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A REPORT OF THE . . .

DEFENSE SCIENCE BOARD

ON

GOVERNMENT IN-HOUSE LABORATORIES

6 SEPTEMBER 1962

Office of the Director of Defense Research and Engineering

WASHINGTON 25, D.C.

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Office of the Director of Defense Research and Engineering
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OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON 25, D.C.

13 November 1962

TO: THE SECRETARY OF DEFENSE

THROUGH: THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

The Defense Science Board respectfully submits its report on "Government In-House Laboratories." The findings and recommendations are essentially the work of an ad hoc Task Group comprised of Dr. C.C. Furnas, then Chairman of the Army Scientific Advisory Panel, Dr. Frederick Seitz, then Chairman of the Naval Research Advisory Committee, and Lt. General Donald L. Putt, USAF (Ret.), then Chairman of the Air Force Scientific Advisory Board.

This DSB Subcommittee on Government In-House Laboratories was formed in 1960 at the request of Dr. Herbert F. York, then Director of Defense Research and Engineering. The Group was asked to take a look at the DOD in-house laboratory program, not from a Service point of view but from that of the DDR&E with a view to assaying the performance of the RDT&E laboratories, isolating their major difficulties and making recommendations for their improvement.

In May 1961, the work of the Subcommittee was associated with that of Task 97 Study Group under the leadership of Dr. Eugene G. Fubini, Deputy Director of Defense Research and Engineering.

In addition to its own investigations and the input of the Fubini Group, the Subcommittee reviewed and evaluated the reports of the Astin Panel of the Standing Committee of the Federal Council for Science and Technology on the Competition for Quality and the Bell Committee on Government Contracting for Research and Development.

This final report of the DSB Subcommittee includes a critique of the above reports combined with the findings of its own studies. For the most part the DSB Subcommittee concurred in the conclusions and recommendations of the other studies, although some differences are

delineated. The degree of concurrence is, of itself, probably of value in bringing about improvements of the in-house laboratories.

The report of the Subcommittee was submitted to the full Defense Science Board and unanimously approved at its twenty-fourth meeting on 6 September 1962.

The Defense Science Board and its Executive Committee stand ready to assist in implementing the recommendations of this report.

Respectfully submitted,

C. C. Furnas

C. C. Furnas, Chairman
Defense Science Board

CONTENTS

SUMMARY

The United States is now in a phase of its development where the Federal Government—in particular, the Department of Defense—is the major factor in the national research and development effort. With this in mind, Dr. Herbert York, then Director of Defense Research and Engineering, asked the Defense Science Board to study ways to improve the in-house DOD laboratory program. Before this study was completed, other studies were begun by the Task 97 Group, the Astin Panel and the Bell Committee. Accordingly, the DSB Subcommittee on Government In House Laboratories decided to concentrate on general conclusions to be drawn from these and other studies and their own individual experiences rather than offer an additional detailed analysis of its own, as originally planned.

The DSB subcommittee finds it is in essential agreement with the other studies with the exceptions noted in Part 3. The most significant exception is that concerning the proposal to establish national institutes for research. The DSB subcommittee believes that the establishment of such institutes as proposed, if such is the intention, would seriously and adversely disrupt the present balance of responsibility between the four major types of R&D organization, i.e., academic, industrial, not-for-profit and in-house organizations, to the great detriment especially of the universities and colleges.

The difficulties and weaknesses that pervade the in-house laboratory system, without significant exception, flow from three main causes: noncompetitive salaries and professional benefits, ill-conceived or misapplied bureaucratic regulations, and lack of truly significant assignments coupled with lack of adequate personal recognition. For remedial action five recommendations are made:

(1) Continue to press for congressional action to increase top salaries and professional benefits to a competitive level.

(2) Maintain the Task 97 function on a permanent basis to ferret out unnecessary controls and frustrations and make recommendations for remedial action to the Director of Defense Research and Engineering.

(3) Establish a system of national recognition specifically for outstanding accomplishments of Federal laboratories and of individuals in Federal laboratories, perhaps through the good offices of the National Academy of Sciences.

(4) Establish a liberal system of sabbatical leaves for government scientists to work in universities or top industrial laboratories, both nationally and in friendly foreign nations.

(5) Establish a reverse sabbatical leave program for competent university and industrial scientists to work in government laboratories, including scientists from friendly foreign nations.

The DSB Subcommittee on Government In-House Laboratories hopes that this report, if concurred in by the full Board, will prove useful in connection with the forthcoming report by the Director of Defense Research and Engineering on implementation of the Bell Report.

1. HISTORY OF THE DSB SUBCOMMITTEE'S ACTIVITIES

The Defense Science Board Subcommittee on Government In-House Laboratories was formed in September 1960 at the request of Dr. Herbert York, then Director of Defense Research and Engineering. Dr. Clifford C. Furnas, at that time Chairman of the Army Scientific Advisory Panel, was made Chairman of the subcommittee, which consisted also of Dr. Frederick Seitz, Chairman of the Naval Research Advisory Committee, and Lt. General Donald L. Putt, USAF (Ret.), Chairman of the Air Force Scientific Advisory Board. They were asked to take a broad look at the in-house DOD laboratory program, not from a Service point of view but from that of the DDR&E, with a view to assaying the performance of the RDT&E laboratories, isolating their major difficulties and making recommendations for their improvement. It was decided early in the study to focus the effort on the R&D laboratories and to give less attention to the T&E laboratories. (An "in-house laboratory" is one which is an integral part of the DOD organization and is supported by direct (noncontractual) funds.)

As the initial step of this study, members of the Defense Science Board and a selected list of other qualified people were asked to give their candid opinions on the factors underlying the successful operation of research and development laboratories generally and to identify indicators that might be used to measure success in over-all laboratory operations. The result of this survey was a preliminary report on in-house laboratories by Dr. Furnas dated 1 July 1961 (Appendix I), the main findings of which are included in the recommendations in Part 4 of this report.

In May 1961 the work of the subcommittee was associated with that of the Task 97 Study Group under the leadership of Dr. Eugene G. Fubini, Deputy DDR&E. This group was set up by the Director of Defense Research and Engineering in response to a request from the Secretary of Defense to "Review the operations of the 'in-house' laboratories of each of the Services and recommend changes designed to improve their effectiveness."

The methods to be used by the Task 97 Group (1) were presented by Dr. Fubini to the full Board at their meeting in May 1961, and the Board concurred in the proposed method of approach. With the advent of this study, the reports of the Astin Panel of the Standing Committee of the Federal Council for Science and Technology on The Competition for Quality(2), and the report of the Bell Committee on Government Contracting for Research and Development(3), which was instituted at the request of the President, masses of information began to accumulate on the problems of Federal laboratories—enough information to support initial decisions to improve and strengthen them.

The effort of the DSB subcommittee was accordingly shifted to general principles rather than detailed problems. Thus in January 1962 the Board agreed to the Chairman's proposal to include in this report the general reflections and conclusions engendered by the study, as well as critical comments on the

conclusions of the three other surveys when available. These comments are presented in Parts 2 and 3 of this report. Meanwhile, the preliminary report of 1 July 1961 was distributed to the members of the Second Conference on Management Problems of Military RDT&E, held at Quantico, Virginia, on 8-9 January 1962. A draft of the Chairman's address at this meeting, entitled "Functions and Management of In-House Activities," is given as Appendix II. Perhaps the principal general point in this address was that all four types of R&D organizations—university, industrial, not-for-profit and in-house—are necessary and need to be maintained in a reasonable balance if we are to have an optimal R&D program in the nation. Taken all together, the positive and negative characteristics of the four types of organizations balance out to produce an effective pattern of action.

2. OTHER INVESTIGATIONS

The Task 97 Study Group, chaired by Mr. John Golden of the Institute for Defense Analyses, produced a report in the fall of 1961 which contains some excellent recommendations for the improvement of the quality and effectiveness of RDT&E laboratories in the Department of Defense. Some ameliorating action has since been taken to improve personnel practices within the laboratories and to improve the budgetary management of research and exploratory development. The Task 97 Action Group was reinstituted early in 1962 and has been directed to make periodic reports to the Director of Defense Research and Engineering. The DSB subcommittee notes this action with approval and recommends that this study group be continued permanently. We also would like explicitly to note that, in our opinion, there are some very good Federal laboratories despite all the problems that appear; we should not be too negative in our appraisal.

The DSB subcommittee also finds itself in essential agreement with the findings of the reports of the Astin Panel, which have appeared under the title The Competition for Quality. These reports are concerned with the entire Executive Branch of the Federal Government.

Part II of The Competition for Quality recently was forwarded to the Federal departments and agencies by the President, together with the request that the recommendations therein be implemented to the extent practicable. The President also requested his Special Assistant for Science and Technology to report to him, from time to time, on the implementing measures which have been taken. This report is concerned primarily with improving the quality, incentives, working conditions, and productivity of Federal scientific and technical personnel.

The recommendations of the present report, as they appear in Part 4, are considered to be consistent with, and in the spirit of, the general features of the Astin report.

The Report to the President on Government Contracting for Research and Development, which was issued on 30 April 1962 by the distinguished group that included Mr. David E. Bell, the Director of the Bureau of the Budget, built upon the results of a number of detailed questionnaires and has the fullest coverage of the national situation of any of the three reports described herein, as well as being the most recent one. This report considers all four major types of R&D organization: university groups, industrial groups, not-for-profit organizations

and in-house agencies. The comments of the DSB subcommittee are, therefore, most particularly directed toward the Bell Committee report.

In a memorandum dated 3 May 1962, Secretary Gilpatric assigned certain responsibilities on the implementation of the Bell Report to the Director of Defense Research and Engineering, and an outline of proposed implementation plans has been submitted to Mr. Gilpatric in response. A full report is required by 1 October 1962; it is hoped that this report of the DSB subcommittee will be useful both to him and to the DDR&E in that connection. It is noted with approval that the Assistant Director (Research) has been assigned responsibility for "recommending guidance to and monitoring of the military departments in their actions of reviewing work assignments to government research and development establishments and of making such changes as may be needed to make sure that these assignments are sufficiently challenging to attract and hold first-class scientists and engineers."

3. CRITIQUE OF THE BELL COMMITTEE REPORT

The DSB subcommittee agrees with the general findings and the conclusions expressed in the letter of transmittal from the Bell Committee to the President (Appendix III). It concurs in the opinions expressed in that letter, that:

(1) A partnership among public and private agencies is the best way in our society to enlist the nation's resources and achieve the most rapid progress.

(2) One of the most serious obstacles to the recruitment and retention of first-class scientists, administrators and engineers in the government service is the serious disparity between governmental and private compensation for comparable work.

(3) Choices among the basic types of R&D organizations—university, industry, not-for-profit, contractor-operated in-house and direct Federal in-house—should be made on the basis of relative efficiency and effectiveness in accomplishing the desired work with due regard to long-term need to improve the nation's over-all R&D resources.

(4) The contracting system can and should be improved by providing more incentives for cost reduction with improved evaluation of the quality of research and development work, giving more attention to and improving feasibility studies.

(5) Improvements are needed in Federal R&D establishments to ensure that they are assigned significant and challenging work, to simplify their management controls and bureaucratic overlay, to provide laboratory directors more autonomy and to raise salaries in higher grades of laboratory scientists and engineers in order to achieve greater comparability with salaries in industry and not-for-profit organizations.

Although the DSB subcommittee is in essential agreement with most of the findings and conclusions of the Bell Report, it wishes to express its strong opinion that certain implications in the report present real dangers of weakening not-for-profit institutions and private industry to the point where they will not serve the

public interest in the DOD research and development program. In strengthening the in-house laboratories, great care must be exercised not to weaken the other members of the quadripartite team. The phases of the Bell Report which cause concern to the DSB subcommittee are as follows:

(1) In the letter of transmittal to the President are the following statements (pp. VIII-IX, Bell Report):

> We have carefully considered the question whether standards should be applied to salaries and related benefits paid by research and development contractors doing work for the Government.... Insofar as a comparability standard cannot be applied—as would be the case with respect to the very top jobs in an organization, for example—we would make it the personal responsibility of the head of the contracting agency to make sure that reasonable limits are applied.

These statements express a principle which in itself is reasonable and which has for years—as in the application of Armed Services Procurement Regulation XV and of a similar Air Force regulation—been practiced with restraint. However, in governmental machinery restrictions often tend to become more restrictive. Accordingly, there should be unceasing vigilance to ensure that the application of this principle does not lead to unwarranted Federal dictation of salary scales in the private sectors doing research and development. This would lead to mediocrity of personnel working on government contracts, which is exactly what the various studies and investigations are trying to avoid. The DSB subcommittee feels strongly that this danger, though not clearly evident at the moment, is very real indeed.

(2) In Part 2 of the Bell Report (p. 10) are the following statements:

> ...we need to be particularly sensitive to the cumulative effects of contracting out Government work. A series of actions to contract out important activities, each wholly justified when considered on its own merits, may when taken together begin to erode the Government's ability to manage its research and development programs. There must be a high degree of awareness of this danger on the part of all governmental officials concerned. Particular attention must be given to strengthening the Government's ability to provide effective technical supervision in the letting and carrying out of contracts, and to developing more adequate measures for performance evaluation.

The DSB subcommittee has no quarrel with the validity of the observations nor with the general philosophy back of the statements. It does see a real future danger, however, in the evolution of a governmental system of providing "effective technical supervision" that would be so rigid and tight that the Government would be telling its contractors exactly what to do and not do. This may be appropriate for straight production contracts, but if such a system should come to dominate research and development many of the nation's most vital sources of creativity and scientific ability would be barred from making essential contributions to necessary DOD research and development programs.

(3) In the case of the not-for-profit organizations the Bell Report (pp. 19-20) propounds a quite restrictive attitude in the criteria for determining the amount of fee allowance, e.g.,

> ...the normal rule should be that where facilities and equipment are required to perform research and development work desired by the Government, the Government should either provide the facilities and equipment, or cover their cost as part of the contract. ...we believe it is generally not desirable to furnish funds through "fees" for the purpose of enabling a contractor to acquire major capital assets.

If these restrictions were recommended as the exception rather than the rule, the DSB subcommittee would voice no objection. But the Bell Report voices the exact opposite—they are to be the rule and not the exception. Inevitably still more tight criteria and restrictions would follow, and the not-for-profit organizations would soon be so restricted in their actions that their very raison d'etre would be destroyed. Not-for-profit organizations, to fulfill their mission of independent creativity, mobility among programs and unhampered objectivity, must have a freedom of action and viability comparable to that of a university. Such a condition is not compatible with, nor possible within, the framework of dictation of use or non-use of "fees."

With regard to the seven proposals of the Bell Report (pp. 21-24) for improving the Government's ability to carry out R&D activities directly, the DSB subcommittee concurs fully with all but the fifth proposal (p. 24), "...establishment of a new kind of Government research and development establishment, which might be called a Government institute," with which it strongly disagrees. We believe that to establish such a Federal R&D institute, if such is the intention, would be to seriously disrupt the present balance of responsibility between the four major types of R&D organizations, i.e., academic, industrial, in-house and not-for-profit organizations, and in so doing would especially weaken the universities and could lead to direct Federal domination of free scientific inquiry. Work of the sort that would be done at such institutes as may be envisioned should more properly be done within the nation's universities and colleges where the researcher can also be a teacher, or in other not-for-profit organizations. Establishment of such institutes with a teaching function would lead to a new, and dangerous, type of Federal university.

The DSB subcommittee feels that such a proposal could not be taken seriously in responsible quarters if all implications and ramifications were thoroughly explored.

4. RECOMMENDATIONS OF THE DSB SUBCOMMITTEE

In attempting to discover and put into general terms the major weaknesses of, or difficulties besetting Federal in-house laboratories (of the noncontractual sort), the DSB subcommittee found that they all, without significant exception, stem from three major causes, which stated briefly, are: pay and professional benefits, inadequate assignments and perso al recognition, and the infelicitous use of bureaucratic regulations with their frustrations and inhibiting effects. The cumulative effects are statistical, not individual. There are many fine examples of

capable and outstanding scientists and engineers who have lived with the system and there are also some first-rate government laboratories, but it is to statistical trends that this report is directed.

It is recognized that in-house structure as a whole must not only have high scientific excellence, it must also be in a position in the national program to serve as the "honest broker" and the "sophisticated buyer." This will require substantial strengthening if the job is to be done properly.

In order to reverse the present trend toward weakness and make a start toward improving the in-house situation, the DSB subcommittee makes the following five recommendations:

(1) Continue to press for congressional action to increase top salaries and privileges to a level competitive with those in the other main types of research and development organization. The emphasis here is on only the upper grades of Federal employees; it includes professional benefits (really, necessities) such as travel, paid attendance at meetings, liberal professional leave provisions and encouragement of publication. Some laboratories are truly research laboratories and they should get first consideration and the top positions; other laboratories are primarily test organizations and should have a secondary status.

(2) Maintain the Task 97 function on a permanent basis to ferret out unnecessary controls and frustrations and make recommendations for remedial action to the Director of Defense Research and Engineering.

The mission of the Task 97 group would include investigation of particular problems involving conflicts between different types of personnel (including civilian and military) in laboratories. It would constitute a continuing internal scientific and technical audit of the situation.

(3) Establish a system of national recognition specifically for outstanding accomplishments of Federal laboratories and of individuals in Federal laboratories.

These awards could be made by the National Academy of Sciences, for example. A special type of award would be justified not only because of the importance of recognizing Federal service but also because the Federal Government is now the major factor in research and development in the nation. Internal DOD awards are not sufficient for the degree of recognition proposed.

(4) Establish a liberal system of sabbatical leaves for Federal scientists to work in universities or top industrial laboratories, including those of friendly nations.

(5) Establish a reverse sabbatical leave program for competent university and industrial scientists to work in government laboratories, including international exchanges with friendly nations.

These two sabbatical leave programs would foster interchange of ideas, mental refreshment and mutual increase in productivity. These leave provisions and other types of temporary transfers should be arranged so that there would be no possible attendant loss of job security or seniority.

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APPENDIX I

Memorandum

TO: Members of DSB Subcommittee on In-House Laboratories—
Dr. Frederick Seitz and Lt. Gen. Donald L. Putt

cc: Mr. L.M. McKenzie, Dr. H.P. Robertson,
Dr. Robert W. Cairns, Dr. Elmer W. Engstrom,
Mr. William Littlewood, Dr. L. Eugene Root,
Dr. E.G. Fubini

FROM: C.C. Furnas

SUBJECT: Preliminary Report on In-House Laboratories - July 1, 1961

The following is the chairman's preliminary report on the analysis of various communications which he has received on the subject. These communications resulted from Lawson McKenzie's memoranda to members of DSB and a selected list of other qualified people to write to me and give their candid opinion on "the factors underlying the successful operation of research and development laboratories generally, and indicators that might be used to measure success in over-all laboratory operations."

As a result I have received 6 communications from members of DSB and 15 from other individuals. Some of them encompassed the opinion of more than one person. As a result, the views of 30 different competent individuals were expressed.

The responders represented a broad spectrum of background and affiliation as follows.

	Individuals
(1) Directors, or key personnel in government in-house laboratories	9
(2) Directors of captive, nonprofit organizations, government-supported	3
(3) Directors of university or other nonprofit organizations partially supported on government contracts	5
(4) Government officials, not directly involved in laboratory management	4
(5) Directors or vice-presidents of research in industry	9
	30

I. FACTORS UNDERLYING SUCCESSFUL OPERATION

As contrasted to a questionnaire, McKenzie's approach to extracting opinions and information had certain advantages. It avoided the twin hazards of the stacked deck and the leading question, and it led those who did reply to really think about the problem—because they had to prepare their own treatises. On the other hand, it complicates the integration and analysis of the opinions. There was but little common structure to the replies, so considerable reliance must be put on the perception and judgment of the analyzer—in this case, the chairman. That has its obvious hazards. However, the essence of the principal ideas, insofar as they could be consolidated, is given below. Despite the varied background and interest of the responders, there was surprising concurrence of opinion on principal points. There were but few areas of outright disagreement.

	Number of people stating
(1) Proper R&D laboratory environment: This necessarily became a many-faceted item. It includes proper competitive salary scales, flexible and sensible personnel policies, freedom and opportunity to give papers and attend meetings and visit other establishments, intelligent colleagues and freedom from the strictures of civil service. One in-house director opined that, since it was apparently impossible for a government scientist to receive more pay than a Congressman, or to ameliorate the strictures of civil service, the only solution was to put all government laboratories on contract operation with nonprofit organizations.	20
(2) Highly qualified research personnel: The general tenor on this item was that a good man is hard to find, but he is the sine qua non of any successful laboratory. Several more than the 14 indicated here intimated the importance of this factor but did not make a direct statement on it.	14
(3) Proper facilities and nontechnical services provided in timely fashion: Some letters expressed strong bitterness at 4- and 5-year delays in getting obviously needed facilities. The theme of "fiddling while Rome burns" was dominant.	12
(4) Firm and adequate financing with reasonable assurance of continuity: The uncertainties and frustrations of stop-and-go financing of government projects is a mammoth bete noire.	11
(5) Smooth intra- and inter-organizational communication: Among other opinions—rigid adherence to the line of command as the only channel of communication will kill all good research.	11
(6) Realistic, purposeful and identifiable objectives: The pure researcher longs for a purpose in life even while he strongly resents being told what to do.	11

(7) Freedom to select or reject projects: As might be expected, this factor seemed to be important where emphasis is on basic research, but not a factor in the development-oriented organization. 6

(8) Minimum requirements of time and attention to extraneous matters: The extraneous matters include budget preparation, giving repetitive briefings, handling an endless list of visitors, etc. 6

(9) Enlightened and understanding top management: The research organization doesn't want much management from on high, but it does want a lot of sympathy. 5

(10) Director must be a respected scientist with adequate authority as well as responsibility: The research team wants its leader to be a super peer—one of the boys, only more so. 5

(11) Firm general—not detailed—guidance from above: This is not necessarily consistent with some other factors, but it does represent the desire for good leadership that leads without dictating details. 5

(12) A substantial program of internal research uncommitted to specific projects: A 10-percent free-will kitty was mentioned as a desideratum. 5

(13) A minimum number of layers of decision making: There was considerable frothing at the mouth on the cloying affects and absurd delays involved in multiple layers of decision and redecision. 5

(14) A logical and well-understood organizational structure: There is no reverence for organization charts, but the average researcher prefers to live in an orderly house. 4

(15) In-house laboratory director must be civilian scientist with sole and complete authority: Though only a few expressed an opinion on this point, they were all violently opposed to the military-civilian duality in management of government facilities. 4

(16) Researchers should have a voice in management: Though the signals were rather weak on this variable, they did indicate the researchers' desire for comprehensive participation. 3

(17) Strengthened coordination and understanding between civilian and military: This would appear to be at variance with sentiment 15. 3

(18) Longer terms of duty for military officers 3

(19) Opportunity to serve as "honest broker": This reflected the feeling of some that the judgment of in-house personnel was not properly respected or used to evaluate and criticize programs and projects. 2

(20) Competition on projects among laboratories and industry should be emphasized and strengthened. 2

(21) Competition and duplication of projects should be eliminated: Obviously, 21 doesn't agree with 20. 1

(22) Effective and frequent evaluation of projects: At least one person desires to see the scoreboard at the end of each inning. 1

(23) Insure that usable results are used: A report merely "received and filed" obviously has a lethal effect on the ambitions of a researcher. 1

(24) In-house programs should be part of balanced mix—government, university, industry. 1

(25) Simplify purchasing rules. 1

(26) Establish integrated management for major projects: This is a valid development attitude for a very few crash projects. 1

(27) Minimize routine work and testing. 1

(28) Establish latitude for farming out work on contract. 1

(29) Keep laboratory informed on value of work performed: The honest pat on the back is always appropriate. 1

(30) Establish and maintain sense of urgency. 1

(31) Close association and ties with a strong university: A number of the respondents on item 1 (environment) would probably admit that this is very important, but only one mentioned it specifically. 1

Since this is only a preliminary report, no particular attempt was made to consolidate items. From perusal it is obvious that considerable consolidation can be accomplished among the above 31. They might be boiled down to 10 or 12 major factors. The chairman looks to the other members of the subcommittee for their evaluations.

II. MEASUREMENT OF SUCCESS

The response on the second part of the assignment, that is, "indicators that might be used to measure success," was much more meager than for the first part. There probably were two reasons for this. The individuals probably expended most of their thoughts on what they deemed to be the more important problem. Secondly, there appeared to be a feeling that there are no really satisfactory criteria for measuring success. However, the following observations which were gleaned from the replies may have some significance.

	Number of people stating
(1) Number of significant reports, publications and patents: This might be classed as self-evident, but one man pointed out the danger which might be involved in announcing that as a true measure of success. It would well lead the laboratory staff to publish and patent frantically without regard to quality.	5
(2) Number of eminent scientists on the staff: This could be measured by the number of prize winners—from Nobelists on down, by the number in scientific or technical Who's Who, or by the general feeling of national recognition. One person felt that the true measure of eminence was the number of his staff who received offers of employment from outside.	5
(3) The number of problems successfully solved: Depending on the character of the laboratory, success would be measured here by reports or publications which represented a solution, or by the number of successful and accepted instruments or other devices.	4
(4) Good reputation of the organization as a whole: This, admittedly, was a very nebulous criterion, but those who mentioned it felt that good national reputations can readily be detected. This could come about by the tenor of conversation among colleagues, by recognition in the national scientific societies and by the acceptability of staff members in important work in such societies.	4
(5) Impact of R&D results on sponsors' objectives: This is somewhat similar to item 3 above, but it goes beyond the delivery of a satisfactory device. Presumably it would be gauged by the degree of satisfaction as expressed by the sponsor.	3
(6) Judgment by a committee of peers: Each of those mentioning this item suggested a small visiting committee, to spend substantial time in the laboratory at least once a year. This would be somewhat similar to the accreditation technique for colleges and universities.	3

(7) Frequency of requests for advice from outside 1

(8) The academic level of staff degrees: Since only one person mentioned this, it appears that there is no widespread fetish for the prestige of the Ph. D. 1

(9) Level of enthusiasm of the staff: This obviously is an intangible, but it can be sensed by a perceptive visitor. 1

(10) Performance in competition: The person who suggested this was not able to present any real measurement except as it might be judged by some of the more quantitative criteria mentioned above. 1

(11) Industry takes over the field of investigation: The person who mentioned this felt that, when an in-house laboratory produced results which were so good that industry wanted to take over, the ultimate of success had been achieved. 1

As was the case in Part I, there obviously can be some consolidation of these opinions. Although it appears there can be no measured scale of success in the manner of IQ tests, at least some qualitatively significant criteria can probably be devised.

ROUGH DRAFT
8 January 1962
Quantico, Va.

APPENDIX II

Functions and Management of In-House Activities

C. C. Furnas

In 1939—which might be considered the last normal pre-World War II year—the U.S. expenditure for military research and development was $25 million. In 1961 the expenditure for military R&D (including new facilities) was about $7 billion, an increase of some 140-fold after allowing for inflation of costs. Further, the degree of complication and sophistication of the work involved has been almost beyond the comprehension of the older generation of scientists, engineers, industrialists and military leaders.

A revolutionary change in the character of the problem, plus a 14,000-percent change in the amount of effort in the span of 22 years, would be a bit of a shock to any major organized activity. It is small wonder that the former organization for carrying out the government's function of military development is creaking at the joints and in need of review and revision.

The American military establishment has always called on civilian segments in time of need to enter into the task of defense. The Minuteman of 1775 dropped the reins and picked up the musket. Privateers served as a temporary backbone of an American Navy in the War of 1812. Eli Whitney, as a private industrialist, accepted a government contract for making muskets in the War of 1812 and incidentally started a major social revolution by initiating interchangeable parts and methods of mass production. President Lincoln called on the reservoir of academic brains for aid in military endeavors when he established the National Academy of Sciences in 1863. This was perhaps the first American nonprofit organization serving military purposes. Specialized arsenals, manned primarily by civilians and devoted to developing and often producing implements of war, have long held an important spot in our history.

These historic sources of civilian participation in military matters have now become highly visible—they spend billions of dollars per year. This, in itself, automatically makes them subject to public criticism. In order properly to comprehend the role of the "in-house" laboratory—which evolved from the arsenal system—it is well to scrutinize the four major classes of organizations involved and to list their positive and negative characteristics as viewed from the viewpoint of military research and development. Note that each of the four types presented below has its roots in our history. Hence, no really new type of organization has been introduced in recent years.

A. Universities

Positive characteristics:

(1) A traditional dedication to the advancement of the frontiers of knowledge.
(2) Creativity induced by the interplay of keen minds among the scientific disciplines.
(3) A minimum of secrecy and proprietary interests.

Negative characteristics:

(1) Teaching obligations on the part of most faculty members tend to dilute research efforts.

(2) Many persons carrying out the research are graduate students—hence, in the inexperienced, neophyte stage.

(3) Difficulty in directing the average academic researcher toward immediate, specific objectives

(4) The average university researcher has small respect for schedules or deadlines.

B. Nonprofit organizations—research institutes, special-purpose foundations, corporations, etc.

Positive characteristics:

(1) Research and development is usually carried out by full-time professionals, leading to a maximum rate of progress.

(2) Research workers are generally free of preconceived acceptance of any given systems or devices—hence, tend to be objective in approach.

(3) As compared to universities, the staff is usually better equipped and staffed to carry through applied research and early development.

(4) As compared to universities, the staff readily accepts specific assignments for specific tasks. Such acceptance is necessary for survival and hence is a powerful motivating factor.

(5) These organizations can be used to treat with interservice problems much more readily than can in-house laboratories or industry.

Negative characteristics:

(1) By tradition and from industrial pressures and tax structure, they are not in a position to carry through final steps of development for practical utilization and manufacture.

(2) As compared to universities, the organizations have less assurance of continuing existence.

C. Industry

Postive characteristics:

(1) When the necessary competence is available, industrial organizations can carry through on applied research, development and production, giving continuity and minimum disruption.

(2) In general, they will accept any specific assignments within the limits of work load and competence.

(3) Economic competition leads to a maximum of effort and drive.

Negative characteristics:

(1) Intense competition tends to make researchers secretive and to strive for proprietary positions. This detracts from the interchange of ideas among the best minds.

(2) The drive for profits tends to point developments toward existing corporate skills or toward existing company products. This detracts from objectivity in approaching new developments.

(3) Because of competition, profit motive, and often-impatient management, there is a tendency to take short cuts in development leading to later severe difficulties.

D. Government in-house laboratories

Positive characteristics:

(1) In general, the organization readily accepts assignments for specific objectives.

(2) A relatively free interplay of ideas among the scientific minds.

(3) Close familiarity with governmental operations.

(4) In a position of substantial authority; often has the decisive role on developments for the military arm. Serves as the "honest broker" for contract selection and weapons evaluation.

(5) Serves as effective liaison between the civilian and military organization, thus resolving many of the difficulties of our dichotomy of military organizations with civilian control.

(6) Traditionally serves as a training ground for capable young men who go on to other organizations, thus adding to the national strength in research and development.

Negative characteristics:

(1) Exposure to, and involvement in, the cloying effects of governmental bureaucracies seems inevitable, hinders progress and detracts from individual motivations.

(2) The organizations are subject to an undue amount of public analysis and criticism; life is too much in a goldfish bowl.

(3) Prestige has been low in minds of scientific and industrial communities.

(4) Because of the bureaucratic system, very difficult to remove incompetents from the ranks.

Note that the quadrilateral approach to handling our defense research and development problems has evolved under the motivation of finding the best way of accomplishing a very difficult and extremely important task. Taken all together, the positive and negative characteristics of the four types of organizations balance out to produce an effective pattern of action. Elimination of any one type would be truly deleterious. Hence, improvements to one segment of the operation should not be accomplished by seriously weakening or eliminating one of the others. We greatly need them all.

The very diversity of the four types of organizations carrying on research and development for the Department of Defense represents an inherent virtue which, apparently, is seldom realized. Each type of organization has its own strengths and weaknesses. In a free society—which we are now struggling desperately to defend—the allocation of talent is by individual preference for the opportunities offered rather than by command. Hence, the greater the variety of choices afforded by the organizations associated with our Defense establishment, the greater the probability of the nation's acquiring the best talent for solving problems of the nation's defense. However, if one segment is weak, the whole structure suffers. It is now generally recognized that the in-house laboratory is the weaker quadrant and, in the public interest, needs to be strengthened.

It must be remembered that all the indications are that, for the foreseeable future, the demand for their talents will be so great that scientists and engineers, short of an all-out war situation, will pick their place of employment in terms of personal interest and advantage. They will be in the position of picking and choosing. The most important factors in the mind of the talented young scientist or engineer in selecting his place of employment are probably these:

Mental stimulation
Freedom from frustration
Long-time security
Income

If a research man is primarily interested in maximum income over his productive life, he will probably choose an industrial position. If mental stimulation, coupled with a minimum of frustration, is the most important thing in his mind, he will lean toward a university. If maximum security stands highest on his list—or that of his wife—he may well choose a position in a government laboratory. If he prefers to play the field and get a reasonable balance of the various advantages, he may take a position with one of the numerous nonprofit organizations.

These possibilities of choice represent a very wide seine which should retain enough of the catch of the scientific and engineering talent.

Unfortunately there is a large hole in that segment of the net represented by the government in-house laboratories. It is very important that this be mended. When stripped of the multitude of details, all of the evidence, from expressions of personal opinions and the results of detailed surveys, shows that the weaknesses of the government laboratories in attracting top talent lie in just two of the motivating factors: A minimum of income for responsible positions and a maximum of frustration within the bureaucratic framework. Both of these detracting influences can readily be ameliorated when those in positions of influence realize the importance of the problem and resolve that something should be done about it.

The mere recruitment of talented personnel, however, is only half the problem. Retention of a core of the best people throughout their professional career is a necessity if the in-house laboratories are to meet their obligations. America is a mobile civilization, and any capable man is not only tempted but free to move to other positions when better possibilities appear. Though the relative importance of the various motivating factors mentioned above may shift with the time in a person's life, they still control. It is most important that the governmental system develop enough flexibility not only to attract the beginner but also to hold a reasonable and necessary proportion of the old-timers.

Frequently comparisons are made between the difficulties of American experience in the retention of top talent in government laboratories with the apparent stability of similar British organizations. It must be remembered, however, that the mores of the two nations are significantly different. Class and occupational boundaries are still quite rigid there, while with us those sociological restrictions are almost nonexistent. On the average, the British scientist who acquires a position in a respected government laboratory is very satisfied with his lot and feels he is fixed for life. In contrast, the average American never considers that his roots are so deep that he will not listen to a proposition to move to another location and organization. In laying plans for the adequate strength of our in-house laboratories, we must reckon with the mobility and restless temperament of Americans and adapt the important motivating forces to the realities of retention as well as to recruitment.

Another factor highlights the importance of the DOD exploration of its R&D activities. There is a strong tendency to evaluate the pattern and program of the military R&D only from the viewpoint of the specific needs of the military establishment. This is the sole criterion used in defending the position of the DOD budget. Inadvertently, however, the military R&D program has acquired an importance in the national scene which far transcends defense needs. A few data on the source and application of R&D funds will help to point up the situation.

In Fiscal Year 1961, the total national expenditures for R&D were approximately $16 billion, of which $3.2 billion went for applied research and $1.8 for basic research.[1]

About 60 percent of the financial support of all of the nation's research and development funds come from the Federal Treasury. In 1961, 81 percent of the Federal funds for development were estimated to come from the Department of Defense, 11 percent from the Atomic Energy Commission and 7 percent from the National Aeronautics and Space Administration.[2]

These three agencies accounted for 98 percent of the financial support of the government's development program. Since both AEC and NASA are very closely linked to defense, it is evident that defense has unwittingly become the major caretaker of the nation's newer technology. Such a stewardship is not to be taken lightly.

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[1]National Science Foundation, Investing in Scientific Progress, NSF Report 61-27, 1961, p. 21.

[2]National Science Foundation, Federal Funds for Science IX, NSF Report 60-80, p. 16.

A similar picture emerges for basic research. The following table covering the nation's program gives the structure of the source and use of basic research funds:

Percent Distribution of Funds for Basic Research[3]
According to Sectors, Fiscal Year 1961

Sector	By source (%)	By performer (%)
Colleges and universities	12	50
Other nonprofit institutions	6	7
Industry	22	25
Federal Government	60	18

As might be expected, the DOD support of basic research is a smaller proportion of the total of Federal input to the field than is the case for development. For FY 1961 the estimated DOD expenditure for basic research was 15 percent of the total Federal support. The AEC support was 14 percent and NASA's was 39 percent.[4]

Thus, 68 percent of the Federal support of basic research was supplied by those three agencies, which are all closely linked to defense.

It is generally agreed that the future well-being of the nation depends in a paramount fashion on a strong and continuing R&D program. It is obvious from the above data that this national program would be promptly wrecked without continuing strong Federal support in general, and defense support in particular. For the nation as a whole, as well as DOD, it is critically important not only that support be continued but also that roadblocks be removed from the path of the four major performing segments—universities, nonprofit organizations, industry and government in-house laboratories—in order to achieve maximum performance and progress. Because of the interwining and feedbacks among these four components, it is important that a study of the in-house laboratory problems be pursued with full cognizance of the role and support of the other segments. The in-house problems do not stand in splendid isolation.

Because of the importance of the problem, there has been within recent months a spate of enquiries, investigations, questionnaires and reports on the in-house laboratories. Three of the most important will be noted here:

(1) Task 97—Review of Defense Laboratories, report of a task group chaired by John Golden, appointed by DDR&E.

(2) The Competition for Quality, Reports 1 and 2, the Standing Committee of the Federal Council for Science and Technology—the so-called Astin Committee.

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[3]National Science Foundation, op. cit. page 19.

[4]Ibid.

(3) Bureau of the Budget study. On July 31, 1961, President Kennedy requested the Secretary of Defense, Chairman of the Atomic Energy Commission, Chairman of the Civil Service Commission, Administrator of NASA, and Special Assistant to the President for Science and Technology to review the government's experience in contract operations. The Director of the Budget was requested to gather the basic information. This information is being gathered through the use of extensive individual questionnaires directed to:

Government agencies
Contractors
In-house laboratories
Universities

Although the results of this study are not available at this time, it is obvious that it will be broad in scope, covering more than the in-house laboratories.

The Defense Science Board study being reported at this time was the result of a request by DDR&E. A small Ad Hoc Committee—C.C. Furnas, Chairman, Fred Seitz and Donald Putt—was formed.

The approach to the study was informal. Initially 30 selected individuals were requested to express their candid opinions on "the factors underlying the successful operation of research and development laboratories generally, and indicators that might be used to measure success in the over-all laboratory operations." Particular attention was called to the in-house laboratories.

The responders were distributed as follows:

Directors of in-house laboratories	9
Directors of nonprofit organizations	3
Directors of major university defense laboratories	5
Government officials not directly involved in laboratory management	4
Directors or vice-presidents of research in industry	9
Total	30

Despite the divergent backgrounds and points of view, the replies showed a great measure of consistency—indicating that there are common parameters for effectively carrying out research and development, no matter what the vehicle.

The responders, using the above approach, necessarily dealt primarily in concepts and principles rather than details. The highlights of the results are as follows:

/Author's note: At this point, I will review the principal points of my "Preliminary Report on In-House Laboratories" of July 1, 1961. In the final report to DSB, I have in mind using the above preliminary material (perhaps modified) followed at this point with the essence of my July 1, 1961, report. The final section would be a comparison with and critique of the reports of the three other studies mentioned above./

APPENDIX III

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON 25, D. C.

April 30, 1962

Dear Mr. President:

As requested by your letter of July 31, 1961, we have reviewed the experience of the Government in using contracts with private institutions and enterprises to obtain research and development work needed for public purposes.

The attached report presents our findings and conclusions. Without attempting to summarize the complete report, we include in this letter a few of our most significant conclusions, as follows:

1. Federally financed research and development work has been increasing at a phenomenal rate—from $100 million per year in the late 1930's to over $10 billion per year at present, with the bulk of the increase coming since 1950. Over 80 percent of such work is conducted today through non-Federal institutions rather than through direct Federal operations. The growth and size of this work, and the heavy reliance on non-Federal organizations to carry it out, have had a striking impact on the Nation's universities and its industries, and have given rise to the establishment of new kinds of professional and technical organizations. At present the system for conducting Federal research and development work can best be described as a highly complex partnership among various kinds of public and private agencies, related in large part by contractual arrangements.

While many improvements are needed in the conduct of research and development work, and in the contracting systems used, it is our fundamental conclusion that it is in the national interest for the Government to continue to rely heavily on contracts with non-Federal institutions to accomplish scientific and technical work needed for public purposes. A partnership among public and private agencies is the best way in our society to enlist the Nation's resources and achieve the most rapid progress.

2. The basic purposes to be served by Federal research and development programs are public purposes, considered by the President and the Congress to be of sufficient national importance to warrant the expenditure of public funds. The management and control of such programs must be firmly in the hands of full-time Government officials clearly responsible to the President and the Congress. With programs of the size and complexity now common, this requires that the Government have on its staff exceptionally strong and able executives, scientists, and engineers, fully qualified to weigh the views and advice of technical specialists, to make policy decisions concerning the types of work to be undertaken, when, by whom, and at what cost, to supervise the execution of work undertaken, and to evaluate the results.

At the present time we consider that one of the most serious obstacles to the recruitment and retention of first-class scientists, administrators, and engineers in the Government service is the serious disparity between governmental and private compensation for comparable work. We cannot stress too strongly the importance of rectifying this situation, through congressional enactment of civilian pay reform legislation as you have recommended.

3. Given proper arrangements to maintain management control in the hands of Government officials, federally financed research and development work can be accomplished through several different means: Direct governmental operations of laboratories and other installations; operation of Government-owned facilities by contractors; grants and contracts with universities; contracts with not-for-profit corporations or with profit corporations. Choices among these means should be made on the basis of relative efficiency and effectiveness in accomplishing the desired work, with due regard to the need to maintain and enlarge the long-term strength of the Nation's scientific resources, both public and private.

In addition, the rapid expansion of the use of Government contracts, in a field where 25 years ago they were relatively rare, has brought to the fore a number of different types of possible conflicts of interests, and these should be avoided in assigning research and development work. Clear-cut standards exist with respect to some of these potential conflict-of-interest situations—as is the case with respect to persons in private life acting as advisers and consultants to Government, which was covered in your memorandum of February 9, 1962. Some other standards are now widely accepted—for example, the undesirability of permitting a firm which holds a contract for technical advisory services to seek a contract to develop or to supply any major item with respect to which the firm has advised the Government. Still other standards are needed, and we recommend that you request the head of each department and agency which does a significant amount of contracting for research and development to develop, in consultation with the Attorney General, clear-cut codes of conduct, to provide standards and criteria to guide the public officials and private persons and organizations engaged in research and development activities.

4. We have identified a number of ways in which the contracting system can and should be improved, including:

Providing more incentives for reducing costs and improving performance;

Improving our ability to evaluate the quality of research and development work;

Giving more attention to feasibility studies and the development of specifications prior to inviting private proposals for major systems development, thus reducing "brochuremanship" with its heavy waste of scarce talent.

We have carefully considered the question whether standards should be applied to salaries and related benefits paid by research and development contractors doing work for the Government. We believe it is desirable to do so in those cases in which the system of letting contracts does not result in cost control through competition. We believe the basic standard to be applied should be essentially the same as the standard you recently recommended to the Congress with respect to Federal employees—namely, comparability with salaries and related benefits paid to persons doing similar work in the private economy. Insofar as a comparability

standard cannot be applied—as would be the case with respect to the very top jobs in an organization, for example—we would make it the personal responsibility of the head of the contracting agency to make sure that reasonable limits are applied.

5. Finally, we consider that in recent years there has been a serious trend toward eroding the competence of the Government's research and development establishments—in part owing to the keen competition for scarce talent which has come from Government contractors. We believe it to be highly important to improve this situation—not by setting artificial or arbitrary limits on Government contractors but by sharply improving the working environment within the Government, in order to attract and hold first-class scientists and technicians. In our judgment, the most important improvements that are needed within Government are:

To insure that governmental research and development establishments are assigned significant and challenging work;

To simplify management controls, eliminate unnecessary echelons of review and supervision, and give to laboratory directors more authority to command resources and make administrative decisions; and

To raise salaries, particularly in the higher grades, in order to provide greater comparability with salaries available in private activities.

Action is underway along the first two lines—some of it begun as the result of our review. Only the Congress can act on the third aspect of the problem, and we strongly hope it will do so promptly.

In preparing this report, we have benefited from comments and suggestions by the Attorney General, the Secretaries of Agriculture, Commerce, Labor, and Health, Education, and Welfare, and the Administrator, Federal Aviation Agency, and they concur in general with our findings and conclusions.

/s/Robert S. McNamara,
Secretary of Defense

/s/James E. Webb,
Administrator, National Aeronautics and Space Administration

/s/John W. Macy, Jr.,
Chairman, Civil Service Commission

/s/Dr. Glenn T. Seaborg
Chairman, Atomic Energy Commission

/s/Dr. Alan T. Waterman
Director, National Science Foundation

/s/Jerome B. Wiesner
Special Assistant to the President for Science and Technology

/s/David E. Bell
Director, Bureau of the Budget