from every angle, the Defense Commission made a recommendation that a start be made on a synthetic rubber program, which, I believe, was in late 1940 or early 1941. You can undoubtedly get at all the reasons, which I shall not attempt to cover, why the thing was not done. Although a great deal of talking was done about it, we just didn't get into any experimental work, as I saw it, on synthetic rubber, and as I see it now.

I think one of the original mistakes was made in that field in that we didn't during that time, even though we delayed them, survey all the processes of

[53] Rubber Report, pp. 15, 21; cf. pp. 39–41.
[54] Proceedings (Mr. Baruch, Chairman), August 20, 1942, pp. 1–3, 5, 17–19.

making synthetic rubber—butadiene, styrene, butyl—doing a lot of experimental work which could have been done at little expense. But that has passed and nothing can change it.

Of course, before Pearl Harbor this thing began to be active again, and right after Pearl Harbor, of course, all of us saw that everything proceeded at full speed. * * *

* * * At that time there was really no central authority handling this rubber situation. The Rubber Reserve, due to the fact it had the money and contracting power, was as near to the authority as I could point out to you. Although it was everybody's business around town, and it wasn't until the formation of WPB that really the control of the material situation, the production program as a whole, was centered in one responsibility, and I was given the responsibility.

After getting WPB organized, to a limited extent, I began then going into this rubber situation, realizing its fundamental importance, having been through the program from the very start. At that time the Rubber Reserve was contracting for various processes of making rubber chiefly with the petroleum industry. I can't say but I have tried to figure out in my mind, and have asked just why we didn't consider some of the other processes at that time, and the best answer I can give for it is the petroleum industry and Union Carbide had been more engineering—first, they had done more research and more engineering and were more really ready to put in production the making of butadiene and styrene; and the petroleum companies, of course, were the ones who could make butyl, and, of course, we were making some neoprene—Du Pont.

Now as the program progresses, I personally began looking into the alcohol processes because it interested me, particularly in view of some of the claims that it could be done faster and quicker, but still there was no engineering work done on it by anybody except Union Carbide, and at that particular time alcohol appeared to be a very scarce commodity. * * *

Then we got into the distillers * * * really begin getting them interested in alcohol * * *. About the 1st of May it began to be very clear that we had, instead of a deficiency in alcohol, * * * we might have a surplus, if we needed, of somewhere around 350 million gallons.

A meeting was held in my office on May 20 of all of the people interested in rubber and synthetic rubber. I think we had everybody there, and the survey was made at that time. The Department of Agriculture was present, Rubber Reserve, our own chemical division, Mr. Newhall, and Mr. Weidlein, and a wide group. I began to make a survey into all the processes which appeared to be in the cards at that time on this synthetic rubber, particularly in view of directing some of it into alcohol, feeling confident then that we had a surplus, or could make available the alcohol to do it. The Department of Agriculture was asked if there were any processes engineered which they felt should be put in, other than Union Carbide, for making alcohol. We couldn't find any. Publicker had done some work with the Polish chemist on the making of butadiene, but it was really a laboratory project at that time.

I had had a few talks with Mr. Newman and Mr. Marks of that concern, and it appeared to me, that while they had something, it was still in the laboratory stage rather than in the pilot-plant stage, and I, at that time, directed them to get it in some sort of pilot-plant stage. * * *

Just recently Seagram has reported, although the Department of Agriculture isn't ready to completely confirm it, at least haven't up to now—but feeling it was of great importance to us, we cut down 20,000 tons of the Union Carbide plant and have substituted 20,000 tons of butylene glycol, feeling that, if possible, without delay in the thing, we ought to get the benefit of every process that appeared to be better.

Now, in the meantime, surveys have been made to see whether we could get butadiene from conversions, even though it was much more expensive to do it. After all, money is no object. * * *

* * * we feel now that we can get a considerable quantity of butadiene from conversion of the petroleum industry and, of course, that will be pushed as rapidly as possible so that we can fill up the polymerization plant that we have now operating. It appears that polymerization can be done much more rapidly than the butadiene and styrene.

The Publicker Co. had a process, which I mentioned previously, which was the catalytic process worked out by the Polish chemist. At first I was told that it was exactly the same as the Union Carbide process. Later developments in-

dicated that it is somewhat different from the Union Carbide process, and feeling again that we ought to put into operation other processes which appear to have value, I have asked Mr. Jones to give them a 10,000-ton plant so that they may go ahead with this Polish process. * * *

Just to tell you, regardless of how crazy a thing seems, we are still going along with a Dr. Castro, a dentist who is supposed to have found a way of making natural rubber out of something or another, nobody knows what. He hasn't told anybody, but it received a lot of publicity in the paper that Dr. Castro had solved the problem. I am still working with Dr. Castro and have made a proposition to him that he divulge his process to a group of eminent scientists. I don't know whether he has anything or hasn't. It sounds purely fantastical. I feel that even fantastic things should be investigated. We investigated, for example, a very fantastic method brought to us from an Austrian on the coast of growing synthetic rubber out of a solution of hundred octane gas made from starch. He still says he can do it and we are still experimenting with him. I merely cite those two examples to show you that no matter what the thing is, I feel it is so important that we can't afford not to follow it through to its logical conclusion.

Now, let's look for a moment at the phase of it that has received so much attention and is responsible for the appointment of your committee. The press has confused the rubber situation tremendously. It has never been confused in my mind, because I feel definitely that we are going to produce synthetic rubber. The program, as originally planned, was some 350,000 tons of Buna S, 40,000 tons of neoprene, and 60,000 tons of butyl. As the situation becomes more aggravated and the demands of the war more and more important, we in the WPB have increased that program at various times until now it stands at some 700,000 tons of Buna S, some 40,000 tons of neoprene, and butyl has been increased to 132,000 tons. * * *

Dr. CONANT. I don't want to take too much time. Just a moment more on that. We have conflicting evidence here about the quick butadiene program from this point of view. There seems to be two groups in the oil company; one feeling that this program will seriously interfere with high aviation program, and the other not.

Mr. NELSON. That is right.

Dr. CONANT. May I ask which group is right?

Mr. NELSON. When it ever gets to a point where it interferes to a point where we have to cut it out, we will have our other processes far enough along and we will not take a chance by cutting down our other program by the full amount which we can get the butadiene. Part of it will not interfere. The quick conversion of the gas plant will not interfere.

Dr. CONANT. There are others who also say that the whole program of making any rubber from butylene is very bad because it interferes again potentially as it does with the high aviation gas, whereas making it from butane—this is, of course, Houdry's organization—uses raw material which could not, by any conceivable imagination, go in high octane. I am interested in to whom you turn to solve that, but it seems to be a tough problem.

Mr. NELSON. Dr. Weidlein and his technical committees which he gets out of the oil industry—I depend upon him to give me that technical information.

Dr. CONANT. Even if this case involved high octane which involved the coordinator?

Mr. NELSON. You see, he works with technical committees of the oil companies. Now, the question of whether it conflicts with hundred octane or does not depends entirely upon whether you are going to need this 100 octane gas over and above the program which has already been developed. Again, I say to the grain people, "You can't assure me that you wouldn't have grain that wouldn't conflict with food, which is just as important as 100 octane gas," and they can't. While we have today a surplus of grain, I have the authority of the Department of Agriculture that by next year we will not have a surplus of grain, and should a drought come next year, we may have a great deficiency in grain.

Now, as to the Houdry, I am not able to devolve. I am told by Dr. Weidlein that he is not so sure that Houdry would do on a large scale. He felt there was a very grave doubt whether Houdry was far enough developed so we could take a chance and put Houdry in place of some of the processes in which he had assurance. There are all kinds of charges made: that this fellow is interested; Standard Oil wants to run out Houdry; that Weidlein is an oil man and

he is not interested in grain; this fellow is a grain man and isn't interested in the oil.

You sit where I do and you see these charges and countercharges float by like motion pictures on a screen.

Dr. CONANT. You spoke about, in the beginning, that there might have been mistakes, that if all processes had been reviewed, it would have been better.

Mr. NELSON. Yes.

Dr. CONANT. Who was the technical man in charge then?

Mr. NELSON. Dr. Weidlein working with Rubber Reserve.

The hearings, reported here as they were transcribed at the small, intimate meetings of the Rubber Survey Committee, permit us to go behind the gloss of official pronouncements, prepared statements and published accounts, to see how things functioned on the spot. Top officials at a point of high national crisis are confronted with the actions they have taken and are asked to explain the basis on which they acted; they are confronted with vital questions and are asked for the criteria by which they would answer these questions. Here is a rare chance to observe the inside operation of the vast machine which organized the war effort. Here is only the raw data. The reader may interpret that data as he will. Yet, surely, it may be assumed that if there is indecision and confusion in the answers of the top official at the highest level of war planning, this reflects an indecision and confusion that existed in fact. If Mr. Nelson cannot clearly say why A has been chosen rather than B, or what the effects would be in terms of the demands for critical resources if A were substituted for B, then it may surely be deduced that the Government was without an effective mechanism for the rational resolution of the critical questions of choice. Not only were the top planners heard. Those charged with implementing the plan—the men in the field like Mr. Madigan who was charged with the construction of the synthetic rubber plants—also had their say. It was to be expected that, at the level of action, those brought in from industry to carry out the task of building for war carried with them the attitudes and the approach that sometimes worked effectively in the competitive free market economy. If you had a job to do for the Government, the way to get it done was to push harder, yell louder, grab quicker than the others who also had jobs to do for the Government, "to bull it through." But the totality of yelling, grabbing, pushing does not resolve the problem of making the best use of critical resources; it does not resolve the problem of choice according to any criterion that is likely to be a correlate of the public interest. This approach is reflected, it seems to us, in Madigan's testimony.[55] Nevertheless, this must be recognized: Though this approach may be inconsistent with rational planning, given the lack of systematic evaluation and the lack of technical competence in government it is difficult to see what choice the individual had other than to act in terms of it.

Mr. MADIGAN. About 2 months ago—I assume it was on the lend-lease basis—I began to work on the construction of the plants, to establish a construction program. I assume that the program that they had already started was what they wanted to do. I tried to familiarize myself with it by going around, looking at what had been accomplished, and then I proceeded to try to put it in some kind of shape, so that we could dovetail it in with the rest of the war construction program, because of the fact that it has all of the critical materials rolled up in one bundle. It just comes in the nature of practically being all critical material.

[55] Proceedings (Mr. Baruch, Chairman), August 12, 1942, pp. 1–2, 6–7.

At the time that I went over, the process was pretty well set, that is, what they were going to use.

Carbon-carbide was the one they were using in the alcohol process, and the oil companies had already had their processes approved by their committees.

We proceeded along that line to get the stuff scheduled. Well, it went into tremendous figures, and then we found that everybody was just giving us a lot of approximate quantities on which they would be well inside of. So we immediately stopped that by calling them all in and saying, "You have to take your flow sheets and get right down into it and see what compressors and what vessels, and what descriptions, and what tonnages, were needed, and so forth."

Well, it takes quite a while to do it, and it brought out the fact that there was a great variation in the amount of critical materials that they intended to use. So we then figured that we would have to have quite an organization, and we created one in New York, made up of the front page of the book here. I am telling you this in my own way.

Mr. HANCOCK. That is just what we want you to do.

Mr. MADIGAN. That's right. Now, on materials, I can't speak so learnedly on that because I can only tell by the results. After you have done your work a couple of years, and if you are a little aggressive, Doctor, you know the right places to get into and you just simply keep shouting until they give you what you are asking for on one or two grounds, either because they think you are entitled to it, or in the second place, to get rid of you. That kind of pressure probably has some effect on upsetting our orderly system. Some fellows are a little more aggressive than others, and they just keep insisting and they try every trick they can try. I spent many years in this work in New York. * * *

Dr. CONANT. * * * Let's take the alcohol thing, supposing somebody came along and said, "I believe we ought to put in another four units of the carbide." I take it that your unit No. 4 is engineered, but probably isn't very far along in construction. * * * Could you do it, and what would it cost to the war effort, and how long would you take to do it? * * *

Mr. MADIGAN. Well, I figure that anything you'd put in now in these plants would be at some expense to something.

Dr. CONANT. Granted.

Mr. MADIGAN. And you could just put it in, Doctor, and that is all there is to that. I couldn't answer your question.

Dr. CONANT. What I meant was, what kind, what would you run into, what would your bottleneck be? It wouldn't be the amount of steel? The amount of steel isn't great. Would it be the machine shops or copper, or the kind of a place?

Mr. MADIGAN. Well, I would rather ask you. You don't mind if I ask you a question, do you?

Dr. CONANT. No, go ahead.

Mr. MADIGAN. What I am thinking about is, if you would increase the program in the total amount of butadiene that we contemplate in making—your question is along that line—then I would say that there is probably not any great material difference in whether you increase it in petroleum or alcohol. The equipment and the shopwork, and so forth, is of a similar nature. Now, I would say this to you, that there is going to be trouble; the only trouble that we are going to have in building this rubber program would be in getting these materials to produce these plants.

The picture is one of confusion. But this much can be said: At least, men such as Madigan were habituated to technical and organizational complexity. Perhaps they were groping because they had not acquired (and did not yet recognize the need for) the techniques and the basic table of values appropriate to choice and judgment in strategic planning—but at least they were groping. In contrast, Jesse Jones and the Government bankers appeared wholly innocent of any such competence, and were apparently oblivious to the idea that such a competence, involving the ability to deal with technically complex problems in the frame of a particular and shifting set of purposes and of resource availabilities, was relevant to the exercise of the governing power they held and to the decisions they made. For Jesse Jones, it was a matter of leaving it to "the boys."

Despite the welter of confusion and conflict, existing from the time he had first struck down the basic recommendation of the NDAC, through the dogfight with OPC, the internecine conflicts over processes, and the culminating conflict on the alcohol process that led to the congressional crisis and formation of the Rubber Survey Committee, Mr. Jones blandly denied that there had been or were any conflicts at all.[56]

Mr. JONES. We have been physically handling the problem at the suggestion of and in cooperation with WPB. We come in contact with OPC, because of the raw materials, and the fact that toluol and 100 octane gas must be coordinated with this or we have got to work in with that program. We have no difficulty with any of them. We have had no suggestions from any of them that have not been adopted. As far as I know, there is no confusion about it except in the public mind due to the testimony and committee hearings and statements made that don't know anything about it, and some who have a purpose to serve in doing it. * * *

Mr. BARUCH. You say there have not been any conflicts?

Mr. JONES. Not to my knowledge.

Mr. BARUCH. Hasn't it been over processes?

Mr. JONES. Within my own crowd, not to my knowledge. I mean WPB and myself.

Mr. BARUCH. There has been no conflict as to processes?

Mr. JONES. Not the slightest that I know about. We have followed the advice of experts, chemists, or whatever you call them. I don't know anything about rubber or chemistry. We have naturally followed the best advice that we were able to get.

Mr. BARUCH. You put up the money and direct the process which is given you, which is the best one under the circumstances?

Mr. JONES. The best that we knew how. We shot at any kind that flew that looked like we could hit it. It didn't matter with us whether they made the rubber out of urine.

When Jones was asked to justify the secrecy clauses of the patent agreements, he replied that he did not know about the patent agreements so he could not very well justify the secrecy clauses. When it was pointed out that the technical information pooled between patent agreement signatories or submitted to the technical adviser was not only closed to outside firms but also to the War Production Board and even to the Rubber Coordinator, Mr. Jones shook his head and said: "that doesn't sound like it is possible." Here, assisted by his subordinate Dr. Hamilton, he is examined by the Committee. To get the full flavor, one must turn to the transcript itself:[57]

Mr. BARUCH. Didn't we hear, Doctor, there was an agreement between the tire manufacturers and the Rubber Reserve, or somebody, and Mr. Jones' organization, regarding the methods and the manner of licensing?

Dr. HAMILTON. It was the pooling of patents, and it was in December.

Dr. COMPTON. What provision had the Rubber Reserve made for directing all the energies of the industry into the development of compounding? I wondered if you could very briefly tell us what procedure has been taken for that purpose.

Mr. JONES. We would treat the rubber industry as a part of ourself; we are part of the rubber industry, working with them, and relying upon them to do the job. We have given them, we have made the money available at all times for anything that would make rubber. I don't know whether I have answered your question or not.

Dr. COMPTON. Well, up to a certain point. Let me amplify it slightly. That arrangement has been a contract—has it not—between Rubber Reserve Co. and the four major tire manufacturers?

Mr. JONES. You mean on the polymerization plants?

[56] Proceedings (Mr. Baruch, Chairman), August 19, 1942, p. 1.
[57] Id., pp. 14–18.

Dr. COMPTON. No, I mean to exchange and develop all information in regard to compounding of rubber.

Mr. JONES. Patents?

Dr. COMPTON. Well, patents and know-how and all information that they have.

Mr. JONES. That was all worked out in our office with the rubber people.

Dr. COMPTON. But it involves just the four major companies?

Mr. JONES. Well, more than anybody else.

Dr. COMPTON. * * * according to the record, in their earlier July meeting, about the middle of July, the RFC entered into a contract, a legal contract with the four major companies for the exchange of this information. But there was there the secrecy clause which prevented the dissemination of the information outside except under certain conditions of necessity that were mentioned.

Mr. JONES. Are you familiar with that, Doctor?

Dr. HAMILTON. Not with this particular contract, but I think it ties in, Mr. Jones, with the general plan of our having asked the chief rubber companies to send us representatives, which was first done in July of 1940, and it started the crude program. We had regular monthly meetings at which the rubber companies, all four of them, had representatives. Then we got to the point where there was a pooling of information, and in December of 1941 we had a contract which provided for an exchange of patent information. Since that time, all of these companies have periodically had representatives meeting with our men and there was this arrangement this summer, in June. I was not at that meeting, so I don't know a great deal about the details.

Mr. JONES. I thought all that had been done in the latter part of last year—sometime last year.

Dr. HAMILTON. This is nothing more than a refinement of what has been done. There was a substantial agreement as long ago as last November.

Dr. COMPTON. That is true, between the rubber industry, as a whole. But, this agreement that I am thinking about is the one that was signed on July 3, 1942, which arranges for the exchange of information between Goodyear, Firestone, Goodrich, and United States Rubber, and also the Rubber Reserve Company. And this prohibits the dissemination of any of that information outside, and that arrangement was apparently made contrary to the recommendations of the technical men, the unanimous recommendation of the technical men who were considering the problem of how best to develop that article. I am trying to find out the explanation, or what was the reason or purpose of that arrangement. * * *

Mr. JONES. The point is that Rubber Reserve made a deal with the four companies.

Dr. COMPTON. Yes.

Mr. JONES. And that was not interchangeable—not available to someone else.

Dr. COMPTON. Right.

Mr. JONES. The techniques, and so forth.

Dr. COMPTON. There are two problems that worried us somewhat in regard to that. That leaves a considerable number of competent rubber companies completely on the outside, and the other point is the question—according to this agreement the information is also closed to the Rubber Coordinator, and the WPB.

Mr. JONES. The information is not available to the Coordinator, or WPB?

Dr. COMPTON. That's right.

Mr. JONES. That doesn't sound like it is possible.

Dr. COMPTON. Well, it doesn't to me, and that is the reason I am asking the question.

Dr. HAMILTON. I think the explanation is that this contract is signed by all parties who have contracts from Rubber Reserve for the manufacture of rubber, for its account. Did you understand that the Defense Plans Corporation, which is an RFC subsidiary, built these plants and actually constructed them with loans from the RFC? And then the Rubber Reserve Company leases them for a nominal amount and makes managerial contracts with the chief rubber companies who actually operate them, and I think that the contract is signed by all of the rubber companies who are manufacturing for the account of Rubber Reserve, so that everybody is manufacturing for the Government, that is, the RFC has an interchange of know-how information.

Dr. COMPTON. But at the present time that involves just those four companies?

Dr. HAMILTON. Well, yes, because they are the only ones who now have actual rubber manufacturing contracts.

Mr. BARUCH. They are the only four people that can make tires?

Dr. HAMILTON. No; a great many of them can. There are 41 companies altogether, but all of the tire manufacturing is being done by this group, and I assume that anybody else may come under the provisions of that contract. That is, anybody who is manufacturing for Rubber Reserve.

Dr. COMPTON. Except that there is no arrangement in the contract to provide for it. * * *

Mr. JONES. We had intended to have enough of this, and let the little companies, who are competent and who are interested, have a part in the program. But, of course, we must rely upon the big companies for the main job.

Mr. BARUCH. Will you look into that? Have you got anything else, Doctor?

Dr. COMPTON. Yes; several more things. One of the reasons that I brought this question out was because of the statement that the relationships, between the Rubber Reserve and the War Production Board on this matter, have apparently been very smooth, and on this particular point, I am informed that the WPB has been trying for some weeks to find some way of getting access to this compounding information which is essential to their job, and that they have been blocked by this secrecy agreement. And as late as 3 days ago they got an agreement with the legal representatives of the 4 companies, but that legal agreement was blocked by Mr. Crossland of Rubber Reserve, and that seems to be one point in which the operations aren't working very smoothly, and I think that should be given some attention.

Mr. JONES. Well, it is the first I have heard about it.

Mr. BARUCH. The contract itself, and the points that the doctor just raised; there are two points——

Mr. JONES. They can't have access to the formulas to the patents?

Dr. COMPTON. The patents and the know-how, because we are told that the know-how is even more important than the patents, in much of this work.

Mr. JONES. They can't have access to the patents and the know-how, and what was the other point?

Dr. COMPTON. That the Rubber Division of WPB had thus far been unable to get access to information on rubber compounding because of this secrecy agreement.

In the course of Mr. Jones' presentation, it appears again and again that there was a lack of real knowledge of what was happening, a lack of real competence to evaluate, much less direct what was being done, and no responsible effort to work out a table of priorities and ascertain relative resource availabilities. The role of Government is conceived as that of effecting a liaison between business interests, and occasionally of exerting the minimal control of the financial agents interested in the manner of rendering accounts. And that was all. It sufficed, in Mr. Jones' view, to turn over the jobs to a few large concerns in which he had personal confidence, and let them operate entirely as they saw fit. Technical matters, he left to "the boys," knowing nothing, and caring nothing, about the issues involved. This is exemplified in the excerpt which follows:[58]

Mr. BARUCH. Can you tell me anything about this rumor of bringing in the Phillips Petroleum now, they have been out of it, haven't they?

Mr. JONES. No; they haven't been out of it. They were one of the first we traded with and they were given their instructions to go ahead. It was found as we got in the matter that they were using entirely too much material, steel and other materials, and we told them to stop work and the reason is, "You are using too much material, whether you can bring it down or not, that is up to you." They worked on it and finally came back and did cut it about half. They have never explained to my satisfaction why they had so much material. At the same time, they are reputed to have as many technical men in their organization as anybody else, and probably the tops. We couldn't afford to exclude them

[58] Id., pp. 6, 7, 21, 22, 24, 30, 31.

when we got them within reason. We started them back on the 5th or 6th to "hit the ball." They say they will be in production by April 1.

Mr. BARUCH. What process is that?

Mr. JONES. The same as the other process. They have been making butadiene for years. They have got their own process. We asked them to consider while they were redesigning the steel—they did say that it wasn't much of a job to redesign. We asked them to consider the process, and from the report I read, I couldn't tell whether they were for or against it. I said, "You have got to tell us whether you are willing to do this and whether you can do just as good a job with the Houdry processes." They said positively that they preferred their process, that they knew what it was and they had been making butadiene from it and preferred not to put in the Houdry process. So, they are going ahead with their own.

Mr. BARUCH. On the question of processes, you recommend that we talk to Newhall and Weidlein?

Mr. JONES. Absolutely. I have been told that the Houdry process has not been perfected to the last stage. If it was my decision alone, I would decide against it for that reason.

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Mr. JONES. On followthrough of plant construction, we have, in our RFC department, Mr. Francis, who is at the head of it. He has it broken down into regions and he has got good men in various parts of the country to follow through. The purpose of that branch of our organization is to visit plants and see what they need and why they are not keeping up with their schedule and this, that, and the other.

That is all being done as perfectly as we know how to do it. Francis is a competent fellow and he knows how to get work done. The men he has employed, they are all volunteers, all capable men and prominent in their communities, and they can go around and they know how to get in a plant without offending the contractor and things of that nature. I think it is going along very well.

It all depends, in the last analysis, on every item of material that we have got to have. There is nothing more important to our whole war program than rubber. It is the boys allocating the materials, and WPB don't give them the stuff, or can't give them the stuff and naturally it causes a delay. I mentioned the procedures so as to let you know what I am relying on. * * *

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Mr. HANCOCK. On this program being worked out on the quick butadiene by the Coordinator's group, we have had a good many impressions that that group went ahead on their own without consultation with you in advance, or the Coordinator. That is one of the conflicts that I thought was in the situation, from what we have heard.

Mr. JONES. Well, I don't think we have allowed it to be a conflict. They did start and grab the ball, like in getting the scrap rubber; they grabbed that one out right from under the WPB, and that is where they went to do that. They are doing their share. These boys, over there, they have got a big organization, and I think they started out on this quick business on their own, but we haven't allowed it to cause any friction. * * *

Mr. HANCOCK. But they don't plan to utilize the same process on the quick butadiene as Madigan has in his schedule? That is the way I understood it.

Mr. JONES. I don't know enough about it. I am trying to find out why we can't make the quick butadiene on the whole program; that is what I am trying to find out now. That is what I am trying to find out from the experts.

Mr. LUBELL. How far along on that are you? How far along on this quick butadiene are you? Are you finding out whether you can get it into the program?

Mr. JONES. I don't know how far along I am, but I will have the answer pretty soon. I don't think there is any answer except one. If you can do it for 6 months, you can do it for 6 years. Maybe a technical man might know better. * * *

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Mr. HANCOCK. On the present plan, regarding the pooling arrangement of patents, involving the four companies, I think I understood correctly, but I want to be sure. The plan is not to have any new rubber companies do the polymerization processes, as far as I know? Your plan is to have the products through those plants utilized by small companies? Have I made my question clear? They were discussing here about bringing in the small people and I was wondering if you plan to bring them in as new contractors in the polymerization, and bring them into the manufacture of rubber goods after that?

Mr. JONES. You mean bring a new manufacturer in?
Mr. HANCOCK. Yes.
Mr. JONES. A fellow who is not our manufacturer?
Mr. HANCOCK. Yes.
Mr. JONES. I wouldn't see the purpose of that. We will take a fellow who is in business and knows how.
Mr. HANCOCK. Yes. But you spoke of bringing in some small companies. You don't intend to bring them into the manufacture of goods after the four companies get through with the compounding of the rubber, the Buna S? Is that clear? At what point are they going to come in? I got it from your last remarks that you don't plan to bring them in at all until it gets to the manufacturing of Buna S into rubber goods.
Mr. JONES. I can't answer that because it hasn't come to me for a decision, but my thought about that is that we try to bring them in at the point where they should come in, where commonsense would tell us to do it. There is no sense of bringing them into the picture earlier, and certainly, not too late; that would be my idea about it. * * *

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Dr. CONANT. * * * I'd like to ask this question, to bring out again the organization rather than the technical points—one of the companies that is now making the largest amount of butadiene from oil is the Dow Chemical Co., but they are not in your program for making any expansion. And as far as I know their processes and their know-how are not being utilized in your program. I am not criticizing that decision. I am just wondering who would make such a decision?
Mr. JONES. Well, they are in the program somewhere.
Dr. CONANT. They are in the styrene but not making butadiene. I just wondered who would make that decision. Somebody must make the decision not to ask them to make butadiene.
Mr. JONES. Well, I assume that the technicians did.
Dr. CONANT. Dr. Weidlein?
Mr. JONES. Yes. It has never come up to me. I haven't heard of the question of ruling down on it, because I think this is a very competent organization.
Dr. CONANT. But you would hold Dr. Weidlein responsible? Or Mr. Crossland responsible, who in turn would hold Dr. Weidlein responsible for such a decision?
Mr. JONES. Yes.
Dr. COMPTON. I think the same sort of question comes in regard to utilizing the know-how of the Du Pont people, for example, in the matter of polymerization, because I believe they were not brought into the practical discussions of polymerization.
Mr. JONES. Du Pont?
Dr. COMPTON. Yes. Although they have had the larger background for the neoprene, but they were not brought in to help in handling the problem of Buna S, which is a somewhat analogous problem.
Mr. JONES. I don't think they have been ever ruled out, but probably they have never been asked to get in.
Dr. CONANT. There is another similar question. We have run into a good deal of discussion among two groups of oil companies, as to whether or not your program of butadiene from oil is in danger of upsetting the program for high aviation octane gas.
Mr. JONES. I don't think so.
Dr. CONANT. May I ask on whose technical opinion you rely on—Weidlein?
Mr. JONES. The OPC boys and Weidlein.
Dr. CONANT. The OPC group?
Mr. JONES. Yes, and Weidlein. We have talked over these things.
Dr. CONANT. I am just getting your views.
Mr. JONES. I will be right back.

The committee tried to discover who had made the complex technical decisions which determined the essential structure of the synthetic rubber program.[59]

Dr. CONANT. I wonder if I could ask you a question or two, The way in which these complicated, technical decisions which are involved are made. For

[59] Id., pp. 3, 4, 6, 11, 12, 13, 14.

example, when you decide about a process, what people do you consult, and how does it flow up in the organization to you?

Mr. JONES. Weidlein, Crossland, and then me.

Dr. CONANT. That is your chain.

Mr. JONES. Yes.

Dr. CONANT. So the decision on technical matters, Weidlein, Crossland, and then you?

Mr. JONES. I adopt their recommendation and back them up, and if they make mistakes, I am publicly responsible. I mean by that I try to support the boys and do the best we can to do the job. I know nothing about the technical phases. I have confidence in Weidlein and Crossland.

Dr. CONANT. Where would Mr. Newhall's recommendation come into that chain?

Mr. JONES. We work just as close to Newhall as one section to another. We are in constant contact with him.

Dr. CONANT. Supposing on a matter of policy, for example, of expanding your program or decreasing it, would Newhall, Crossland, Weidlein—would they all be in a committee together?

Mr. JONES. That would be decided by Newhall and me. I mean we would naturally get our recommendations from the boys, from the technicians, but we would make the decisions.

Dr. CONANT. And, on technical things, both Newhall and yourself would rely on Weidlein?

Mr. JONES. Yes.

Dr. CONANT. There is no other technical group except under Weidlein?

Mr. JONES. That is all I know of. I understood that he was head of a group of some 20, 30, or 100 technicians. I don't know how many, but I was asked by a Senate committee to give them the names of these technicians, and I asked for a list of the names, and they gave me a list of about 100, and I didn't submit the whole list. I got reprimanded by the chairman and when I did send it, I only sent about 30 names. It looked foolish to me. I didn't understand how he could have 100 fellows conferring.

Dr. CONANT. Where would Mr. Nelson's authority come in?

Mr. JONES. He would rely on Newhall and me. No conflicts there at all.

Dr. CONANT. But you and he would agree.

Mr. JONES. Always have.

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Dr. COMPTON. Well, I had 1 or 2 questions that came out of the discussion. One is this: Is there any definite veto power any place along the line in regard to any new process or program? Who would have the final veto power that, perhaps, 2 or 3 people get enthusiastic about it, and some are not so sure, and who has the final veto power on that, on that situation?

Mr. JONES. On the process?

Dr. COMPTON. Yes. A process for producing some new type of synthetic rubber.

Mr. JONES. I don't know that anybody has it. We always agree to get along. We don't have any difficulty about it.

Dr. COMPTON. The question hasn't arisen yet?

Mr. JONES. We don't have any disagreement about it.

Mr. BARUCH. As I understand it, the process might come from you and go to the WPB, or from the WPB to you.

Mr. JONES. And we operate together.

Mr. BARUCH. Yes. I'm glad to know that you don't have a different opinion from the Secretary of the Interior.

(Discussion off the record.)

Mr. JONES. We get along well, and our dealings are with Davis, and Brown, and Gary. And the boys seem to know their business; at least they impress me that way. Maybe it is because of my ignorance, but we get along all right.

Dr. CONANT. Supposing there was a disagreement between that group that you named and Dr. Weidlein? Who would resolve the disagreement? You would, I take it. If the group that you spoke of, working under the Petroleum Coordinator, should disagree—shall I say—with your group, Madigan and Crossland, who would settle the difference?

Mr. JONES. Well, it just hasn't arisen.

Dr. CONANT. You don't cross the bridge until you come to it?

Mr. JONES. We don't have much trouble in getting along. We don't have any trouble.

Dr. CONANT. Well, I just wondered who would settle it if you did have a difference.

Mr. JONES. The boys would settle it themselves. They are in agreement because I haven't seen any indication of anything else.

Mr. BARUCH. You must have arrived at this, that you have got 60 percent or 65 percent of the petroleum, and 35 percent alcohol, and that was arrived at by the discussions; is that right?

Mr. JONES. No; that wasn't the way it was arrived at, at all. It was arrived at by the Gillette Committee.

(Discussion off the record.)

Mr. JONES. We were told how much alcohol was available. There was none except a little synthetic. I believe by Carbon-Carbide.

Mr. BARUCH. What do you mean?

Mr. JONES. Well, the Gillette Committee got started, and the boys found some more alcohol, and we were told, along about the 1st of May, or the 2d or 3d of May, that we could have a certain amount of alcohol, so we immediately tied that into the program instead of the other. And, on the 25th we were told that we would have enough to make it up to 200. And we immediately tied that in, and so, the Gillette Committee is entirely responsible and due whatever credit there is for having rubber made from alcohol.

Mr. BARUCH. As I understand it, then, when you started to make your synthetic rubber you were advised that there was no alcohol from which you could make it? So, any alcohol process would have to be ruled out because of that. And, therefore, we don't want to go to the petroleum; is that it?

Mr. JONES. I didn't know you could make it out of alcohol. I thought that all you could do with alcohol was to drink it. I really didn't know that you could make it out of alcohol.

Mr. BARUCH. But, as I understood it——

Mr. JONES. I always understood that you make it out of petroleum.

Mr. BARUCH. But you were moved to your decisions by the statement that alcohol at that time was not available?

Mr. JONES. I didn't know it, but the boys found it out. I found it out later. The decision was made before it ever came to me on that.

Mr. BARUCH. In other words, your program makers were advised that there was not sufficient alcohol, even if the alcohol process was available. And afterward you found, or that committee found, that there was available alcohol, so they went for this 220,000 tons which came from alcohol?

Mr. JONES. When the fire got hot, the boys found alcohol and we put it into the program.

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Dr. COMPTON. Then, I have just one more question, Mr. Baruch. In regard to the plan to go into production of butyl rubber, do you happen to know on what scientific basis or on the basis of what scientific recommendation that decision was made, and whether WPB technical staff was consulted in connection with that?

Mr. JONES. Well, of course, we look entirely to Newhall for the WPB, and he was in on it, so, I think it is like this—the technical parts, I haven't had much to think about or say about, because I don't know anything about it.

The Survey Committee in its report condemned the administering agency roundly and bitterly. It found such "overlapping and confusing authority" that it was "unable to determine, in spite of many inquiries * * * where the responsibility has lain for many of the decisions which have been made in the past 8 months." It saw "bad administration" behind many of the "adjustments and readjustments—a 'stop and go' policy." It deplored the fact that "because of the shortsightedness and failure to act on technically sound advice, we must now proceed with insufficient experience."

The Committee put its finger specifically on the lack of technological competence, on the failure to develop facilities for objectively evaluating processes, methods, technical suggestions; and failure

to work out procedures for resolving controversies, controlling private pressures, searching out information prerequisite to the formulation of sound policy, and undertaking the overall planning that was an absolute essential to a successful program. It summarized its views as follows:

> The production of synthetic rubber represents an investment exceeding $600 million and is one of the most complicated technical projects ever undertaken in this country. Yet, in none of the Government agencies has there been a clearly recognized group of independent experts to make the technical decisions. Reliance has been placed on one part-time technical adviser aided by committees drawn from industry.[60]
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> The failure of the Government to provide a clearly recognized group of independent experts who would make technical decisions has added greatly to the public confusion and uncertainty. The reliance on one part-time technical adviser, aided by committees drawn from industry, has, in the opinion of the Committee, been insufficient for the development of an entirely new industry involving an investment exceeding $600 million. The technical adviser has testified that on more than one occasion he requested the appointment of an adequate technical staff.
>
> It would have been wise administration for the officials in charge of policy to have delegated to a competent technical staff the function of collecting information about various processes. Such a staff should have been relied upon for supplying through regular channels the data on which all important decisions were made. Instead of such orderly methods of procedure we found many evidences of a chaotic situation in which nontechnical men have made decisions without consultation with subordinates nominally in positions of responsibility.[61]

The Committee asked "whether the present administrative organization is such as to insure the effective carrying through of the program," and answered itself, "It is not." The Committee therefore recommended "a complete reorganization and consolidation of the governmental agencies concerned with the rubber program."

The Committee asked that the WPB assume to itself all the power and responsibility for the rubber program, and that it delegate its full powers to a Rubber Administrator, the so-called Rubber Czar. Under him there was to be established a Technical Division, which would concern itself with "various phases of research and development."

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[60] Rubber Report, p. 13.

In his book, op. cit. supra, note 20, p. 413, Mr. Jesse Jones writes:

"One unpardonable error in the Baruch committee's report, and one undoubtedly prompted by a disposition to be critical (a disposition which Dr. Conant and Dr. Compton did not share), was the statement that we had the service of only one part-time rubber-expert-scientist-chemist, in doing this big job. As a matter of fact we had the help and services of most of the experts, chemists, and scientists of the rubber industry, the oil industry, and the chemical industries. True, they were not on our payroll; but the leaders of these industries had put their experts at our disposal in a patriotic way, and without cost to the RFC."

The picture which Mr. Jones here implies of "most of the" many thousands of "experts, chemists, and scientists of the rubber industry, the oil industry, and the chemical industries" hurrying down to Washington (without compensation) in order to assist the trio, "Weidlein, then Crossland, and then me" in its deliberations, is somewhat fantastic. What is perhaps worth commenting on is the apparently complete misunderstanding of Mr. Jones of the nature of the criticism which was leveled at his administration. The Committee did *not* deny that Dr. Weidlein had been assisted by the employees of the firms concerned. It stated specifically that reliance had been placed in "one part-time technical adviser, *aided by committees drawn from industry.*" What it called for was "a clearly recognized group of *independent* experts." [Our emphasis.]

One wonders whether Mr. Jones was ever willing to rely on the opinions and advice of committees of business experts on the loans, interests, fees, and payments made to those same concerns by the RFC.

[61] Id., p. 50.

Since "good administration dictates that the Rubber Administration use the available facilities of other governmental agencies in the execution of its program," it was recommended (1) that the Petroleum Coordinator be charged by the Rubber Administrator (*a*) with research into problems connected with the production of butadiene from petroleum, and perhaps (*b*) with supervising the operations of the petroleum-butadiene plants once they are constructed; and (2) that the Rubber Reserve Company through its Construction Division be charged with the "construction of all plants under the rubber program" including "the construction of all plants and equipment concerned with the production and purification of butadiene from petroleum."

Except to suggest certain additions, however, the Committee asked for no changes in the actual program as it was then scheduled. On the contrary, for reasons already noted, it froze the program and its processes. The new Rubber Czar, whoever he might be, was directed to "bull the present program through."

The Committee report, published a month after the Committee had started its work, had a tough drastic tone. It tongue-lashed the administering agency in a way that must have been gratifying to a number of people and which, no doubt, cleared the air. But the Committee's recommendations had only a mild impact on the program itself or on the source and nature of its administration.

The program was frozen in the form and magnitude already contracted out, with certain additions asked for. Further evaluation, choice, technological revamping or replanning were all to be put aside—a recommendation that would inevitably limit greatly the possible value or significance of the new Technical Division. Such a division might be useful in the ad hoc search for information or in the organization of a research program, but it could play no decisive role in policy formulation.

Paradoxically the Baruch committee, in spite of its condemnation of the administering agency, permitted and/or recommended that operative control of all the remaining vital phases of the rubber program, namely plant construction and finance, be left in the hands of that same administering agency. Eventually the Rubber Reserve Company would be in charge also of plant operations.

There remained for the Rubber Director only the function of superexpediter, whose main job was to get the critical equipment and materials for the rubber project in the face of the competing needs of other phases of the war program.

CHAPTER VII

SECOND LESSONS

National policy for the development of the new industry had now been fixed. Investment costs and operating costs were to be borne by the Government. The plants were to be owned by the Government. But the planning of the industry was not Government planning. The very conception of the new industry was a private-company conception. Policy was the projection of private-company policy, planned from the point of view of a few great companies with a commercial interest in the development of a synthetic rubber of a particular character and kind.

No discredit is due those private companies because they formulated this program and pushed it through the political mill. Theirs was the basic research, the painstakingly acquired technological concepts and the operating know-how. In the formative period, the question did not arise as to a choice between their program or some other. They pressed for action in the face of official passivity and even antagonism. They offered a program. The alternative was not their program or some other, but theirs or none at all.

The role assumed by the Government was not to plan but to finance. Insofar as there was a distinctive voice of Government, it was the voice of the Government banker. The Government did not plan; it bargained. It negotiated with the intention of striking a deal favorable to the Treasury. It saw its task as that of buying what was offered as cheaply as possible. It looked for "reliable" companies. It did not look beyond the particular bargain to that total framework, created by the cumulation of bargains, within which the operations and subsequent development of the industry must take place.

The Government arranged for its plants to be operated by private concerns at cost plus a fixed fee, and for its research to be done by these firms for a fixed fee. The drives to efficiency and progress supplied by the pressure of competition, the promise of profits and the fear of loss were absent. No consideration appears to have been given to the need for substituting an alternative to the traditional incentive. It was thought to be enough to put fabrication and research into the hands of reputable private concerns. In that way the Government supposed that it was relying on "private enterprise." It was not relying on private enterprise for, here, there was no enterprise. It was relying rather on a peculiar breed of officialdom. The difference between corporate and public officialdom is not a difference in kind; but a difference in the nature of the pressures under which they operate. Remove the pressures of market competition and the force of the profit lure from the corporate executive, put him under the Government umbrella, and he becomes a kind of public official except that his responsibilities are less clear, he is less accountable for his acts, his

loyalties are more likely to be divided and the satisfaction of his ambition is less likely to be related to the successful accomplishment of the public tasks. The problem is to introduce into Government enterprise, whether run by public or private officials the drives to efficiency and the incentive to progress that will take the place of the kick of competition and the promise of profits. This is a point to which the Atomic Energy Commission and the weapon builders might well now give heed.

Nowhere was the failure to foresee the effects of the immediate bargain on the long-run structure of industry operations more clear than in the patent agreements. These agreements virtually eliminated all incentive on the part of those who entered into them to seek further to develop the technology of synthetic rubber in the areas which they covered. Indeed, they created a strong and positive disincentive to the pooling of knowledge by operators of Government plants, to the objective evaluation of alternative processes by such operators, and to the standardization of processes. The system for financing research was through the straight cash handout wherein no attempt whatsoever was made to link payoff to accomplishment. And, finally, the freedom of operators to change the processes used in the Government plants, incorporating into these processes modifications on which they held new patents, created barriers to the sale of those plants after the war to any firm other than those which operated for the Government.

Failure to take account of the need for incentive to progress and efficiency could be expected to result in technical stagnation. Failure to seek a cumulative release in patent claims could be expected to narrow the potential market for the postwar sale of the plants, and hence reduce the possibility of creating a competitive basis for the future, privately owned synthetic-rubber industry.

Most serious of all, in a war emergency the Government failed to plan in terms appropriate to war strategy. In the war economy, price provided no index of relative real costs or of the priority of objectives. An alternative table of values was required to guide planning and to enable technically complex choice to be made on a proper basis. Such a table of strategic values and relative scarcities was never available for the critical development of a synthetic-rubber program.

The administering agency did not develop the technological competence needed to evaluate the plans or processes offered by the companies and outsiders, or to shape the program to the needs of war mobilization. The Government had technical experts, laboratories, and experimental facilities, but they were not incorporated into the processes of social choice and evaluation, i. e., into the essential process of governing.

The governing agencies had no alternative but to leave technical evaluation to private officials who at least could evaluate operational feasibility. But this meant that the conflicts which central planning should have foreseen, were not foreseen; that the strategic criteria and the relative availabilities of resources which should have been taken into account, were not taken into account.

The results were as might be expected. The program was adjudged technically feasible by the private companies, and it was technically feasible. It worked, eventually. The program was adjudged commercially sound by the private companies, and it was commercially sound. Eventually it was proven to be a good moneymaker. These

two evaluations—technical feasibility and commercial soundness—were within the orbit of private-company judgment. But the individual firm could not and did not take into account the priorities of strategic objectives, the shortages, the noncommercial values. The firm planned with these things left out of account. The result was to be failure to produce what was needed according to the timetable of scheduled requirements, and the useless and dangerous dissipation of resources greatly needed for the war effort.

Congress was not designed for technical planning and choice. A congressional investigating committee is not the place to work out the complex organization of a new industry. Yet it was Congress, through its investigating committees, inexpert and ill adapted to such a task, that rightly challenged the program and forced through the changes that were to save it.

Against the solidarity of officialdom and the clique of insiders, Congress provided a court of appeal for those who would challenge the organization, direction, and inequities of the program.

Those who fought from the outside were often as self-interested as were the insiders. Few were nonpartisan. But under the circumstances, rather than minimize partisan pressures, it was best to encourage and bring partisan pressure groups into play around the whole circle. In this way considerations which might otherwise have been neglected were at least brought into view.

CHAPTER VIII

PROGRAM AND PERFORMANCE

The Rubber Survey Committee consisted of knowledgeable men assisted by a small staff of experts, but the Committee was not a Board for the technological evaluation of the program. The competence required for such an evaluation is slowly evolved and hard to come by. Moreover the Committee did not have the time for any considered evaluation, and did not attempt to judge between processes or between rubbers. Its technical investigation was a quick look-see with a threefold purpose:

(1) To check the claims of those outside the program in order to find out whether there were any technological miracles on the horizon. It concluded that there were not—that all alternative processes required development and testing and involved chance and uncertainty.

(2) To determine whether the processes scheduled to be brought into operation were technically sound. It concluded that they were, in the sense of being "ultimately workable."

(3) To determine whether the production time schedule was likely to be met. It concluded that it was, provided the necessary equipment and materials were promptly forthcoming and no unforeseen difficulties should develop. Here, the Committee relied on the qualified confidence (and reflected the anxieties) of the industrialists with "the plans in hand."

Having made these determinations and working under the general assumption that any drastic changeover "at this late date" would be undesirable and disruptive, it concluded that the program should not be changed by reason of the technical characteristics of the processes contracted for, or by reason of the qualities of the synthetic rubbers scheduled for production.

We have seen that certain critics predicted an insoluble conflict between the aviation fuel and synthetic rubber programs to the extent that the latter depended upon hydrocarbons derived from petroleum. The Committee minimized the danger of a real resource shortage, suggesting that the problem was chiefly one of improving the allocations system.[62]

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[62] Rubber Report, p. 48.

"Much has been said of shortages of critical materials. There are two kinds of shortage: The first where there is not enough to go around for essential purposes; the second type of shortage is where, though sufficient exists, it is short in the sense of not being available when and where it is urgently required. There are a few materials short in the first sense, but many have been short in the sense of failing to be where needed when needed.

"This has been due to permitting materials to be used for purposes not essential to the conduct of the war; to the lack of a vigorous policy of conservation, inventory control, and the finding of substitutes; and, most of all, to the changing, complicated, and ineffective efforts at material distribution and priority control."

The danger of a conflict between the demands of the synthetic rubber program and those of the high-octane fuel program, is lightly dismissed:

> It is our conclusion that, while the possibility of a conflict between the two programs does exist, it need not become serious if the possibility is recognized and if the administration of these two closely related enterprises is properly integrated. * * *
>
> If and when the armed services should decide that the larger quantities of high-octane aviation gasoline are needed, there are ways by which this demand can be met by the industry without diminishing the flow of butylene to butadiene plants.[63]

The Survey Committee satisfied itself that the Rubber Reserve program would enable America "to survive the rubber crisis without serious impairment" to its military program or domestic economy. Nevertheless, there appeared to be cause for alarm. Out of the 224,000 tons of rubber scheduled to be held in stock at the end of 1943, the Committee regarded 120,000 tons as a necessary working inventory, and considered the remaining 100,000 tons as an insufficient margin of safety.

The Committee did not take into account the limit of substitutability of synthetic for natural rubber; i. e., it did not indicate the natural rubber required as a proportion of total rubber consumption. This failure, perhaps due to the lack of reliable technical information, greatly changed the significance of the Committee's prognosis. Thus, postwar strategic planning, even in 1951, assumed a natural rubber requirement in the neighborhood of 20 to 25 percent of total (synthetic plus natural) rubber consumed. At the time of the Baruch report, a similar estimate of the natural rubber requirement might have run to 50 percent or more.[64]

The effect of taking this factor into account would have been (1) to scale down sharply the prospective real value of the marginal synthetic rubber output called for in the completed program and to raise the question whether, in the light of competing demands for all resources, the planned level was not higher than it should have been, (2) to underline the need for a vigorous quest for natural rubber or substitute polymers, and more research directed toward minimizing adjustment lags or otherwise reducing the strain on stocks of natural, and (3) to require that plans and requirements be adjusted in the light of the reappraisal of probable supplies.

A recalculation of the Survey Committee's balance sheet, taking this factor into account, would have indicated the prospect of a growing crisis in the need for natural rubber, likely to deepen as the war continued. It also would have indicated the probability of a large overflow of synthetic rubber into nonessential civilian uses from 1944 onward. It could have been anticipated that under the Survey Committee's plan a surplus of synthetic would exist side by side with a shortage of those high-priority products requiring a large proportion

[63] Id., pp. 40, 41.

[64] The Committee's mistake reflects the lack of essential technical knowledge required for sound planning. The "expert" opinion of the Rubber Reserve had vouchsafed before the Committee that "no more and probably less" than 10 percent of natural rubber was (in 1942) required in combination with synethetic and that "we could get along without crude after 1944." At the end of World War II about 30 percent of overall rubber requirements were for natural rubber, and items of the highest military priority such as large truck and aircraft tires had to be made entirely out of natural. Subsequently, during the postwar period, the industry has shown itself reluctant to use less than 40 percent natural.

of the natural. Thus, the Rubber Reserve program, with or without the incorporation of the Survey Committee's recommendations, called for the production of synthetic rubber in excess of all essential requirements. Under the circumstances of full economic mobilization, an ultimate goal that is too high is as much against the public interest as one that is too low, for it can be achieved only by sacrificing other war mobilization goals.[65]

Granted that a certain quantity was absolutely necessary for the prosecution of the war, this could not justify building capacity to produce any quantity of synthetic rubber. An annual output of 200,000 tons of synthetic rubber might be of incalculable value for the war economy. But the 300,000th ton would be a lesser importance. When 500,000 tons were produced, rubber might be available for uses that had no strategic consequences. And the 800,000th ton might have no value at all in a war economy. Clearly one could not logically establish the need for the 800,000-ton program on the grounds that 200,000 tons were prerequisite to victory. Yet this is what the Survey Committee did. It "sold" the program on an all-or-nothing basis. It made no attempt to evaluate the various possible levels of synthetic rubber output against alternative uses of the resources required to produce those increments to output. And even if the Committee had sought to make this evaluation, it probably would not have been possible to do so, for the data and organization required for such a determination were lacking. This was a shortcoming not limited to the Survey Committee, but one which pervaded the whole spectrum of war planning. The generality of the failure made it no less telling, however. The initial absence of planning based on such an evaluation was bound inevitably to result in delay, wastes, and conflicts.

Summarizing the approach of the Committee: It accepted the Rubber Reserve processes as ultimately workable, and refused to attempt a reevaluation of processes or rubbers on any other ground. It declined to take upon itself the task of modifying the technological structure of the program in order to minimize the possibility of conflicts with other war programs. It did not consider the modifications of program

[65] It is sobering to realize that Germany conducted a mechanized war of great range and indubitable effectiveness with the following consumption of natural and synthetic rubber during the war years.

Consumption of rubber in Germany

[In metric tons, equivalent to long tons]

Year	Natural	Reclaim	In Germany	In occupied Europe	Total in Germany
1938	97,000	29,000	5,000		131,000
1939	61,000	34,000	14,000		109,000
1940	27,000	46,000	40,500		113,500
1941	22,000	46,000	51,500	16,500	119,500
1942	26,500	40,000	70,000	26,000	136,500
1943	4,000	50,000	90,000	25,000	144,000
1944			[a] 103,872		

[a] Production.

Figures are from the Rubber Reserve Company, op. cit. supra, note, p. 47.

Any comparison of German war consumption of rubber with American consumption must be qualified, of course, by recalling (*a*) the German prewar military buildup, (*b*) the size of the American economy and the extent to which it is geared to automotive transportation, (*c*) the long communications required by the American assaults as compared to the central position from which Germany waged her offensive.

goals in terms of a possible conflict with more essential end-use requirements for the same resources. Placing major emphasis on the dangers and possible disruptions of change, the Committee froze the program qualitatively. Quantitatively it only suggested certain additions to the program as a margin of safety.

It recommended that the ceiling on Buna S rubber be raised from 705,000 tons to a level of 845,000 tons. This 140,000-ton increase was to be based, first on a 100,000-ton increase in butadiene capacity along the "refinery conversion" route, with corresponding increases in styrene and copolymerization capacity. This expansion was pointed above all toward 1943 a year "so critical for the rubber situation that the production of 100,000 tons more or less of Buna S might be the determining factor in the success of our military program." [66] Secondly, there was suggested a "later construction of a 27,000-ton (alcohol-based) butadiene plant and a 30,000-ton polymerization plant to be located near the center of grain production" if the Rubber Director should so decide during the spring of 1943 or thereafter. The Rubber Director was never to request this expansion.

The Committee also recommended that planned capacity of neoprene be increased by 20,000 tons to a 60,000-ton total. This recommendation, made in spite of the "relative high costs of neoprene in terms of critical materials and electric power," was based solely on the proposition that "Neoprene is the one synthetic rubber which has been shown to be the full equivalent in quality of natural rubber for combat and heavy-duty tires." The incident of neoprene stands as a monument to the paucity of the reliable technical information prerequisite to overall planning.

Further it was recommended that another rubberlike substance, thiokol, supposedly useful for the recapping of tires, be increased from a privately planned capacity of 24,000 tons to a new level of 60,000 tons. Because of the availability of reclaimed rubber the thiokol program was suspended in March 1943 and later was canceled altogether.

The Committee attached an overriding importance to the production of the full quota of synthetic rubber in 1943.[67] This emphasis on the importance of 1943 was fully in accord with the military time schedule. The Germans had cleared the Crimea and had pushed to the foothills of the Caucasus. In the north, the Russian and German Armies were joined in the ultimate test of Stalingrad. During that August in 1942, G2 reports which reached President Roosevelt already conceded a complete German victory at Stalingrad, and wrote off the Russian armies there as lost. Since February 1942 the British and American Combined Chiefs of Staff had been basing their preparations on two alternatives, a limited invasion of the European Continent during 1942 should it be necessary, even at great cost, to relieve the German pressure on the Russian front, or a full scale, cross-

[66] Rubber Report, p. 41.

[67] All the efforts of the Committee were pointed toward meeting the crisis of 1943. Again and again the point is made that it would be in 1943 that the margin between supply and requirements would be dangerously close; that in 1943 a supply failure might wreck the military machine and bring disaster in the field of battle; that because 1943 was so important, the program dare not be tampered with. The test was to be 1943. Statements to this effect can be seen on pp. 7, 8, 16, 17, 34, and 41 of the Committee's report.

channel invasion of the continent in the spring of 1943. The north African operation was later added as a means of coming to grips with the Germans during 1942.

Thus everything indicated an enormous demand for rubber-bearing equipment in this last half of 1942 and during 1943 to support the operations of our allies, to make possible our own military buildup and with the probability in mind of a massive European campaign during 1943. In such a campaign our forces would have use for limitless supplies of planes, trucks, tanks, and aviation fuel. A shortage of any one of these items—all of which required rubber or competed for the basic raw material components of synthetic rubber—might spell the difference between victory and disaster.

On September 17, 1942, the President created the Office of Rubber Director, as suggested in the Survey Committee report. William M. Jeffers, president of the Union Pacific Railroad, was appointed Rubber Director. He was later succeeded by his deputy, Col. Bradley Dewey, president of the firm of Dewey & Almy.

The building of the new industry is frequently lauded as a magnificent technological achievement. This it may well have been. But measured against the promises of Rubber Reserve, or against the directives of the Baruch Committee, the realized program was a failure. Especially was this true for the year which was expected to be the critical one—1943.

Thus, for 1943, Rubber Reserve promised an output of 400,000 tons of Buna S; the Survey Committee directed a production of 450,000 tons; actual production was 181,470 tons. Of butyl, 60,000 tons was directed; a mere 1,373 tons was forthcoming. As against the Committee's call for 596,000 tons production of all synthetic in 1943, only 217,235 tons, or about 37 percent, were produced. Overall, this inability to meet output schedules in 1943 led to a drastic scaling down of military allocations and exports; and to a reduction in the planned crude natural rubber stocks.

Ironically, after intense shortages during the early period, only partial use could be made of the synthetic rubber which was produced later. During the latter part of 1944 and in 1945, excess stocks of synthetic rubber were heaped up.[68]

The Survey Committee had greatly underestimated the proportional need for natural rubber. Consequently, in 1944, while synthetic stocks were accumulating, the stocks of natural rubber were being dangerously depleted.

Measured by its own objectives, the synthetic rubber program failed. For the fact that this failure did not have tragic consequences, we can thank the fortunate turn of world events, not the engineers and administrators of the rubber program.

The great test did not come in 1943 as anticipated. After Stalingrad, there was no longer any doubt about the staying power of the Russian Army. The cross-channel invasion was put off until May 1944. The rubber program was thus afforded more than a full year of grace; and the contemplated scale of warfare never did develop.

[68] "* * * the inventory of synthetics rose during the first half of 1944 from 43,806 tons to 104,495 tons * * * this increase in inventory was entirely due to the inability of the rubber goods manufacturing industry to consume as much as had been estimated should be consumed * * *." Rubber Director, Progress Report No. 6 (July 25, 1944).

It might have been otherwise. Had the crisis come when contemplated, it is doubtful that any petroleum-based synthetic rubber would ever have been produced.

Why did the synthetic rubber program fail to meet its goals and expectations? It may be assumed that the Office of the Rubber Director and other agencies did a workmanlike job of administration. The failure was rather one of planning and timing:

(*a*) Plans were laid with insufficient regard to the conflicting demands of other war programs.

(*b*) The time delays inherent in bringing complex innovative processes into full-scale operation were underestimated, as were the difficulties of converting equipment to the fabrication of synthetic rubber and of converting products to the greater use of synthetic.

(*c*) The administrators failed to foresee, through anticipatory product and processes research and testing or otherwise, the development of limiting bottlenecks; and, when the bottlenecks occurred, were unable to evade or break them.

Above all, what blocked and limited the program were the shortages of equipment, raw materials, and manpower. The crucial conflict was precisely the one the critics had forecast: the conflict with the demand for high-octane aviation fuel in the production of petroleum derivatives. This conflict arose, not only in the demand for butylenes, but also, as Wiezmann had predicted, in the demand for the whole research apparatus and the man and machine power of the petroleum industry.

The Office of the Rubber Director explained the cutdown in the program for producing butadiene from petroleum, thusly:

> The expansion of the high-octane gasoline program makes it essential that everything possible be done to avoid unnecessary drains upon components, facilities and feedstocks and labor usable by both programs * * * (February 18, 1943).
>
> * * * the need for isobutylene in the high-octane program is more urgent than its use in butyl rubber (February 18, 1943).
>
> A major raw material for butadiene from petroleum sources is butylene made from the cracking of oil, largely by the use of the modern catalytic cracking processes now being built for the high-octane gasoline program. The oil industry has undergone a huge expansion program to supply this material as well as other materials for the productions of butadiene and high-octane gasoline. Manpower as well as shortages of critical component parts, has delayed the construction of both butadiene plants and the raw material feedstock plants (November 10, 1943).
>
> Other new war programs rated as more vital and immediate have caused delays in the final completion of some of the large butadiene-from-petroleum plants. Consequently, production will not be at full capacity until the second half of 1944 (March 17, 1944).

At the same time that the demands for high-octane fuel delayed and limited the expansion and hampered the effectiveness of the synthetic rubber program, the demand for rubber strained, delayed and limited the aviation fuel program. Alcohol, on the other hand, was never a limiting factor.[69]

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[69] See the Progress Report of the Rubber Director, op. cit. supra, note 68:
"This diversion [of butylene to the aviation gasoline programs during July and August] made possible by the demonstrated overcapacity of the butadiene from alcohol plants—was agreed to in order to help fill the emergency requirements of Army and Navy aviation resulting from the flying of more than originally forecasted missions over Europe."

Because of the conflict between petroleum-butadiene and the aviation fuel program for equipment, labor, and basic raw materials, and because of the lesser complexity of the alcohol processes, it was alcohol-butadiene that carried the Buna S program (83 percent) during the year of the expected crisis, 1943, and which continued to shoulder the great share of the burden in 1944.

Butadiene production during 1943 and 1944 (in short tons)

	1943	1944
Butadiene from alcohol	129,685	361,731
Butadiene by thermal cracking of naphtha [1]	[2] 7,350	195,874
Butadiene from butylene or butane	[2] 20,400	
Total	157,435	557,605

[1] Approximately 48,056 tons were produced by this method in 1944.
[2] An adjustment was required to reallocate tonnages which were produced by thermal cracking but purified elsewhere.

When, because of a tapering off of military activity and a decline in the demand for high-octane fuel, more of the cheaper butylene were available, the production of butadiene from alcohol was cut back. During August 1944, however, before the cutback, the alcohol butadiene plants produced at the rate of 412,544 tons per annum, or at nearly twice their rated capacity. From this we may deduce that in order to have attained the highest output of butadiene attained during the war period (575,482 short tons in 1945 equivalent to 724,859 long tons Buna S rubber) we need only have built 163,000 tons of capacity in addition to the contracted-for alcohol-based capacity, instead of the rated 415,500 tons of petroleum-butadiene capacity which was in fact constructed. From the point of view of war planning, nearly all of the vast expenditure of vital resources in the building of petroleum-butadiene capacity was waste.

Viewing other aspects of the program, it would appear that planning greatly overestimated (*a*) the ease, value and economy of makeshift arrangements and underestimated (*b*) the difficulties and delays inherent in bringing into scale production innovative processes, proven at the laboratory or even at pilot plant level.

With regard to (*a*) and referring presumably to the "quick butadiene" program, the Office of the Rubber Director reported:

> Experience to date has shown that the use of a large measure of secondhand equipment in some plants, although seemingly advisable at the start, was false economy. The processes for making butadiene are difficult to make work even under the most favorable conditions. In several plants it has been found necessary to replace much of the secondhand equipment with new and specially designed equipment. In the same way it has been found that the attempts to overscreen some of the original designs in order to save bypass valves, spare pumps, compressors, etc., and to use substitute materials was false economy. The shutdowns necessary to install the missing units and replace the broken pipelines have been costly in both equipment and manpower, not to speak of the loss of vital production (March 17, 1944).

It would be unfair to explain the failure of the "quick butadiene" program wholly in terms of the technical limitations of makeshift arrangements, or to impute from this failure a condemnation of the "quickie program" as it had originally been conceived by OPC. The original program had been asked for in February 1942 in order to

produce butadiene in 1943. Construction on the actual program was not begun until nearly a year later—still in order to produce butadiene in 1943. The original program presumed a period of business crisis with gasoline gluts and widespread underutilization of plant capacity and manpower; the actual program was inaugurated at a time of industry overload with most companies straining to fulfill existing commitments, so that by now the large companies and the medium-sized independents were disinclined to participate. The original conception had been of an industrywide reorganization and reintegration of existing equipment; the actual program amounted to segregated negotiations with the small number of firms who had old or unused equipment which they thought might be turned to the cracking of naphtha. Indeed, 4 of the authorized projects (3 of which were canceled) were in no sense conversions but called for construction from the ground up of new plants using the Houdry process.

The second lesson which might be inferred from an examination of experience in the technical sphere would be the high degree to which the forecasts of the most competent experts must be discounted when they have to do with complex innovative processes; and consequently, the premium which ought to be placed, in times of urgency, on processes which are simple, developed and to some degree proven.

Thus the arguments of those critics of the program who contended that a greater shift should be made to alcohol-based butadiene on the grounds that the alcohol-based processes were simpler and proven by experience abroad, were substantiated by the events. Under the first "directive," 184,000 tons of petroleum-based capacity and 220,000 tons of alcohol-based capacity were given the very highest priority; but from the petroleum plants only 27,750 tons of butadiene was forthcoming in 1943, whereas the alcohol plants produced 157,435 tons. About the alcohol-butadiene plants, Rubber Reserve could in 1945 report:

> Operations * * * has been excellent. Initial operations were characterized by a minimum of operational difficulties.

The plants were operated up to 213 percent of their rated capacity. Nothing like this could be said about the reliability or expansibility of the processes on the petroleum side during the war period.

With the petroleum-based processes, less serious difficulties and fewer delays were encountered where the time previously devoted to its development was greater. The least difficulties were experienced with Standard's butylene dehydrogenation process. Phillips Petroleum Co.'s plant, producing butadiene from natural butane, was held down to a maximum of 60 percent of rated capacity during 1944 and 71 percent during 1945 on account of "process and operational difficulties." It is also notable that a limit was placed on the production of butadiene from butane (as well as from butylene) by the need "to divert substantial quantities of intermediate materials to increase the production of aviation gasoline." After repeated delays and breakdowns, the Houdry type plant at Toledo went into production during June 1944; operations during the last quarter of that year were at 50 percent and during 1945 at 60 percent of rated capacity.

The greatest disappointments were experienced in the attempt to get the complicated process for producing the new butyl rubber into scale operation. Substantial production, as we have seen, was not

achieved until late in 1944. Soon after the Survey Committee report, the current engineering plans for the production of butyl were found to be "impractical," and earlier less efficient methods were reverted to, with a corresponding decrease in planned capacity from 132,000 tons to 68,000 tons. The first unit at Baton Rouge was completed in early 1943, and operations were undertaken. Very serious difficulties were at once encountered and extensive redesigning and plant alterations were deemed necessary. To make their process work, Standard undertook an intensive new research and development program which was not completed, with a satisfactory construction plan and operating procedure finally set, until June 1944.

The Survey Committee had recommended the construction of an additional 20,000 tons of neoprene capacity in spite of the high cost of such an expansion in terms of critical materials and equipment because "neoprene is the one synthetic rubber which has been shown to be the full equivalent of natural rubber for combat and heavy-duty tires." In its second progress report on February 18, 1943, the Office of the Rubber Director reported:

> Further testing and experience have indicated to the military authorities that, except as a last recourse, neoprene and butyl will not be used for military tires.

Technical and program difficulties were also encountered in converting products to the use of synthetic rubber and in converting manufacturing capacity to the fabrication of synthetic rubber. Conversion difficulties and lags augmented the drain on natural-rubber stocks. In some instances the working out of the means of converting products to the use of synthetic led to the discovery that the materials required for such conversions were not available in sufficient quantities. For example, it was determined, after much experimentation and testing, that large truck tires could be made with a larger proportion of synthetic rubber if the synthetic were blended with special carbon blacks and the tires were made with rayon cord.[70] But the carbon blacks and especially the rayon cord were in short supply. In spite of a $75 million expansion program, the shortage of rayon cord remained throughout the war one of the limiting factors in the use of synthetic rubber. When such a bottleneck was foreseen, the remedy was not only to shout a warning but also to look for substitutes which were in more plentiful supply. Nylon cord was such a substitute for rayon cord but, as of March 17, 1944, the "technological problems incident to the use of nylon fibers" were not yet solved.

The difficulties and consequent resistances to the conversion of fabricating facilities are indicated by another instance. We are told by a high technical authority in the Office of the Rubber Director that the now famous "cold rubber" was known during the war, but that tire fabricators objected to being obliged to use a new polymer, even one of such superior qualities, on the grounds of delays and difficulties inherent in the adjustment of equipment, in work flows and in process development. For this reason "cold rubber" was not used for scale operations.

[70] Cf. Rubber Director, Progress Report No. 3 (May 17, 1943), p. 4.

CHAPTER IX

PATENTS, RESEARCH AND TECHNOLOGICAL DEVELOPMENT

A. PRELIMINARY COMMENT AND BACKGROUND

The particular interest of this study is in the relationship between Government policy through the patent system, and through the direction or support of research, to the development of an industrial technology.

It will be recalled that during the war a series of patent agreements was concluded between Rubber Reserve and companies participating in the synthetic rubber program. These agreements, covering the production of GRS (copolymerization), butyl, butadiene, and styrene and other components and providing for the pooling of patents and the interchange of technical information, were born of crisis and expediency. As such, they had two important virtues. They enabled operations to be put in motion with a minimum of preliminary negotiations between private claimants to patent rights, and they limited the liability of the Government.

The elaborate mechanism set up for the settlement of disputes concerning the division of the fixed Government royalty payment, contemplating mediation by the technical adviser and referral to an arbitrator selected by the courts, was not resorted to. GRS was royalty free, through the patent contributions of Standard and through the seizure of I. G. Farben's patent rights. Butyl remained strictly a Standard product, with licenses to Rubber Reserve. The bulk of the butadiene royalties were split four ways between Standard, Universal Oil Products, Phillips Petroleum, and Shell. As for styrene, Standard resorted to litigation in order to force Dow and Monsanto into a settlement on rights and fees.

Especially significant was the form of the patent agreements coupled with the organization of operations. A fixed royalty fee was paid by the Government to all operators, which was, in turn, repaid and divided among those whose processes were in use. Operators also received a fixed operating fee per pound of feedstock or of rubber produced. Thus, for the operator using his own processes, there was no profit incentive to develop new processes or to improve his old ones, for he would receive the same operating fee and the same royalty payment whether he developed much and added greatly to the producing technology, or whether he developed nothing and contributed nothing. In relying on him for technological development (and, as will be seen, the Government relied on him exclusively in important areas), the Government depended not even on private altruism but on company charity, for the private operators would have costs to incur in supporting development and no possibility of realizing profits as the fruit of such development.

Under this system, the licensed operator might be induced to develop his own techniques so as to preempt the royalty payment to himself, but he would not be induced to develop better techniques.

Moreover, under this system of patent agreements, there was not only eliminated the incentive of self-interest as a spark to technological development, but there was created for profit-seeking operators a positive deterrent to their searching out and incorporating into their own operations such superior techniques as might have been developed by others since, no matter how costs might thereby be lowered and their product improved, they could gain nothing by incorporating improvements from the outside; indeed, they might lose, since their share of the fixed Government royalty payment might thereby be lessened. The outside originator of the new development would have a claim on the share of the fee that hitherto they had held as their own.

After the war, the Interagency Policy Committee, in its second report, insisted that "the necessity of continuous and extensive research cannot be overemphasized," [71] but concerning the effect of the patent agreements on technological progress the Committee had its grave doubts. It expressed these as follows:

> The present intercompany exchange of information and Government-directed research programs might not be too well adapted to this end, even though a very broad area of synthetic-rubber research would be outside the field covered by the wartime patent agreements. A private company might want to hold back development of a new discovery if it were to be required to share the fruits of that discovery with its competitors. It might not be likely to lay the necessary stress on research of which it could not have the exclusive benefit. This attitude might, in turn, be reflected in the motivations affecting company research organizations. Private research personnel might not have adequate incentives if research assumed a minor role in company operations and if rewards and promotions therefore did not depend largely upon important improvements and new discoveries.
>
> The Committee, furthermore, believes competition in itself to be an extremely powerful incentive. A research problem involving original thinking and constructive imagination may better be solved by a number of research organizations working independently and in competition with one another than by one organization which may have undertaken the problem under Government sponsorship. * * * [72]
>
> It is * * * the consensus of the Committee that its recommended program of creating competitive conditions within the industry conducive to the maximum of research may be impeded by the continued technical information exchange and patent cross-licensing provisions of these agreements as to new developments. To the extent that the present agreements prevent private enterprise from enjoying exclusively the fruits of its future research under the protection of the patent system, they may restrain competitive operation of the industry and inhibit the development of new processes and new polymers.[73]

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[71] Interagency Policy Committee on Rubber, 2d Report, p. 41. This Committee, sometimes called the "Batt Committee," was formed at the end of the war to formulate the administration's policy on synthetic rubber. In a report published on July 22, 1946, the Committee recommended that, for strategic reasons, a guaranteed minimum of one-third of American rubber requirements should be satisfied with the use of domestically produced synthetic. Congress imposed a lower level of guaranteed output, to wit, 200,000 tons. Actually, commercial demands tended to exceed the imposed minima. The Committee also formulated a plan for the sale of the plants to private industry; and, in fact, certain styrene plants useful in the production of many plastics, and certain "fringe" facilities which could be sold without the need for assurances that they would be used for the production of synthetic rubber or its components, were sold. The bulk of the industry, however, which it was considered necessary to hold either in synthetic rubber production or in standby for such production, could not be sold to private industry at that time, since the long-range commercial prospects of the new material appeared at that juncture to be exceedingly poor. Hence, the industry continued to be owned by the Government, and operated by private contractors, as it had been during the war.

[72] Id., p. 55.

[73] Id., p. 57.

Faced with the futility of expecting the needed spur to progress under the existing system, the Committee could suggest no solution in terms of the reorganization of the system or in the direct organization of research. It could suggest only that the industry be sold quickly to private enterprise, and then that the patent and technological interchange system be scrapped completely. Thus:

> Active and vigorous research is most necessary if synthetic rubbers able to compete with natural rubber in a free market are to be developed. In order to add the competitive forces of private industry to the attainment of this objective, the Committee believes that the synthetic-rubber industry should be transferred to private hands as rapidly as possible.[74]

The Committee's solution was irrelevant. There would be no sale of the plants at that time, for there was no market for them. For the time being, a solution would have to be found within the context of Government ownership.

In spite of the continued operation of the industry under Government ownership, the general patent agreements were eventually terminated; the GRS patent and technical interchange agreement was ended by congressional action in 1946; the styrene agreement was cut off in 1948; the butadiene agreement was terminated in 1952; and the butyl agreement was also ended in 1952. The pressure to terminate the agreements came from private industry, over the resistance of Rubber Reserve. The purpose of the private operators in seeking the termination of the agreements, in spite of continued Government ownership, was, presumably, to free the hand of the firm in its jockeying for a stronger position with regard to acquired know-how and patent rights after the anticipated sale of the plants to private ownership. Rubber Reserve resisted the change, presumably because of the equivocal position in which the administering agency would find itself when it could no longer claim the research results of the private operators on whom it wholly depended for technological development.

In general, the patent and technical exchange agreements had provided for the subsidization by the Government of the research carried on by private firms and institutions, and for pooling the results under the ownership of Rubber Reserve. After the termination of these agreements, operating firms were no longer bound to pool all their research results, but could now undertake private projects, and keep their results secret or patent and withhold results pending their takeover of Government plants. Rubber Reserve proceeded to negotiate contracts with the operators of Government plants covering future research on Government account. In these contracts, the private operator was offered a subsidy to support its research within a defined field, under the proviso that the results of any research it carried on within that field would become the property of Rubber Reserve to be shared by all the operators of Government plants. The fields were broadly defined, and it seems to have been the hope of Rubber Reserve to recreate through these contracts the situation that prevailed prior to the termination of the patent- and information-interchange agreements. This was not possible. Not all avenues of research could be covered by such agreements; not all operators entered into these agreements, and the agreements themselves were subject to various interpretations as to what research projects did and did not fall within

[74] Id., p. 55.

their scope. In any case, after the termination of the exchange agreements, an undisclosed amount of private research was carried on by private companies, with a consequent accumulation of research results awaiting the day when the plants would be transferred to private ownership. The existence of such an undisclosed quantum of research results was bound to be a deterrent to the entry of newcomers into the industry when the Government ultimately disposed of the plants.

With regard to the patent and technical interchange agreements, then, the following can be concluded:

1. The agreements were designed to minimize the immediate problem of negotiation under the stress of wartime urgency.
2. The agreements did fix the level of Government liability.
3. They eliminated the profit incentive that companies might otherwise have had to develop lower cost processes and better products for the Government-owned industry.
4. They created a positive deterrent to the incorporation of new and more efficient methods into the Government operation.
5. The elimination of the agreements permitted a hidden sphere of private research to develop, but no new inducement was offered for the development of improved processes or products in the plants operated by these companies for the Government, or for the incorporation of more efficient known methods into Government operation.
6. Some provision was made in the patent agreements to facilitate turning over patent rights and technological information to the prospective purchasers of plants. Often, however, these provisions were vaguely worded and their value as safeguards was uncertain. Their value was to be indicated in subsequent events.[75]

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[75] Synthetic Rubber, Recommendations of the President, transmitted to Congress with a Report to the President on the Maintenance of the Synthetic Rubber Industry in the United States and Disposal of the Government-Owned Synthetic Rubber Facilities (January 1950). This report, prepared by John R. Steelman, assistant to the President, and hereinafter referred to as the "Steelman report," described the status of patents and technical interchange agreements, as they stood as of 1950, as follows (pp. 107–111):

Copolymer plants.—As a result of the cross-license agreement (buna rubber), the Government may give to any purchaser royalty-free licenses for the use of patents and technical information conceived by the signatories prior to March 2, 1946. These licenses are for the life of the patents. A purchaser who is not a party to these agreements, in order to obtain this information and these rights, must give his patents and technical information developed up to the date of his license, to Rubber Reserve for use by the signatories royalty free.

With respect to patents based on inventions reduced to practice between March 2, 1946, and March 31, 1949, by the signatories to the Agreement on Exchange and Use of Technical Information of December 19, 1941, as a result of expenditure of their own funds, nonsignatories will be granted licenses (any time up to the expiration of the 10th year after the end of the national emergency proclaimed by the President on May 27, 1941) upon payment of a reasonable royalty. After March 31, 1949, there is no provision under the agreement for the further exchange of technical information and granting of new patent rights by the signatories.

Since March 31, 1949, all companies operating copolymer plants have carried on research under research agreements with Rubber Reserve which provide that any and all technical developments arising from any research done by these companies on general-purpose synthetic rubber, regardless of the source of funds with which the research is financed, are available to the Government and its nominees without payment of royalty.

Research financed by the Government and conducted by these companies or by other private institutions from 1942 to the present has been conducted under agreements which provide that all resulting technical information and patent rights are available without payment of royalty to nominees of the Government.

In summary, it would appear that all technological and patent rights involved in the present operation of the Government-owned copolymer plants may be transferred royalty free to any purchaser of a Government plant.

Butadiene plants.—Under the General Agreement on Exchange and Use of Technical Information Relating to Butadiene of February 5, 1942, amended November 1, 1943, and the Substitute Agreement Regarding Exchange and Use of Technical Information and Patent Rights Under Oil Industry Processes for Production of Butadiene, of February 5, 1942, amended October 12, 1942, purchasers or lessees of Government-owned butadiene plants are entitled to licenses under all applicable patents and to technical information

7. No provision was made to assure that patent rights and technical know-how would be generally available to newcomers in the industry, other than potential purchasers of Government plants—an assurance that would have encouraged the creation of competitive conditions in the future.

One cannot say that the private operator of a Government plant, bound by a patent pooling and interchange agreement or by specific research contracts, was wholly without incentive to seek new developments or to incorporate them into the processes of the plant which he operated. Nonfinancial incentives do exist. Moreover, an operator who expected to take over the plant which he operated might be interested in introducing efficient methods into that plant. On the other hand, the private operator who was able to control the design of the plant he operated would tend strongly to see to it that the processes to which the equipment of the plant was adapted were processes upon which he had a strong patent claim, even though this meant forgoing the processes which, after objective evaluation, he was convinced were the most efficient ones. This ability to shape the Government plant in terms of the company's own patent claims would give the particular operator great leverage in bidding for the plant when finally it should be offered for sale, or, should another purchase it, would tend to strengthen the patent claims of the former operator against whosoever bought the plant.

Since it could not be expected that those who operated the plants and were bound by the patent exchange agreements would spontaneously provide a source of research and development for the Government-owned industry, the Government was itself obliged to organize a research program. This it did. By 1952 it had spent $40,895,839 on synthetic-rubber research directed toward 2 objectives. First, there was the strategic need to develop a synthetic rubber with a resistance to the generation of internal heat under pressure, i. e., of a low hysteresis, which could be substituted for natural rubber in the production

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developed by the signatories prior to the expiration of the general agreement. These licenses are for the life of the patents. The general agreement terminates with the expiration of the last operating agreement between a signatory and Rubber Reserve, or with the end of the national emergency, whichever is sooner. Under the general agreement, licenses are granted to signatories and nonsignatories on reasonable terms and conditions approved by Rubber Reserve, which terms shall not be less favorable than those offered others. Under the oil-industry agreement, licenses are granted to signatories and nonsignatories subject to payment of specified royalties (within a range of 0.125 to 0.375 cent per pound of butadiene) and to the condition that the licensee shall grant back to the licensor royalty-free licenses which are identical in scope to those which he receives and which later licenses are extendible to others on a reciprocal basis.

A limited amount of research on butadiene has been conducted by private companies and institutions with Government funds. The Government has complete royalty-free licensing rights to the results of such research done by industrial corporations and outright ownership of results of such research done by universities and research institutions.

Styrene plants.—The "Agreement on Exchange and Use of Technical Information Relating to Styrene" of March 4, 1942, entitles any purchaser of the one remaining Government-owned styrene plant to a license for the life of applicable patents and to the technical information theretofore used in the plant, subject to reasonable terms and conditions upon approval by Rubber Reserve and payment of a royalty not to exceed 5 percent of the actual sales price of the styrene produced in the plant.

Butyl plants.—Patent rights covering the manufacture of butyl were obtained by the Government under an agreement dated May 15, 1942, negotiated between Rubber Reserve and Standard Oil Development Co. and Jasco, Inc., which had developed this particular product. By that agreement, the purchaser of a Government-built butyl plant can be licensed (under patents based upon discoveries made prior to June 6, 1950) to produce butyl upon payment to Standard Oil Development Co. and Jasco, Inc., the licensors, of royalties of 3 percent of the net sales price of all butyl sold. The purchaser is also required to give to Standard and Jasco an irrevocable, nonexclusive, royalty-free license under any comparable butyl patents which he may have. Such grant-back licenses are extendable by Standard and Jasco to other licensees. Technical information with respect to operations under each licensed patent flows from licensor to licensee so long as the license is in effect.

of heavy truck and aircraft tires. Until such a synthetic rubber was developed the United States and its allies would remain to a considerable extent dependent on vulnerable foreign imports of natural rubber. Second, it was important to accelerate the pace of technological discovery in order to strengthen the competitive position of synthetic vis-a-vis natural rubber, thus to benefit consumers and hasten the day when the industry would be commercially secure and salable. It will be our purpose to examine and to evaluate the Government program in the light of these two objectives.

It should be made clear at the outset that this was not a Government research program. It was neither operated nor run by Government. There was virtually no synthetic rubber research by Government-employed scientists in centralized Government laboratories.[76] There was only Government subsidy of research done outside the Government. Therefore, the synthetic-rubber experience sheds no light on the value of Government research by Government scientists under centralized governmental direction. The lessons it has to teach relate to a program of quite a different sort—one in which Government subsidizes research by private companies. In this instance the RFC, through committees consisting of the representatives of private firms and private institutions, farmed out from $4 million to $8 million a year in support of research projects carried on by private companies, private research institutions, and universities. By 1952 private industrial companies had received $24,378,791, universities had received $12,882,311, and "others" had received $3,643,737. The allocation of Government funds to industrial companies, universities, and others is shown in the following table:

General research and development expense, synthetic rubber program, Reconstruction Finance Corporation, from beginning of operations through June 30, 1952

Universities:	
Akron, the University of	$328,470
Akron, the University of [1]	7,613,613
Case Institute of Technology	747,208
Catholic University of America	8,853
Chicago, the University of	762,669
Cincinnati, the University of	27,477
Cornell University	597,777
Delaware, University of	272,467
Illinois, the University of	1,097,232
Johns Hopkins University	71,732
Louisville, University of	21,584
Massachusetts Institute of Technology	408,080
Minnesota, the University of	631,214
New York University	29,706
Notre Dame, University of	25,074
Princeton University	44,616
Rochester, University of	35,243
Stanford, Jr., Leland, University	12,778
Texas, University of	116,918
Wisconsin, the University of	29,500
Total universities	12,882,311

[1] For the operation of the rubber evaluation laboratory.

[76] The exception is certain assignments made to the National Bureau of Standards.

General research and development expense, synthetic rubber program, Reconstruction Finance Corporation, from beginning of operations through June 30, 1952—Continued

Industrial companies:	
Cities Service Refining Corp	$7,479
Copolymer Corp	1,253,461
Copolymer Corp [1]	6,083,324
Firestone Tire & Rubber Co	2,985,624
General Tire & Rubber Co	422,313
Goodrich Chemical Co., the B. F	2,491,135
Goodyear Synthetic Rubber Corp	3,031,369
Humble Oil & Refining Co	136,659
Kentucky Synthetic Rubber Corp	87,978
Koppers Co., Inc	331,448
Lion Oil Refining Co	9,457
Midland Rubber Co	487
Monsanto Chemical Co	198,582
National Synthetic Rubber Corp	152,502
Neches Butane Products Co	45,698
Petroleum Conversion Corp	54,038
Phillips Petroleum Co	1,340,688
Shell Chemical Corp	714,105
Sinclair Rubber, Inc	9,292
Southern California Gas Co	181,875
Standard Oil Company of California	40,664
Esso Standard Oil Co., Louisiana division	2,090
Standard Oil Development Co	1,008
Sun Oil Co	167,972
Taylor Refining Co	5,013
United States Rubber Co	4,456,982
Vulcan Copper & Supply Co	10,000
Western Electric Co	154,158
Westvaco Chlorine Products Corp	3,390
Total, industrial companies	24,378,791
Others:	
Burke, Dr. Oliver W., Jr	243,091
Franklin Institute of the State of Pennsylvania	691,166
Mellon Institute of Industrial Research	1,447,542
National Bureau of Standards	1,230,321
Smith, R. A. H. Reesor	22,617
Total, others	3,634,737
Total expenses	40,895,839

[1] For the operation of the tire test fleet.

Research projects were decided and funds were allotted through committees consisting chiefly of representatives of the private participants in the program. Research contracts covered costs plus fee, and sought to provide for the disposition of equipment used. The results of such research accrued to the Government.

What then was the outcome of this large and expensive program? The answer is: "Nothing of importance." The RFC-supported research yielded no significant technological advance. The gigantic program was a gigantic failure.

It developed no important new rubbers. It failed to solve the problem, vital to national security, of finding a substitute for natural rubber although the solution of this problem was a primary objective of the whole Government research program for a full decade. It achieved no change in process resulting in a significant reduction of

costs. It achieved no important improvement in the quality of product.

There were, during the period of Government postwar ownership and control of the industry, a few important technological developments. Consider the source of these technological developments: A 1953 RFC report on the plan for disposal of the plants attempts to justify the "comprehensive research program" on the ground that it "led to contributions of major importance to the consuming public as well as to military planners." Only two such contributions are mentioned; namely, "the development of cold GR–S and oil-extended GR–S." [77] A 1955 National Science Foundation report likewise mentions only these as other than "minor improvements." [78] These two, then, cold rubber and oil-extended rubber, are touted as the major technological developments in synthetic rubber. It is also implied that they are the "product," the "contribution," of the Government-subsidized research program. This implication is misleading. Precisely these two developments, major if one chooses to so regard them, had their origins and development outside the Government-subsidized program.

From our studies it appears that not only these "major" developments, but all or nearly all of the other technological developments having a significant impact on the industry, had their origin in the peripheral private research conducted by a few companies outside the Government program—companies which, through the period of their critical research contributions, had no research contracts with the Government, received no Government moneys, and were (or thought themselves to be) relatively free to profit from their own discoveries.

Up to the year 1950, by which time all of these "major" technological contributions had been made, only four of all of the substantial industrial companies involved in the new synthetic rubber industry had remained (or were kept) outside of the Government-supported research program. It may be presumed that these four had the expectation of greater commercial benefits to be derived from their (revealed) research than would the other companies who were in the program.[79]

These four outsiders were General Tire & Rubber Co., Phillips Petroleum (and Chemical) Co., Dow Chemical Co., and Polymer Corp., Ltd. The last-named is a Canadian "crown company." Although the Canadian Government owns its common stock, the company is run for profit, with its survival at stake if it fails to make profits, and with all the usual incentives to self-gain and the freedom of maneuver associated with private corporations. It was precisely these four companies, in the brief period before the American companies entered into any research contracts with the Government and while they still were free of Government claims on the results of their research, who were responsible for the so-called major and the bulk of the significant minor new developments. This becomes apparent from the histories

[77] RFC, program for the disposal to private industry of Government-owned rubber-producing facilities (March 1, 1953), p. 38.

[78] NSF, recommended future role of the Federal Government with respect to research in synthetic rubber (December 5, 1955), p. 3.

[79] Standard Oil Development Co. (New Jersey) only participated to a minor extent, but subsidiaries and associates of Standard were important in the program.

of the main developments of recent years, briefly summarized below. These developments, reconstructed insofar as possible, are as follows:

(1) Cold rubber.
(2) Oil-extended GR–S.

In addition, brief note will be taken of developments in:

(1) The conversion of oil feedstocks into butadiene.
(2) The black-masterbatch technique.
(3) Cold-resistant butyl.
(4) High-abrasion carbon blacks.
(5) A synthetic "natural" rubber.

B. PRIMARY RESEARCH DEVELOPMENTS

(1) *Cold rubber.*—When GR–S is copolymerized at lower temperatures the result is a more flexible rubber with greater wearing and weather-resistance qualities. The lower the temperature of polymerization, the stronger the rubber becomes. The formation of ice on the vat surfaces, however, created operational problems.

Knowledge of the effects of lower temperature polymerization was not, in fact, new and the wonder is not that cold rubber has come into use but that it did not come into use sooner. Thus, we were told by the research chiefs at the B. F. Goodrich Tire Co. (which probably leads the field in rubber-chemistry research power) that before World War II Goodrich held nine patents covering a complete cold rubber polymerization process; that these patents had all been turned into the Rubber Reserve patent pool; that Goodrich had, from before the war, been aware of the superiority of cold rubber; that it had suggested the initial production of cold rather than hot GR–S and its suggestion had been vetoed because of the critical shortage of refrigeration machinery. We were told, also, by the wartime head of rubber research under the Office of the Rubber Director that the merits of cold rubber had been known during the war and that the idea of converting to cold rubber had been considered but abandoned because of the resistance of the manufacturing companies to anything that might further disturb their standard practices at that time of stress and crisis. But the question remains: Why wasn't the cold-rubber technique taken up after the war?

To this question we could get no answer from the former director of wartime rubber research; he had gone back to his own business and his teaching. We asked the research group at Goodrich: Why hadn't they pushed cold rubber (whose virtues were so well known to them) after the war's end? They replied candidly that they were not interested in the cold-rubber development or in GR–S problems generally. They had a contract with the RFC covering research in the field of GR–S and were not, therefore, in a position to exploit any GR–S developments to their own advantage. Nor could they legally reserve any GR–S developments for later exploitation. So far as GR–S was concerned, they carried out the project that was currently assigned to them and dutifully complied, submitted, and circulated the data related to that project (whatever it might be). It is, it turns out, a long and tedious matter to develop a laboratory-proven idea and to gain the support of one's own company for that idea,

let alone to sell it to the committees layered upon committees which constituted the vague activating mechanism of the Government research program.

After the close of hostilities in Europe, research teams returned from Germany with enthusiastic reports on low-temperature Buna S copolymerization. The Germans had worked out the fundamental theory and had developed the method at laboratory levels. The reports of the German claims were circulated, duly filed, and almost forgotten among the mass of scientific literature which crams our library shelves. Not quite forgotten, however. They were later picked up again by the Phillips Petroleum Co., which began to experiment with the process on its own.

Not only did Phillips have no research contract with the Government; it was not even an operator in the GR–S program, although it was a producer of butadiene. But prior to 1951, Phillips had been the private company which most persistently committed itself ultimately to purchasing an integrated rubbermaking operation and to going into the private production of both butadiene and GR–S. Phillips was intent on gaining a superior know-how that would enable it ultimately to outdistance in the private market those who had been operating GR–S facilities for nearly a decade. Therefore, Phillips took up the German theory, persisted with it, developed a working technology, carried production through the pilot state, and arranged for the fabrication and testing of the rubber. It was not until then, during 1949, that the RFC—desperate, we are told, for a fruitful avenue of research—embarked on the Phillips' line and carried development and testing to its present state. Low-temperature polymerization puts synthetic rubber in a position where it can outclass natural rubber for use in passenger car treads even when natural rubber is offered at a substantially lower price.[80]

(2) *Oil-extended GR–S.*—This is a process which produces a superior tread rubber at a (perhaps) 20 percent or more lower raw material cost than ordinary GR–S. Its development started with the speculations of a young research chemist, Dr. Emmet Pfau, who was then working for the B. F. Goodrich Co.

Pfau evolved a theory which may be described somewhat as follows: The straight copolymerization of butadiene and styrene produces a relatively hard, tough material but a material not malleable enough to be fabricated directly into tires. The relative strength of this material and its lack of malleability derives from the long, intermingled chains of butadiene molecules. In order to render this rubber plastic enough for tire fabrication, a modifier (neocaptans) is added at the copolymerization stage. This modifier chops up the butadiene chains and at once renders the finished material more plastic and weaker. Hard rubber could also be plasticized through the use of oil. Therefore it might be possible, by introducing oil into the copolymerization of unmodified GR–S, to produce a sufficiently plastic material, yet one which would retain the strength and elasticity derivable from the longer butadiene chains, and, at the same time,

[80] The use of improved carbon blacks and polymerization at low temperatures have combined to make the Government-produced Buna S rubber qualitatively superior to natural rubber for use in tire treads. It has been variously estimated that tires with the new synthetic rubber treads will give from 10 to 30 percent greater mileage than tires with natural rubber treads. Tread rubber makes up from 50 to 60 percent of the new rubber used in the fabrication of tires.

to produce that rubber at a reduced cost to the extent that cheap oil replaced the costlier styrene and butadiene.

Pfau had marked success with his laboratory experiments but the research chiefs and the higher echelons of the B. F. Goodrich management were not interested in his findings. To develop this process, would involve costs, trouble, and diversion of effort. B. F. Goodrich, with its Rubber Reserve contract covering GR–S research, was not interested in initiating new developments in this field. Under such circumstances it was not difficult to advance good reasons why this (or any new idea) could not be expected to work out in practice; e. g., the oil might migrate back through the tire to deteriorate the fabric of the carcass.

Pfau would not abandon his project. Instead, he went to the General Tire & Rubber Co. to offer his services and his idea. General, it will be recalled, had no research contract with the Government and was, therefore, in a position where it might possibly exploit the approach to its own commercial advantage. The idea also fitted into General's experiments with and successful use of the masterbatch technique. General hired Pfau and enabled him to continue his work.

The actual technological development could not take place nor could the new process be used in the facilities which General operated for the Government, for then General would be obliged to reveal the development under its operating agreement with the RFC. Therefore, General turned to Polymer, Ltd., in Canada and cooperatively with that company turned out in 1951 the oil-extended GR–S, trademarked and marketed as Polysar, Krynol or Polygen. General also tried without success to sell its process (without revealing it) to the RFC as a means of improving GR–S quality, lowering costs, increasing output, and conserving scarce butadiene and styrene supplies during the Korean war crisis. Under the circumstances it was now not difficult to deduce the nature of General's development and the RFC commissioned another tire manufacturer to develop a rival oil-extension process for GR–S. The research group of the RFC went to considerable trouble to prove that the oil-extension process was not original with or patentable by the General Rubber Tire Co. To this end they cited the use of oil as a rubber plasticizer and have cited also the published result of numerous experiments with oil-extended synthetics, all of which makes it the more remarkable, with the process being familiar and its values being known, that those charged with Government-sponsored research did not seize upon and develop the process much earlier on their own.

The most important result of the oil-extension process is drastically to reduce the costs of producing a rubber of superior qualities and, under the circumstances of war crisis, to ease the national security problem by reducing the styrene-butylene, and hence the butylene-benzene-industrial alcohol, requirement.

Thus, neither of the two major developments in the synthetic rubber was conceived within the frame of the Government-supported program. In both cases the essential data were under the noses of those charged with the responsibility of research and development in the Government-owned industry. In both cases those data were ignored by them until it had been incorporated into operations by those few

private companies who were then conducting private research in the expectation of private profit. In both cases it was the drive of the peripheral research outside the large Government-financed program that was responsible for these developments.

It is not implied, and it is not to be thought, that General Tire & Rubber Co. and Phillips Petroleum Co. had a better, more effective research organization than those companies who were tied to the Government through research contracts. It was simply that they were acting under a different set of pressures than those others who confined themselves to the performance of tasks assigned to them by the research committees of Rubber Reserve. As it turned out, neither Phillips nor General was able to profit from their original explorations and contributions. Any attempt in that direction was effectively prevented by the Rubber Reserve. General and Phillips were brought into the Government program. They were given contracts. They performed their assigned tasks and received their subsidy, but there is no record of further new and significant developments contributed by either company once they were within the fold.

C. SECONDARY RESEARCH DEVELOPMENTS

Aside from the development of cold rubber and oil-extended GR–S, the same preeminence of peripheral private research for profit over cooperative private research for a Government fee, revealed itself in other important areas of development.

(1) *The conversion of oil feedstocks into butadiene.*—One obvious area for advance in the postwar synthetic rubber technology was in raising the low conversion rate of petroleum feedstocks into butadiene. The Rubber Reserve research group sponsored no research in this area, apparently out of deference to those companies which had originally patented the butylene-to-butadeine processes.[81] Standard Oil (New Jersey), which held the patents, did develop a new catalyst which was more convenient for operators to use than the old one, but which, evidently, did not make any significant change in the conversion rate or in Government production costs. Clearly, under the given system of patent arrangements and operating fees, there was no profit inducement for Standard to develop a more effective conversion system. Royalties would not be increased. Fees would not be increased. An improved butadiene recovery process, indeed, would have cut down the market for the butylenes produced and sold as a feedstock material by the oil industry generally, and by Standard Oil as an important petroleum producer. The Government-sponsored program did not undertake research in this important area, presumably in deference to the private research of the petroleum refiners. But these refiners had no profit incentive to undertake the development of a more efficient butadiene catalyst, nor were they under any competitive pressure to do so.

The only important claim to a significant new development in the production of butadiene is by the Dow Chemical Co. which, in conjunction with Polymer Corp., has developed (and offered for sale)

[81] Even though the company that had originally developed the process was Germany's I. G. Farben, which was hardly interested in promoting the technology used in the United States production of synthetic rubber.

a catalyst which (it is claimed) would raise the conversion rate by 20 percent. This development, if its promise is fulfilled, would lower the production costs of GR–S and ease the potential conflict between the demands of high-octane gasoline and synthetic rubber for petroleum-butylenes. Both Dow and Polymer were outside the Government-financed research program and the circle of Government-plant operators.

The use of the Dow catalyst requires the installation of new, complex, and expensive machinery and the reorganization of operating systems. As was earlier noted, the system of private operations under a cost-plus-fee basis, gave no incentive whatsoever to private operators under the Government program to investigate what Dow had to offer, or to incorporate the Dow system into their operations. Moreover, the royalty payments received by important private operators would have been threatened by the introduction of the Dow system, thus creating a positive disincentive to the objective evaluation and possible use of the Dow system in the Government's program. Whether Dow's catalyst represents a highly significant contribution will be known only when, under competitive pressure, private operators are obliged to develop their methods with an eye to survival and to profits. Especially it will be seen in the choice of method in new plants built by independent operators.

(2) *The development of the black-masterbatch technique.*—This technique involves merely the mixing of carbon blacks with synthetic rubber still in the latex stage rather than grinding the carbon black into the already molded rubber. It (*a*) makes for cleaner and lower cost fabrication, (*b*) minimizes the need for complicated and expensive mixing machinery (such as the Banbury mixers), which effect is especially advantageous to the small processor, and (*c*) considerably lowers transportation costs. Synthetic rubber and carbon blacks are both produced in the petroleum areas. A premium must be paid to ship dirty, space-consuming, hard-to-handle carbon blacks, and that premium is eliminated by shipping it premixed in the raw rubber. The technique was initiated and developed by the General Tire & Rubber Co., independently of the Government program.

(3) *The development of cold-resistant butyl.*—As with butadiene, the Government research group sponsored no research in the area of butyl rubber, deferring to Standard Oil. Standard was without incentive to do any research for the Government under contract, for this would have meant turning patentable discoveries over to Rubber Reserve, thereby relinquishing Standard's own patent monopoly. Rubber Reserve acted, it will be recalled, as Standard's licensee. On the other hand, Standard had no incentive to conduct vigorous research on its own account, for it could use any new butyl discoveries that it made only in the plants that it operated for the Government, and this would mean neither an increase in royalties (for the royalty payment was fixed), nor an increase in profit through greater operating efficiency (for operating income was on a fixed-fee basis). Hence the butyl technology stagnated during the period of Government control.

One significant development did arise out of the tendency of butyl to grow brittle and crack at low temperatures. For this reason, extensive difficulties developed in the use of butyl inner tubes by car

owners in the American Northwest and especially Canada. Because of the effect on its domestic sales volume, the Polymer Corp., Ltd., was especially concerned with this problem. Polymer manufactured butyl as a licensee of Standard Oil of New Jersey, and was bound by agreement to a mutual exchange of patents and technical information with Standard, Therefore, Polymer first turned to Standard for assistance. Presumably because Standard was then relatively disinterested in butyl research and had no ready answer to the problem, or clear prospect of finding one, Polymer, whose business interests in the Canadian sales of its butyl output were very much at stake, tackled the problem on its own and solved it, incidentally evolving a new theory of the structure of butyl rubber. The problem was solved by extending the copolymerized isobutylene and isoprene with oil. Since oil is far cheaper than the two hydrocarbons, not only was butyl rubber improved in quality but its cost was lowered. The net result of this development was (*a*) to render butyl preeminent as an inner tube rubber for passenger cars under all weather conditions, (*b*) to render butyl usable in military inner tubes where resistance to very cold weather might conceivably be a prior condition for use, and (*c*) to lower production costs. Standard has claimed that it also solved the problem of cold-buckling and has challenged the priority of Polymer's claim. The disputes between companies need not concern us. Suffice that the development did arise out of the needs of a company that operated under competitive pressure. Once again, discovery and development were outside the Government-sponsored program.

The importance of a cold-resistant butyl is diminished by the advent of the tubeless tire. Standard, now in full private possession of the butyl rubber industry, in response to the crisis created by the diminution of the demand for butyl to produce tubes, has accelerated the development of the butyl rubber technology with a host of minor innovations that have the effect of opening new markets for the material. It had also developed the techniques for the use of butyl in the fabrication of tires, such as the development of a butyl latex usable in dipping tire cords.[82] These developments merely throw into sharper relief the stagnation of the butyl technology during the previous decade.

(4) *The development of high abrasion carbon black.*—Sharing importance with low-temperature polymerization in the qualitative improvement of GR–S is the use of the new high abrasion carbon blacks. The Phillips Petroleum (Chemical) Co., searching for new outlets for its refinery byproducts, developed these independently of the Government research program.

The foregoing summaries show that all the major developments in the synthetic rubber technology during the postwar decade and, so far as we can find, the minor discoveries and innovations as well, had their origin and initial development outside the Government-financed program. Devouring funds to the tune of $50 million, that program

[82] See Attorney General, Second Report on Competition in the Synthetic Rubber Industry, July 1, 1957, p. 21:

"The possibility of using butyl for automobile tires was indicated by research sponsored by the Esso Research & Engineering Co. Butyl tires, produced in 1956 at a pilot plant operated by Armstrong Rubber Co., are being made available to tire and automobile companies for testing. In announcing these developments, Esso claimed that butyl tires would cost only slightly more than those made from GR–S and natural rubber; provide superior traction; eliminate squeal while turning corners; improve riding qualities by absorbing shock and vibration; and resist cracking caused by atmospheric or chemical attacks on rubber."

never transcended mere routine. It never showed vigor, vision, originality. It never produced the results that count in significant innovation. The innovation that came, came from the peripheral private research beyond its orbit.

But, the most striking story is yet to be told. This has to do with the development of a substitute for natural rubber.

D. THE DEVELOPMENT OF A SYNTHETIC "NATURAL" RUBBER

We have seen that GR–S was not sufficiently a substitute for natural rubber to free the United States from dependence on imports of natural rubber from the distant and vulnerable East Indies. To develop a substitute which could be used instead of natural rubber in the production of heavy truck and aircraft tires, was the primary objective of the Government research program from the very beginning.[83] This was the principal reason why it was contemplated that the program of Government research would be maintained even after the transfer of private facilities into private hands.

It is not possible to determine from the data that has been published, just how many millions were devoted to the solution of this problem and which of the subsidies and projects were justified as being directed toward its solution.[84] But no matter how much was spent, the Government subsidized program did not solve that vital problem.

Just 6 months after the sale of the synthetic rubber plants to private industry, three tire companies, Goodyear, Goodrich, and Firestone, announced that they had each "succeeded independently in synthesizing material with composition and properties similar to natural rubber, using isoprene as raw material." [85]

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[83] See The Rubber Requirements and Resources of the United States, a report submitted by Dr. Arthur Flemming, Director of Defense Mobilization, April 23, 1956, pp. 8–9:

"(c) *Demand ratio between natural and synthetic rubber in the absence of controls*

"Some material having natural-rubber characteristics is required for products of adequate quality throughout virtually the entire gamut of rubber articles. The special qualities of natural rubber are particularly important for large truck and bus tires, and for airplane tires, the key to our transport and military mobilization. That is why we stockpile natural rubber.

"At the moment, new rubber consumption is almost exactly 40 percent natural, 60 percent synthetic. The record up to the present indicates reluctance of the United States rubber industry to use less than 40 percent natural rubber in rubber products, and willingness to use up to 60 percent (all that was available) at a price level near that of S-type synthetic. Whether the United States rubber industry would again willingly use 60 percent natural rubber, now that the synthetic plants are privately owned, is, however, open to question.

"Until 1955, whenever supplies of natural rubber became short, reduction of its domestic use to the 40-percent ratio usually sufficed to restore fairly close balance between demand and supply. If due to growing foreign demand for natural rubber, American rubber manufacturers should be unable to maintain a use rate of 40-percent natural, they would face the necessity of reducing their percentage use of natural—as for instance to 35 percent natural, 65 percent synthetic. The lowest rate for natural in the period 1947–54 was 36 percent in 1952, when its consumption was limited by official product specifications. During World War II, however, the natural-rubber ratio was very much lower, and for the year 1945 use permitted by Government regulations averaged only 13.2 percent."

[84] An example of the subsidization of such research is the instance of the Burke Research Co. Dr. Oliver W. Burke, Jr., one of the Rubber Reserve officials in charge of the Government-supported research program, left the Government in 1950 and set up his own research institutions, operating under Government subsidy. He directed his efforts to discovering a substitute for natural rubber, or, as he put it, "research directed toward the improvement of synthetic rubber for the manufacture of heavy-duty tires and tires on passenger vehicles with emphasis on the following two approaches: (*a*) Improvement of low hysteresis elastomer; and (*b*) improvement of the reinforcing agent."

By 1952, the Burke Research Co. had received $243,091, and in 1955 was still being subsidized at the rate of $150,000 a year.

[85] See NSF, op. cit. supra, note 78, p. 14: B. F. Goodrich Co., Amerpol SN–A Synthetic Cis-Polyisophrene and Firestone Tire & Rubber Co., A Cis-Polyisophrene Having the Molecular Structural Features of Hevea Rubber, both papers presented at the 68th meeting of the division of rubber chemistry, American Chemical Society, Philadelphia, Pa., November 3, 1955; Goodyear Tire & Rubber Co., Synthesizing Natural Rubber, Chemical and Engineering News (October 24, 1955).

Nothing could better illustrate the inadequacy of the Government research program, and its failure to utilize the research potential which, supposedly, it had put in harness.

It was Goodrich which succeeded in patenting the process for the synthesis of "natural rubber." Other companies resisted Goodrich's claim, and the Department of Justice has sued Goodrich, on behalf of Rubber Reserve, in an attempt to break Goodrich's patent. Whether the Government succeeds in this objective or not, the onus of failure will remain with the Government-supported research program. The line of research which led to the development of a synthetic "natural rubber" was not laid down and assigned by the Rubber Reserve research program, nor is there any claim by the Government that it was. Goodrich, Goodyear, and Firestone, in their development of the new process, were not performing tasks assigned to them by those charged with the organization of Government-sponsored research. These companies had tasks which were assigned and on which they reported, accounting for their results and for their expenditure of funds in a stream of 'CR" and "CD" reports. That the synthesis of "natural" rubber was outside the organization of Government-sponsored research is evidenced by the surprise which greeted the revelation of this accomplishment. Indeed, if these companies had actually succeeded in surreptitiously spending large sums of Government moneys over an extended period of time in the maintenance of a particular research project without the administering agency knowing of the existence of such research, then the program failed not only at the level of conception and organization (as we have contended), but also at the level of honest and effective administration. The Government's case, however, does not appear to rest on any contention that the developments in question were paid for by Government funds, or were planned and directed as a part of the rubber research program organized by Rubber Reserve. The Government appears to argue that (1) when Goodrich signed a research contract with Rubber Reserve and undertook the performance of certain tasks assigned to it, it committed itself through a clause which was contained in that contract to make available to the Government and its nominees "all technical developments arising from any research * * * *regardless of or the source of funds*"[86] (italics are by the Department of Justice) within a defined field, and (2) that the development of a synthetic "natural" rubber falls within the field thus defined in the Goodrich contract. It is argued, therefore, that the rights to use this process must be made available to all purchasers of Government plants, royalty free, even though the development was outside the Government-organized assigned research tasks, was privately financed, and would not have been undertaken except in expectation of profits to be derived through patent ownership. The legal merits of the Government's case need not concern us. It is enough to note two things: (*a*) While the development of a natural rubber substitute was the prime problem of national security and, presumably, the chief concern of those who organized the rubber research program for the Government, nevertheless the elaborate studies organized, the tasks assigned, and the projects financed by the Government for a

[86] Attorney General, op. cit. supra, note 82, p. 28.

full decade under this program, did not lead to a solution of this prime problem. By this measure, the program failed. (*b*) The problem was solved presumably by the peripheral secret research of a few firms that were, at a different level, participants in the Government-supported research program. This indicates that the cause of failure was not the scientific competence of the participants, but a weakness in the nature and organization of the program which was unable to harness that competence to primary objectives of Government-supported research. If these private participants siphoned off Government funds to support research projects of their own choosing, or were able to withhold for their own benefit, information which was the proper due of the Government, then the program failed doubly—in its conception and direction, and in its administration.

That the Goverment-financed postwar research program in synthetic rubber failed may be a fact of merely historical interest, for that program no longer exists. But it is of vital importance that we seek to understand why it failed, for if there has been an end to Government-supported research in synthetic rubber, Government-supported industrial research as a whole is not at an end but is constantly expanding in scale and significance. This author has given his interpretation of why that program failed in an article, Research and Development in the Synthetic Rubber Industry, which appeared in the Quarterly Journal of Economics, February 1954. Here we shall summarily recapitulate some of the major points made in that article.

Again, let it be emphasized that this was not Government research, but private research under Government subsidy.

The program was organized and run by representatives of companies, research institutions, and universities who were also participants in the program and beneficiaries of Government subsidy. Under this circumstance, the temptation existed for the participants of the program to run the program for their own sake and in the interest of their own profit and convenience, rather than for the sake of the public. Nor was there any technically competent, independently powerful Government authority able to speak for the interest of the public.

The program seemed to have left out of account the need to create a bridge between basic research and innovation, between the new concept or new knowledge and the incorporation of these into industrial operations. A mass of research was carried on with results published or tucked away in doctor of philosophy theses. But an effective means must also be at hand to realize and put into practice the technical potential of basic research, systematically seeking out the industrially significant idea or discovery and introducing it into the processes of production. Such a means was not at hand, as is evidenced by what happened in the oil-extended GR–S and cold-rubber areas of research.

The program seemed to have overlooked the need for an effective system of incentives. It relied on private enterprisers but not on the private-enterprise system. The business firm in itself is not, as such, a wellspring of progress. Attuned to the lure of profits and adapted to the competitive struggle, it functions as a part of a larger scheme. Remove this lure of profits and the pressure of competition and one is left with a bureaucracy that is without direction or responsibility.

Reason and history makes it clear that creative research entrusted to private companies is almost certain to fail, where the company is not driven to obtain results by the pressure of competition and/or by the lure of profits. These are what make the company move, and give it drive and direction. And nowhere is drive and direction more necessary than in wresting from the unknown new knowledge, new concepts, and new techniques. Other pressures and incentives might have been devised to substitute for the competitive drive of the market place, but none were devised. Large, reputable companies were taken into the program. They were paid well. The promise of profits was taken away. The threat of competition was removed. They were told to go discover—go develop—go find. But there was nothing to tempt or drive them. In consequence, they went through the motions; they honored their commitments. But nothing was discovered; nothing was found; nothing developed.

The program lacked a center of responsibility. It was run through a series of committees. And it is suggested that whatever the values of group concensus might be, successful research and innovation, involving as they do the probing of the unknown and the conception of the new, must rely on the drive, the vision, the imagination of individuals.

At bottom, the great lack in the program was that it was leaderless and directionless. There was no technically competent Government authority to whom the various participants were answerable. There was no independent, responsible authority, self-interested in the success of the program as an instrument for its (or his) own prestige or promotion to devise incentives, to exert pressures, to demand results from the participants, to evaluate performances and, on that basis, eliminate from the program those incapable of producing results, and to reallocate funds into channels where results were more consistently forthcoming.

The program did not fail because it was Government run. The Government did not run it—it merely paid for it. But, as events showed, passing out the cash is not enough.

E. POSSIBLE AREAS OF CONTINUED GOVERNMENT-SPONSORED RESEARCH

A case might be made for the continuation of some Government research in synthetic rubber, even now that the industry has been transferred into private ownership, inasmuch as there remain certain projects where the commercial incentive to development is not proportionate to their relative importance in terms of strategic needs and the social well-being of the Nation. A justification of Government research expenditure on such projects, however, amounts to an argument in favor of a level of State-supported research in many fields besides that of synthetic rubber.

Those projects where the value to the Nation is inadequately reflected in the commercial incentive to the undertaking, and which, therefore, require a special interest on the part of the Government, are likely to be of the following sorts:

(1) *Long-range fundamental research.*—Here, the expected findings are likely to be of a general value beyond the specific, commercial interests of the particular firm. Similarly, from the vantage point of the particular firm, a project might require an investment not com-

mensurate with the possible gains, although these findings might fully have justified the investment if they could be made available to a number of firms. In sum, these are projects where the individual firm, by reason of the nature or narrowness of its market, or by reason of its special and limited competence, or because of the legal circumstances, is not able to exploit fully the income-increasing potentialities of the findings which might be expected from a certain avenue of research. Such projects, shunned by the firm whose interests are narrow and specific and whose market share is relatively small, might well be carried on by a widespreading cartel, such as I. G. Farben in Germany, or by a large company with a very wide range of industrial interests, such as the Du Pont Corp. in the United States, or through an interindustry or intraindustry research association, such as the Cooperative Fuel Research Committee, as well as directly by (or for) the Government.

(2) *Research directed toward the development of materials of strategic value.*—The prime problem of developing a synthetic rubber which is a complete substitute for natural (or a sufficient substitute for natural in certain essential products) has now been solved. It might be necessary, however, to support the evolution of an industrial technology in this area, if commercial incentives are not sufficiently pressing. There are, no doubt, other items of military importance for which a strong commercial incentive to develop better adapted polymers is unlikely to exist because of the minute quantities which could be used even if the superior polymer were successfully developed.

(3) *Research into, and development of, alternative processes, alternative supplementary materials, or alternative polymers, which might aid in war planning or facilitate the industrial mobilization for war.*—The knowledge of such alternatives gives a flexibility to war planning by enabling a reshuffling of material flows. It also may indicate the need for a structural modification of the industry in order to lessen the possibility of program conflicts in an anticipated crisis. It would be directed toward enabling the readier adaptation to special shortages and toward the avoidance of bottlenecks to expansion.

There may be no commercial incentive to this search for alternative processes or polymers. The possibility of a divergence between commercial criteria and the social criteria appropriate to war planning is instanced by the case of alcohol-based butadiene in World War II.

(4) *Research directed toward the development of techniques of plant reconversion and material conservation, and other specific techniques of mobilization and war control.*

Government-supported research may be either centralized or decentralized. Decentralized Government-directed research—i. e., the practice of contracting out projects to private companies, research institutions, and universities—has a number of advantages. It facilitates the use of already existing equipment and trained research staff. It enables the various special capabilities of particular scientists or research groups scattered over the country to be brought to bear on particular phases of a given problem. It encourages a widespread knowledge of and interest in the problems with which the program is concerned. On the other hand, under such a system it is difficult to

create a real locus of authority and responsibility, to coordinate the spreadout efforts, or to bridge the findings of pure research into significant technological developments. Moreover, grants made to private companies are not likely to be effective unless there is a direct coincidence between the objectives of the program and the direct commercial interest of the companies.

Centralized Government-conducted research—i. e., the setting up of Government laboratories with projects carried on by Government-employed scientists—has a number of possible disadvantages. Standardized recruiting methods and fixed wage scales might make it difficult to bring into or hold within the organization first-class scientists, engineers, or research administrators. Bureaucratic procedure and political control might limit or stifle the requisite freedom of action. Nevertheless, such research has sometimes shown itself to be effective; for example, in aeronautical research or in the development of atomic weapons.

There are, moreover, certain advantages in centralizing such Government-financed research as does take place. Under a system of centralized research, it would be relatively easy to establish a responsible, authoritative, and accountable direction for the research carried on. A system of centralized research would serve to recruit and train an independent technical staff that is competent to assist in the formulation of the criteria and the resolution of the problems that are basic to effective planning and war control. In other words, such a system can help provide the special technical competence in Government which has been argued for throughout this study.

But whether research and development by Government is centralized or decentralized, one lesson, pointed up by the experience in synthetic rubber, is that any research and development program must be directed and run by a technically competent and responsible authority which stands accountable for the results, and whose position and reputation and/or monetary reward will be determined by the failure or success of that program.

After the sale of the Government synthetic-rubber plants, the operating research contracts with private companies were not renewed. However, research contracts with universities, individuals, and institutions, including the National Bureau of Standards, continued, with administrative responsibilities shifted to the National Science Foundation. The same group that was nominally in charge under RFC and Rubber Reserve continued in charge under the National Science Foundation.[87]

The Government evaluation laboratories at Akron were also brought under the control of this rubber group in the National Science Foundation.[88]

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[87] NSF, op. cit. supra, note 78, sec. C.

[88] Id., pp. 10–11: "In accordance with decisions by the Office of Rubber Director, the facility known as the Government laboratories was constructed in 1943 by the RFC. The eventual construction costs amounted to somewhat over $2 million. During the period 1944–55, the laboratories comprised one of the principal research and pilot-plant components of the synthetic rubber industry as operated for the Government during those years.

"The present net book value of the laboratories is approximately $545,000 * * *.

"The laboratories are presently operated by the University of Akron under a management contract with the National Science Foundation. In fact, the university has operated the facility for the Government since January 1, 1944. Under the present contract, the university is reimbursed for all costs incurred and is paid a yearly management fee of

A commission that included university scientists and leaders in private industrial research was formed to review and formulate a policy for the Government in regard to a postdisposal research program in synthetic rubber under Government aegis. This Commission examined the need for continuing Government-supported research. With regard to research in the interests of national defense, it concluded that—

> research directed toward specified end products needed by the military agencies, whether called basic research or applied research, is most appropriately carried on through contracts placed by the Department of Defense.[89]

The Commission also took note that the research problem of discovering a "synthetic rubber or rubberlike material to replace natural rubber completely" had now been solved, and the problem had become one of industrial development. The Department of Defense and the Office of War Mobilization must consider whether Government support will be required to accelerate this phase of industrial development. Thus:

> The Commission is advised that subsequent to the preparation of the MAB report, the Goodrich, Firestone, and Goodyear companies have each succeeded independently in synthesizing material with composition and properties similar to natural rubber, using isoprene as raw material. Isoprene, like the butadiene needed for GR–S rubber and the isobutylene needed for GR–1 rubber, can be made from petroleum in any necessary quantities, although much time will be required to complete the details of the industrial production methods, to integrate most economically any large new production of isoprene with other phases of the oil and petro-chemical industries, and to build the new equipment needed. The initial estimates of production cost are within the range of recent prices of natural rubber.
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> The Defense Department and the Office of Defense Mobilization will doubtless examine the prospects for supplies of natural-rubber substitute made by the new units, and will reach their own conclusions in due time; but prima facie, the natural-rubber substitute problem is now an economic and industrial problem rather than one requiring Government-sponsored scientific research. Economic conditions may provide an environment under which commercial development of the new processes for making natural-rubber substitute will move forward without any governmental action. If not, such an environment can be created by appropriate governmental action which may be either legislative or executive and may take any one of a number of different forms. * * *
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> The Commission feels impelled to recommend that the Government, at its highest levels, give immediate consideration to the following question: Does the national security require governmental action to foster the industrial development of the new processes of synthesizing "natural rubber"?[90]

The Commission was "unanimously and firmly of the opinion" that the Government should expand its support of fundamental or basic

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$50,000. The laboratories are managed as an operation separate from the university's educational program.

"The operating costs for the laboratories will approximate $950,000 for the fiscal year ending June 30, 1956.

" * * * The laboratories function as a member of the 'research team' which carries out the present rubber research program supported by the Government through the National Science Foundation. The activities of the laboratories are largely of an applied and developmental character. Some of its work is directed toward the servicing of the university contractors, but this is a relatively small portion of its total effort. Following cessation of governmental manufacturing operations as the synthetic plants were transferred to private hands, the laboratories have been concerned primarily with work on special projects suggested by the Department of Defense and recently with the solicitation of contract work to be undertaken for private industry."

The laboratories were sold in August 1957 to the Firestone Tire & Rubber Co., for approximately $760,000. Sale was by sealed bid to the highest bidder and was approved by the Bureau of the Budget.

[89] Id., pp. 12–13, Ch. III: Responsibility of the Federal Government for Future Supports of Basic Research in Rubber and Related Elastomers.

[90] Id., p. 13.

research, but felt there was no reason for a special appropriation for rubber research in this sphere of fundamental studies. Rather, the central agency charged with allocating Government research funds should be allowed to choose between alternative avenues of fundamental research in the area of high polymers and elsewhere, so as to maximize the value of such research expenditure. The Commission, therefore, recommended:

1. The present program of Government-sponsored rubber research projects, costing about $1 million per annum and now temporarily administered by the National Science Foundation, should be regarded as terminated at the end of June 1956.

2. In place of this program, the National Science Foundation should support a new and more basic program made up of research projects in the general area of molecular structure and arrangement, composition, and properties of high polymers, particularly elastomers, and methods of preparing such materials. To inaugurate this new program in the most effective way and to conserve the human and scientific assets developed under the former rubber research program, the Commission recommends that special funds be made available to the National Science Foundation for the 1957 fiscal year, during which the Foundation would wind up the old program, absorbing such parts of it into the new program as appropriate.[91]

Given the choice between general allocations by a central agency, and funds earmarked for research on rubber under a separate program, this recommendations seems sound. There remains however, the need for some research and development activities at a high level by Government (as against the mere allocation of funds through Government) if for no other reason than to develop a competence for evaluation within the context of social and strategic choice over the whole range of science and technology. This competence, as was shown earlier, may be vital to strategic planning and social choice.

The Commission also recommended the sale of the Government laboratories to private industry. The Commission rejected the idea of transferring the facilities to the National Bureau of Standards in spite of the "advantages which might accrue to industry, the Government and the general public" because the Commission was "not convinced that the acquisition of the facility is essential to the program of the Bureau of Standards."[92] This last recommendation depends on the doubtful underlying premise that direct research and development as a Government function should be minimized. Even aside from the need to develop a vastly greater technological competence within and as part of the frame of Government, that which is "essential" in the program of the Bureau of Standards or of any other Government research agency is never an absolute, but has meaning only insofar as thereby "advantages might accrue to industry, the Government and the general public."

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[91] Id., p. 15.

[92] The Commission's comment was summarized by the National Science Foundation report as follows (id., p. 19):

"The Commission noted certain advantages which might accrue to industry, the Government, and the general public were the laboratories to be placed permanently under the Bureau of Standards. Any occasional need of the facility by Government agencies could be met easily, work which was not in any way competitive with private laboratories could be performed for industrial concerns on a fee or contractural basis, and the facility could integrate partially into the regular activities of the Bureau. However, the Commission is not convinced that acquisition of the facility is essential to the program of the Bureau of Standards, although that part of the facility concerned with physical testing and evaluation might be used by the Bureau in its programs of materials testing and standardization."

As noted above (note 18), the laboratories have now been sold to the Firestone Tire & Rubber Co.

F. CONCLUSION

This chapter warrants a brief word in summary and conclusion. A critical chapter in American industrial development, and especially an important chapter in the development of the relationship between Government and industry in the support of research, has now been surveyed. The survey indicates that Government subsidy of research standing alone will not suffice. It is not enough to rely on reputable companies and well-known scientists. The mechanism of action and self-interested motivation must not be lost sight of, as it frequently was in this program. A Government research program, to be effective, must have leadership; a leadership that is clearly motivated, powerful, knowledgeable and responsible; one that is prepared to stand or fall on the basis of results. We would generalize to suggest that whether or not the Government is now spending enough for research, clearly too much is being spent without attempting to evaluate the results of such expenditure. Direction, evaluation, choice and incentive are as necessary in this as in any other activity. Patents are part of the mechanism of action and motivation; and if their use is misplaced, patent arrangements may be a positive disincentive to progress and a barrier to development; as they were in synthetic rubber research while the industry was Government-owned and privately operated. Finally, in sponsoring or organizing research, the Government cannot overlook the need to develop (possibly as an aspect of its research programs) a technical and scientific competence permanently integrated within its own decision-making apparatus.

CHAPTER X

THE TRANSFER TO PRIVATE OWNERSHIP

The first of several plans for the sale of the synthetic rubber plants was formulated by the Interagency Policy Committee on Rubber (the so-called "Batt Committee") in 1946. The facilities were divided into the efficient "basic" plants and the "fringe" plants. It was proposed that the latter be sold without conditions, for whatever they would bring; and that negotiations be entered into to sell the "basic" facilities under conditions designed to insure (1) that the plants would continue to be used to produce synthetic rubber, and (2) that a sufficient capacity would be purchased to "constitute the nucleus of a strong and diversified private industry." Then the Government would cease the production of synthetic rubber once and for all. The possibility of a piecemeal disposal of the "basic" plants was rejected by the Committee, for this would put Government in competition with private industry in meeting the demands for synthetic rubber.

Subsequently, the fringe facilities were sold to be dismantled and junked or to be used to produce specialty synthetics, such as rubber-based paints. For the basic facilities, there was then an insufficient market to permit of a general disposal.[93] Du Pont bought the neoprene plant. Four of the five styrene plants were sold to private chemical companies (styrene having many commercial uses aside from the production of synthetic rubber), with the Government retaining the right to purchase a fixed proportion of their output.

In the years that followed, plans for the sale of the facilities were prepared by the Rubber Industry Advisory Committee, by the Petroleum Industry Advisory Committee, and by the RFC. Most significantly, an interagency committee under the chairmanship of John Steelman, assistant to the President, formulated a comprehensive report on the industry, including a proposal for its disposition. This report, endorsed by President Truman, was forwarded to the Congress in January 1950. The Steelman report blueprinted a procedure designed to increase the number of potential bidders for the plants, and to create industrial conditions which would maximize competition under private ownership. It was recognized in the Steelman report that both these objectives would be difficult of attainment. Negotiations must perforce be limited to those few business entities which were both technically competent and financially powerful, since operations involved new and complex techniques and since large sums of money would be required to purchase and to operate physical units of this magnitude. It would require, the report estimated, annual working capital of more than $2,500,000 to operate a single GR–S

[93] Cf. the author's The Sale of the Synthetic Rubber Plants, in Journal of Industrial Economics, December 1953. With the single exception of Phillips Petroleum Co., no firm appeared aggressively intent on buying butadiene and copolymerization capacity and going into the synthetic rubber business during the early phases of the program.

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plant. Moreover, the large tire and petroleum companies which had built and which had, for a decade, been operating these plants possessed special advantages in any bidding for them. These firms alone had the organizational know-how, the special technical competencies, the experienced operating staffs, and research personnel trained in terms of the technology and science of synthetic rubber. Since these companies had been conducting private synthetic rubber research projects at least since 1948, it could be supposed that they had an accumulated backlog of unapplied and unexploited invention—which supposition might be sufficient to frighten away an outsider from bidding. Moreover the companies operating GR–S plants controlled a major part of the market for GR–S, while the companies operating feedstock plants owned the refineries upon which these plants must depend for basic raw material. And all butadiene plant and butyl plant capacity was physically integrated into the private operations of petroleum refiners.

To meet the difficulties of dispersing ownership widely, financing schemes were designed to shift the risks of initial operation to the Government, with the recommendation that special terms be extended to "nondominant firms and especially small business." It was proposed that limits be set on the amount of capacity that could be acquired by a single firm, and that "three step" vertical integration be forbidden except by a special Presidential determination. It further recommended that Government "undertake to reach understandings with the signatories of the agreements as to what constituted the maximum limits of a 'reasonable royalty' "[94] as written into the patent agreements, and that a statement of the precise meaning of the phrase be widely advertised to prospective purchasers along with other clarifications of the terms of sale. The various antitrust objectives and procedural protections suggested by the Steelman report were destined to be ignored. The onset of the Korean war prevented carrying out the plans under the Truman administration, and in the administration which followed, there was a change in the guiding values of Government.

It has been universally recognized that the operation of Government-owned synthetic rubber plants by private companies tended to give these companies a cumulatively more favored position with regard to the ultimate takeover of the plants they operated—hence minimizing the likelihood of a vigorous bidding for the plants and a wide dispersion of their ownership. Alternative systems for the operation of the plants under Government ownership might have avoided this bias.

One such alternative is suggested by the organization of the Canadian synthetic rubber industry. During the war, an integrated synthetic rubber unit capable of producing 101,368,000 pounds of rubber in 1946, was built for the Canadian Government in the newly industrialized area of Sarnia, Ontario. Finding no private buyers after the war, the Canadians organized the property into a so-called Crown Company, Polymer Corporation, Ltd. An individual was chosen by the Government to act as President and Chairman of the Board of the new company. He in turn selected a group of prominent Canadians as Board of Directors. The board, serving without remuneration, was approved by the Government. Thereafter the Board of Directors

[94] Steelman report, op. cit. supra, note 75, p. 81.

perpetuated itself by selecting its own succession, and maintained the same relationship to the senior company officials as they would in a private company. A staff was hired; operations were carried on. Given virtual freedom of action as a competitive agent on a free market, the Crown Company was set loose to sink or swim. During the war, operations in Canada had been carried on by private operators on a fee basis as in the United States. These contracts were gradually terminated and by 1951 Polymer was working all of its own facilities. The subsequent success of the Canadian Company, unaided and without a sufficient domestic market for its product, was no mean achievement. Emphasizing research, it developed profitable specialty markets and sold electric power, steam, styrene, ethylene, butane, and isobutylene, all as byproducts of the synthetic rubber operation. It reinvested a part of its profits to expand its operations, and in part has channeled its profits, i. e., paid dividends, to the Canadian Treasury. The Canadian approach would not have been appropriate to the whole of the American Government-owned industry, because of the monopoly power which such a single firm, so organized, might have possessed. But this type of operation would have been appropriate for the organization of a part of the American synthetic rubber industry, say, that part which could not have been disposed of by sale to private industry in 1946 or thereafter under conditions which would have safeguarded the public interest. This sort of organization not only avoids favoring particular operators in the ultimate disposal to private ownership, and makes use of market incentives as a spur to efficiency and progress; it also has the advantage of making possible a gradual shift of ownership through the sale of shares in a going concern, using organized security exchanges as the medium for marketing the stock. Clearly, the market for shares is much wider than the market for facilities. Individuals and concerns can thus be enabled to participate in ownership without the initial possession of technological know-how and vast financial resources. Under such a system the Government could, where strategic interests require, continue to hold a portion of nondividend common stock so as to retain a voice in the formulation of industrial policy where strategic interests were affected.

The stage was finally set for the disposition of the plants during the first Eisenhower administration. On August 7, 1953, the President signed the Rubber Producing Facilities Disposal Act of 1953 (Public Law 205, 83d Cong., 1st sess.).

A three-man Commission was set up to sell the Government plants. The Commission advertised in November 1953 for proposals to purchase the facilities. In May 1954, at the conclusion of the 6-month period for the receipt of proposals, 56 proposals and 19 alternative proposals had been received from 35 prospective purchasers. Negotiations were commenced and continued for 7 months. On January 24, 1955, a disposal program was recommended providing for the sale of 689,600 tons of GR–S capacity, and 90,000 tons of butyl capacity. The statutory minimums required by Congress as a prerequisite for sale had been 500,000 tons of GR–S and 43,000 tons of butyl.

The Commission had been charged by Congress with several objectives: to obtain the "full fair value" for the plants, to insure that disposals would be in a form "consistent with national security," and

to construct a "free competitive" synthetic rubber market and one in which small business would be able to obtain a "fair share" of the end product of the industry.

It would appear, however, that the criterion which primarily shaped the negotiations and subsequent form of sale was that of obtaining as high a sales price as possible for the Government plants. In essence, if there had been no other criterion than this, the form of the plant disposal would have been precisely as it was. Thus, in response to the injunction by Congress that "in the event that there may have been a financially more advantageous proposal for the rubber-producing facility than the sale recommended, [the Commission submit] a statement of the reasons why such a sale is nevertheless proposed," the Commission could reply in its report that "without exception, the Commission sold to the highest bidder." [95]

It is beyond our competence to judge whether a "full fair value" was received for the plants. The Commission asserted that the selling price of the facilities covered 99.2 percent of the "estimated replacement cost less depreciation and obsolescence" of those facilities [96] In one instance, the Commission refused to sell a plant on which only one bid had been received because it could not negotiate a "fair value" price.[97]

With regard to national security, the Commission chose to assume (probably quite rightly) that the growing commercial outlets for synthetic rubber would guarantee the continuing availability of industrial capacity better than any paper assurances could. Nevertheless, the Commission inserted a national security clause in each contract of sale, as it was required by statute to do, supposedly insuring—

> the prompt availability of the facility, or facilities of equivalent capacity for the production of synthetic rubber and its components—

for a period of 10 years from the date of the transfer of the facilities. The national security clause is essentially a weak one. It provides for the reactivation of equivalent capacity within 180 days (approximately 6 months) after a formal request had been received for reactivation from the Government, with indefinite extension allowed where the—

> purchaser is unable to comply therewith by reason of its inability to procure essential material, unavailability of labor, * * *

But it is at precisely the times when the Government would require quick reactivation that labor and essential equipment and materials would not be available. The only type of security reservation that would be meaningful would be one that assured that a critical plant would be available in time of crisis without imposing an additional drain on special labor and on scarce equipment and materials.

There was very little competitive bidding on the plants. This change as indicated limited the possibility of maximizing the competitive structure of the new market. It also creates doubts whether the plants were sold at their "full fair value."

For the butyl plants there was no competitive bidding. Bids were received only from Standard Oil or its affiliates.

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[95] Rubber Producing Facilities Disposal Commission, Report to Congress Recommending Disposal of Government-Owned Rubber Producing Facilities (January 24, 1955), p. 31.
[96] Id., pp. 16–17.
[97] Id., p. 21.

As for the copolymer plants, except for the Los Angeles plant, only one bid was received for each of the plants offered for sale. In every case it was from the tire or rubber-products company (or companies) which had operated that plant for the Government. The extra (and successful) bid on the Los Angeles copolymer plant was that of a subsidiary of Shell Oil, which sought to preserve the technical unity of the integrated styrene-butadiene-copolymerization operation in Los Angeles, for which Shell was bidding.

In butadiene there was some competitive bidding, as is shown in the following table.

Bidders for butadiene plants

Location	*Bidders*
Port Neches, Tex., plant	Goodrich-Gulf Chemicals, Inc.[1] Texas-United States Chemicals Co.[1] Allied Chemical & Dye Corp. W. R. Grace & Co.
Houston, Tex., plant	Food Machinery & Chemical Corp.[1] Allied Chemical & Dye Corp. Goodrich-Gulf Chemicals, Inc. Goodyear Synthetic Rubber Corp. Sinclair Refining Co. W. R. Grace & Co.
Baytown, Tex., plant	Humble Oil & Refining Co.[1] Food Machinery & Chemical Corp.
Lake Charles, La., plant	Petroleum Chemicals, Inc.[1] Merck & Co. and Climax Molybdenum Co.
Torrance, Calif., plant	Shell Chemical Corp.[1] Dow Chemical Co. Edwin W. Pauley Standard Oil Co. of California
Baton Rouge, La., plant	Copolymer Corp.[1]
Borger, Tex., plant	Phillips Chemical Co.[1]
El Segundo, Calif., plant	Standard Oil Co. of California [1]

[1] Successful bidder.

There were thus 15 bidders for 8 plants. In every case but one, the successful bidder is to be identified with previous operation of the Government facility bid upon. This confirms the significance of the entrenched position of those who operated facilities for the Government. It is to be noted, also, that the number of bids received was very small considering the momentous opportunity represented by the disposition of the Government plants. Furthermore, the petroleum producers did not bid against each other. Most of the stimulus to bid came from outside the circle of Government operators, chiefly from chemical companies presumably interested in the use of butadeine for purposes other than the production of synthetic rubber. As the report described it:

> In every instance the present operator filed a proposal for the plant adjacent to his refinery, and, conversely, with the exception of the butadiene plant at Torrance, Calif. (which has been run in tandem with the plant operated by Standard Oil (California) and on which that company did file a proposal), no petroleum company either within or outside the program filed a proposal for a plant adjacent to another oil company's refinery.
>
> A petroleum refiner would be disinclined to place himself in a position of extreme dependence for feedstock on a direct competitor in the petroleum field. Thus, the outside interest evidenced in the butadiene plants came from major chemical companies, which historically have been purchasers of various feedstocks from oil companies. Further explanation for the interest evidenced by chemical companies is the rather widespread belief in the industry, a belief which

the Commission shares, that butadiene, while presently in major use only as a feedstock for GR–S, has a promising future as a major industrial chemical quite apart from its use in the manufacture of synthetic rubber.[28]

It is somewhat surprising that the Attorney General accepted this pattern of bidding without protest. It is not enough to pass this off, as the Commission did, with the suggestion that—

the size of the facilties and the technical and financial requirements for their operation was such as to preclude their purchase by small business. It was further pointed out that the most likely purchasers, particularly of the coplymer plants, were the present operators.

It is not enough to pass it off, as Judge Barnes did in testifying for the Department of Justice before a Senate committee, by referring to the following passage from the Reconstruction Finance report of March 1, 1953, which stated:

The most likely purchasers of the synthetic-rubber facilities are the rubber, petroleum, and chemical companies now operating them for the Government's account. Obviously, the desire of the rubber companies to control the source of their raw materials supply, and of the petroleum companies to maintain an outlet for their refinery products, provided initial business incentive to this result.

Additionally, the present operators of these facilities have acquired a familiarity with management and operating problems that places them at an advantage over newcomers to the field. The likelihood the disposal will in large part follow this pattern is enhanced by the circumstances that many of the facilities are dependent for their efficient operation upon adjacent facilities owned by the present operators which were never part of the Government program. Such dependence rests upon feedstock supply as in the case of the butyl facilities and several of the butadiene plants, and in some instances upon the supply of essential utilities, such as steam, electricity, or water. This dependence is not absolute from an engineering viewpoint, but in most instances severance can be achieved only at the cost of substantial economies.[29]

Even if it is true that Government operators acquired know-how, etc., which favored them in the bidding, there are many questions left unanswered.

Why did no outsiders, i. e., others than those operating on Government account, bid for GR–S plants?

Was the rubber market shut off for them?

If the reason was, as alleged, that only operators had the special know-how of the particular plant, then why did 10 outsiders without the know-how of the particular plant bid on the styrene plant? Why did a number of outsiders bid on the butadiene plants though they had no plant and industry know-how? Butadiene operations were much more interlocked with the refinery operations of adjacent facilities of oil refineries than GR–S facilities ever could be with those of the tire fabricators. Indeed, GR–S facilities were often located half a continent away from the tire plants, yet outsiders came in to bid on butadiene plants but not on GR–S facilities.

And even if, because of "know-how," etc., outsiders could not bid to advantage, then why did not those who had operated the Government GR–S and butadiene plants and had all the know-how, bid against each other?

Each GR–S plant operator, for example, submitted one bid for the plant(s) it operated. That was all. No rubber company challenged

[28] Id., pp. 26–27.
[29] Hearings before the Subcommittee on Production and Stabilization of the Senate Committee on Banking and Currency, 84th Cong., 2d sess. (March 9, 1956), p. 21.

the bid, nor did this company bid to take the plant of other GR–S operators. When General Tire & Rubber's bid was rejected because the company did not meet the Commission's criteria of "fair value," no other operator then ventured to bid.

Inasmuch as the system of Government operation, through private contractors, did give private companies special advantages in the takeover of Government plants, would it not be appropriate to reappraise that system of operation so as to devise a future approach that will not so restrict the area of potential disposal? Has this experience, for example, any relevance to the present policy of the Atomic Energy Commission in the area of industrial development?

No doubt, the factors pointed to by the Commission and by Judge Barnes—i. e., the large-scale nature of the operations, the intermingling and interdependence of plant facilities, the possession of know-how peculiar to a given plant, the numerous tangible and intangible advantages that inhered in the market position of the previous operator—serve to explain the apathy which prevailed. However, the possibility cannot be overlooked of some sort of understanding, agreement, or conspiracy on the part of the interested concerns to eliminate any effective competition as between themselves in the bidding for Government facilities.

There is also another factor, more directly within the scope of administrative discretion, which minimized the possibility of effective competition in the purchase of Government facilities. This was the policy of the Government in its dealing with patents and industrial know-how.

To what extent did Government patent policy preclude an active interest by outsiders in bidding for Government plants? It was clear that, during the long years of Government operations, there had been no clearing of the decks of the patent barriers to disposal. Thus, when the Disposal Commission inquired of those involved in the synthetic program as to the patent rights to which private companies laid claim with regard to processes and products "presently in use in Government-owned facilities," the companies involved in the Government program listed a large number of patent rights, and indicated their firm intention of asserting these rights againsts future owners and operators of the Government plants.

Dow listed six patents covering the production, preservation, and utilization of styrene and related compounds.

Standard Oil (New Jersey) listed very extensive claims to control over the production of butyl rubber, isobutylene recovery, isoprene recovery, styrene production, and butadiene production and recovery. This included 163 butyl-rubber patents, 56 patents relating to butane dehydrogenation and to the extraction of butadiene, 13 styrene patents, 19 isoprene patents, and 21 isobutylene patents.

General Tire & Rubber Co. asserted claims covering the so-called black-masterbatch process in the production of GR–S, and the process for producing oil-extended rubber.

Goodrich asserted patent rights in certain processes of butadiene purification.

Gulf asserted five patents covering the production of butadiene.

Hercules Powder Co. (Du Pont) asserted rights under 19 patents relating to the production, compounding or vulcanization of buna rubber.

Phillips Petroleum Co. asserted rights under 21 patents covering (unspecified) aspects of Government operations in particular plant complexes.

Shell Chemical Corp. asserted miscellaneous patent claims relating to the production of ethylene (1 patent), the production of ethylene benzene (7 patents), the production of ethyl benzene dehydrogenation catalyst (10 patents), the process for ethylene benzene dehydrogenation (14 patents), copolymerization (6 patents), copolymer softeners (5 patents), copolymer plasticizers (2 patents), copolymer compositions (2 patents), cold-acid polymerization in production of butadiene (5 patents), butylene extraction (7 patents), butylene dehydrogenation (7 patents), butadiene extraction (2 patents), butadiene stabilization (3 patents).

Can it be doubted that this phalanx of patent claims provided a formidable barrier and discouragement to all those outsiders who might be inclined to enter into the industry through the purchase of Government plants?

An idea as to the worth of the supposed protection extended by the Government to prospective plant purchasers with regard to patents is indicated by the procedure by which the Disposal Commission dealt with these rights. First, the Commission distributed an enormous Brochure of Agreements Relating to Patent Rights, Technical Information, etc., in Connection With Sale of Government-Owned Rubber-Producing Facilities. This brochure covered only certain illustrative agreements, and it was stated flatly that the "following commentary is designed to facilitate location of pertinent agreements, but does not interpret any agreements."

The Government did not help the prospective purchaser find out where he stood with regard to claims to patent rights and technical information in the plant on which he was supposed to bid—for the simple reason, as far as one can tell, that it did not itself know where he stood. It referred him to the complex of agreements, and told him to figure them out for himself and make up his own mind as to what his chances were. Could it be doubted that such a situation of uncertainty would discourage the newcomer from venturing into the field?

The Government also publicized and circulated the claims made by various companies as to their rights against private purchaser-operators of Government facilities, with the statement that—

> The attached collation of statements on rights made by various prospective purchasers is solely to aid bidders in their check of pertinent situations. In no way does this constitute any representation whatsoever by the Commission.

In retrospect, the Commission's circumspection appears to have been well advised, whatever its dampening effect upon prospective bidders. Sale of the plants plunged the new industry into a period of struggle, controversy and negotiation, as the respective parties, under the threat of litigation, sought to settle their conflicting claims and bring order out of the confusion that existed. The course that events have followed bears little resemblance to the claims of guaranties and protections to prospective purchasers, so often vaunted by the administrators of the rubber program.

In sum, the existence of a mass of patent claims on processes built into Government-owned plants, and the uncertainty of prospective purchasers as to the claims which might be made against them, and as to their consequent relative position in a competitive struggle, may in large part account for the failure of the Government to create a broad demand for the property which it was offering.

The Government had allowed private companies to incorporate their patented processes into the Government-owned operations with which they were charged. The machines, equipment, and factory design as offered for sale, were likely to be useful only in the operations of these processes patented by the private operators who had run them, so that any others who might buy the plant would be obliged to pay an extensive (and uncertain) fee to that former private operator. Not only did this occur in the initial organization of the plants, but it occurred constantly in the expansion, restructuring, and reequipment of plants, so that new patent claims could constantly be introduced. Thus, Phillips Petroleum in the Memorandum Re Claims of "Rights" could state:

> * * * Plancor 484 * * * was designed by Phillips Petroleum Co. based on technical information and trade secrets originating with Phillips Petroleum Co., its operation involves the use of said technical information and trade secrets and Phillips Petroleum Co. intends to claim a royalty or license fee in connection with the use of such technical information and trade secrets for private (as distinguished from Government) benefit. In additional, Phillips Petroleum Co. is the owner of the following United States patents which contain claims covering the operations of said plant, and Phillips Petroleum Co. intends to claim a royalty or license fee for a license for the continuance of the present operations of said plant for private (as distinguished from Government) benefit: * * *
>
> As to other butadiene plants of the Rubber Producing Facilities, Phillips Petroleum Co. furnished technical information for the design of the butylene and butadiene-recovery facilities employed in the butadiene plants at Port Neches, Tex., operated by the Neches Butane Products Co., and at Houston, Tex., operated by Sinclair Rubber Co., Inc. In addition, all of the above patents contain claims which are pertinent to the said recovery facilities except Patents Nos. 2,586,408, 2,606,159, and 2,666,692. Phillips Petroleum Co. intends to claim a royalty or license fee for a license for the continuance of the present operations of said plants for private (as distinguished from Government) benefit.[100]

It seems inevitable that such circumstances as these would create a formidable barrier to the entrance of newcomers into the industry, and thereby reduce the force of competition both in bidding for the plants and, potentially, in the operation of the new industry itself. Moreover, these circumstances were not a matter of technical necessity. They arose as a consequence of choice by the administering agency of the Government. The industry was sufficiently long in Government hands that operations could have been standardized and/or cleared of private patent claims. This would have cleared the decks for free bidding, and would have facilitated new entry into the industry. It might be argued that to have standardized operations and/or permitted modifications only when such developments were owned by Government (or the claims regarding them settled), would have caused the synthetic rubber technology to stagnate. But the technology stagnated in any case. The organization of the Government

[100] Rubber Producing Facilities Disposal Commission, Memorandum Re Claims of "Rights"—Synthetic Rubber Facilities (memorandum mimeographed for distribution to prospective bidders), November 1954.

synthetic-rubber operation failed to clear the decks for free disposal and permitted the creation of patent impediments in an industry financed by the public and supposedly run by the Government—and for this price did not even receive a progressive technology in return.

The patterns of the new industry which did emerge reflected the oligopolistic form of the petrochemical and tire industries where a large proportion of total output is concentrated in the hands of a few "dominant" firms. Butyl, of course, is a monoply in the hands of Standard (New Jersey) and its licensees.

This is the form of the new American synthetic rubber industry. It is an industry which, regardless of past programs and performances, happens now to be in the hands of vigorous firms in two highly vigorous industries, albeit industries capable of backsliding into the stagnant byways of monopoly. Here, as elsewhere, it will be the problem of public policy to clear the way for the full force of competition to drive the new industry to the full realization of its potential contribution to consumer welfare and strategic strength. The task that confronts us is much more difficult than it would have been if the synthetic-rubber program been administered with greater competency, firmness, foresight and understanding of the public responsibilities involved.

CHAPTER XI

PROBLEMS AND POLICY

The preceding chapters were written a year before Sputnick. Their essential conclusions were formulated in 1951. Thus this critical analysis of the organization of research and the means of providing incentive for technological advance through Government policy, is no mere rationalization of recent events. Rather, events confirm its hypotheses and arguments.

In good part this study has been concerned with the patent system. It was shown how, in extending the powers of monopoly, this system can sometimes work against the economic progress and consumer welfare which it is intended to sustain and promote. It was shown that, through patents, important developments may be shelved, deliberately or inadvertently, thereby blocking the technological progress which the system was intended to accelerate. These dangers are familiar and remedies of sorts have been proposed. Less familiar is the conflict between the needs of national security and the objectives of business action, illustrated by the international patent deals. Many aspects of business choice, following normal commercial criteria, may lead to actions which conflict with the interests of national security. It then becomes the responsibility of Government to protect the strategic interests. The trouble is that, with rare exceptions, where the issues are cloaked in technological complexity, the Government has not developed the competence that is required to discharge this responsibility. Thurman Arnold and the Department of Justice did a real service in investigating the relations between American and foreign corporations when the latter were presumed to have become agents of hostile governments. They would have performed a greater service if, rather than attempting to fix personal guilt, they had pointed up the incapacity of Government agencies that failed to recognize the dangers of such dealings when they occurred, and that were unable to deal with those dangers even had they been recognized. It is not known how often such divergences between business action and the security interest arise, or how important these might be—for no more today than yesterday is there available in Government an agency responsible for, and able to take cognizance of, such conflicts and to deal with them effectively. The possibility of conflict arises every time a factory is built in one location rather than in some other, every time a road is laid, every time an investment is made.

In the case of synthetic rubber, those who raised the issue of national security were those who had a commercial stake in public action. But there is unlikely to be more than a partial coincidence between commercial stakes and strategic interests. The synthetic-rubber experience shows that a government is ill advised to rely on a competence shaped to the criteria of commerce in formulating its policy for national security. Yet, today as yesterday, measures pur-

porting to insure the national security continue to be based upon the demands of those who have commercial stakes in public action. And, today as yesterday, the Government continues to rely on a technological competence for the formulation of national security policy, that is shaped to the purposes of private profit. Thus, air transport and the merchant marine are given aid and subsidy for the supposed purpose of insuring national security. It is folly to assume that, inasmuch as such aids and subsidies are freely used by the recipients according to the criteria of good business, a maximum return in national security will ever be derived, or that any national security return will necessarily be derived per dollar of public expenditure. The oil companies demanded and received protection for their oil ownership overseas—this on the ground that our limited and depleted domestic reserves must be preserved in the interests of national security. Yet, at the very same time, domestic oil producers were demanding and getting protection against the import of foreign oil into the United States—again, on the ground that it is necessary for national security to accelerate the rate at which we use up our known reserves as a stimulus to the exploration and development of new domestic reserves. We must expand our foreign commitments and spend billions for overseas bases to protect Arabian oil so that our domestic oil will be less rapidly depleted, at the same time that we impose quotas against foreign imports and permit higher prices to consumers in order to stimulate the use of our domestic supply.

One need be no expert to sense these contradictions. They are apparent on their face. In other areas, however, they may be more subtle. In such cases, where the issues are cloaked in technical complexity, upon whom shall we rely, in the face of conflicting demands, to determine the course appropriate to national needs?

The synthetic rubber story bears witness that where the objective is to encourage technological advance, it is never enough to contract out research to private companies, no matter how successful and powerful they are. Company research is geared to the spur of loss and the lure of profits. Remove that lure and spur, and it is unlikely that research efforts or accomplishment will transcend the level of the routine. Other incentives must be built into the system. In some instances, the Government has allowed its contractors to patent and commercially exploit its research results, requiring only that royalty-free licenses be extended to the Government and its agents even though that research was wholly paid for by the Government. This method may have merit in some situations, for instance, in weapons development where commercial exploitation is a minor byproduct and patents offer a kind of bonus for successful efforts. But where the objective is to provide a general stimulus to economic growth and a widening of scientific horizons, then the method is not appropriate. There is inequity, for the company receives first claim on the benefits of research for which the public, not the company, paid. Further, there is distortion of the purpose of public support of research. The range of possible applications of research results is narrowed, and the promise of a patent payoff pushes such research effort in the very directions where ordinary commercial incentives suffice and public subsidy or support are not needed.

Other methods are surely available to build incentive into the system of Government-subsidized research. Why not offer substantial prizes for the solution of outstanding research problems? This would open the field to individual invention as well as to corporation research and would remove a perennial suspicion of favoritism and manipulation in the obtaining of research contracts. It was in the successful effort to win a prize offered by the Czarist Government that the butadiene base for general-purpose synthetic rubber was developed. It is not entirely unreasonable to suppose that the "natural rubber" problem, the objective of such a long period of futile Government-subsidized research, might have been solved under the stimulus of a money prize, just as it was solved under the stimulus of a patent prize when the end of Government ownership made the lure of profits through patents available. And, giving prizes, even lavish ones, for solutions might in many cases cost the public less than giving patents for solutions, for then the advance would be made freely available to all. Nor is it unthinkable that the Government might offer research contracts that provide for substantial gains if the project succeeds in its creative objective, and a minimal payment, or none at all, if the project fails. This, after all, is precisely the condition under which private commercially oriented research is undertaken.

Nor should it be assumed that contracting out or otherwise dealing with private firms and institutions is the only approach, or is necessarily the most effective method for solving research problems and otherwise furthering the ends of scientific and technological advance. In many areas the most effective results may be achievable through direct Government research and development, using Government-hired scientists in Government-owned laboratories, with such research having the advantage of a single center for organization, direction, and responsibility. But will the question of the possible effectiveness of direct Government research be decided on its merits, or will our paths be dictated by slogans and taboos?

The public is rightfully uneasy over the performance of American science and technology. Taking advantage of this moment of uneasiness, the official and self-appointed spokesmen of science clamor for greater subsidies to carry on basic research. Financial support for research is, indeed, needed. But a warning is in order. Subsidy is never enough, whether to university researchers, Government researchers, or private-company researchers. The history of synthetic rubber development gives ample evidence that the world of science, like other sectors of the world of men, has its waste and futility, its manipulators and its parasites, its massed echelons of good, competent workers who nevertheless have not that special capacity to proceed beyond the refinement of the already known. Only a few are blessed with the creative spark. If aid is to be effective, it must be selective in discriminating between those who can contribute and those who cannot. Simply to raise the level of public subsidy will not suffice as a stimulus to progress. Nor is monopoly only a problem of business. It is a problem of all human institutions, and the institutions which set themselves up as the creators and purveyors of concept and knowledge (the universities, the faculties, the academies, the societies, the foundations) are all too human. Here also is manifested a vested interest in status and position, in fixed procedures and in established

ideas. Here also may be a fierce maneuvering to monopolize the seats of power; here also will be found rigidity and bias. Yet nowhere is flexibility and real competition more necessary. Unfortunately, we take for granted without troubling to analyze them, the form, mechanism, and adequacy of those institutions on which our society depends for that intellectual dynamic which is the ultimate key to survival and growth.

Whether the concern is to organize research in government, evaluate private research for government, so direct the use of funds as to maximize the return on research subsidized by government, or simply to formulate policy in the light of technological and scientific complexities, for all or any of these tasks there must be a technological (and scientific) competence in the Government. This competence is the first requirement. The schemes and the devices come after. The need for technological competence in government has been the constant theme throughout this study. This is not a competence that can be bought or borrowed. It must be created. It must be incorporated into the processes of governing and the processes of governing must be remade thereby. This final chapter will take as clear and established what the whole weight of this study has sought to clarify and to establish, namely, that the technological competence shaped to the market choice that normally characterizes our commercial and industrial institutions and serves these institutions well, is of quite another genera than the technological competence that is directed to social choice and is essential if wise social decisions are to be made. This special competence is needed in government, in the functioning of Congress and of the executive branch.

The pace of Russian technical, scientific, and economic advance is not the standard by which to measure the sufficiency of our own. Though we surpass them many times over, we may still have failed to make use of our full potential. Yet the race between the two nations is so critical that points of comparison are important. With respect to the development of a technological competence appropriate to the processes of government, the form of their organization would seem to have a certain advantage over ours. In our society there are two distinct and important spheres of decision making—that of business, where action yields to market pressure and follows the quest for profit; and that of government, which intervenes in the name of the community in those instances where competition fails to bring about an accord between business action and the social weal, and where other than commercial criteria must be introduced as a basis for choice and action. Our available technological competence has been shaped by training, by the conditioning of a career and by the pressures of success and survival, to the needs and values of business choice, and not to the requirements of social choice. An additional kind of technological competence is needed, namely, an expertise shaped to the needs of social choice. In a socialist community there is not this dichotomy. There all decisionmaking presumably bears the aspect of social choice; expertise is shaped to governmental planning, since no other sphere for the exercise of technological competence exists.

A technological competence shaped to the values, and wedded to the purposes of society, working through its government, is needed. How

to develop it? In our view, this competence will develop and the educational mechanism serving to train men for this task will be developed if two conditions are satisfied. First, there must be a clear recognition of the need for such competence, a need in every branch of government and at the top levels of authority; and a recognition that the technological competence shaped to serve the business function is often incompatible with the processes of government. Second, attractive careers must be open to those who would dedicate themselves to the creation of this special competence, careers that lead to the top rung of authority and to participation in the formulation of public policy. The corps of Government scientists and technologists must come to stand as the peers of their business counterparts, with their views carrying a primary authority in the sphere of social choice.

But if top grade young scientific talent is recruited and brought into Government, how is it to be used, how incorporated into the task and trained to the processes of Government? There are, of course, ways to use it profitably right now. Such men might undertake and/or direct Government research. They might be made the technical attachés to our Embassies abroad. They might organize and carry through international technical and scientific interchange. They might organize and carry out foreign aid and foreign technical education programs. They might aid in the study and the ultimate restructuring of the American systems of scientific and technological education. They might assist Congress in a range of investigations, studies, and deliberations. They might partake in military programing and planning. And so on. But all this would be of no avail unless there is also a sense of the long-run purpose of this corps to develop a distinct and necessary competence shaped to the task of social choice; which means that they will be turned to for advice and decisions involving social choice, and that leadership will be drawn from their ranks. It will not work if, in the crux, Government turns to the officials of General Motors or General Foods for decisions as to weapons research, or to a Wall Street admiral or a West Point general for the organization of atomic research, and so on down the line.

The hard fact is that we do not have, today, the kind of competence that we need for effective government in this age of science and technology. Yet, this competence will evolve, fitted to the needs of social choice, just as competence fitted to the dictates of market choice has evolved, provided intelligent men will turn themselves to this task as their career. This, of course, is not the entire solution; it is only the beginning: for once the competence is acquired, it still must be used systematically. But the importance and significance, and the difficulty of this beginning, should not be underrated. The hardened patterns of institutional organization, the deep-grooved habits of thought, the slogan-fed complacency, the widespread and instinctive resistance to effective government, the great power of the interests in whom the decision-making function now resides—all these present a formidable barrier. To achieve that beginning is a major task and a sufficient present goal. We shall not speculate beyond it.

Actually, this need for creating a competence in Government to deal with relatively new and vital tasks, is part of a larger problem, namely, deliberately and as a matter of public policy of accelerating

the rate of scientific advance, technological development and productivity increase. At bottom we are concerned with the creative process, which is both an individual and social function. The patent system plays a part in that process. Our school system plays another. Our universities, existing on a fare of business charity, alumni sentiment and public handouts, dwelling in a "nether land" between commerce and politics, are supposedly at the core of it. Every industry, every firm, every farm, every sector of government, all play their part. The strata of social values, the flux of social attitudes, the stimulus of competition, the barriers of monopoly, the ballast or the anchor of tradition, the effectiveness of communication and association, the opportunity for experimentations—all these are variable determinants of creative advance. We know little of these variables and how they are fitted together, much less of how to go about reshaping the processes which carry our society forward. But there is some hope, at least, that at long last we are beginning to try to understand.

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