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COORDINATION OF RESEARCH AND DEVELOPMENT

22 September 1948

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Publication No. L49-17

THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

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COORDINATION OF RESEARCH AND DEVELOPMENT
22 September 1948

CAPTAIN ROWLEY: Our series of lectures returns this morning to the ubject of technological progress--research and development.

I think you will all agree that in our generation we have seen a reat advance, probably the greatest in the history of the world in that ame period of time, in technology. As an example, we may think of the arge, heavy radio sets of 1918 as compared to the very small radar set hich is in the proximity fuse. That VT-fuse production effort, including esign, can hardly be defined or described by the terms "applied research" nd "development." They are entirely inadequate. Our speaker this morning, r. Hafstad, was in the thick of that job. He called most of the team plays. ou have seen his biography and you know that he is now Executive Secretary f the Research and Development Board. The team play exemplified in the esign and production of the VT fuse required a high degree of coordination, s well as scientific work. He is now in a position where he can use his nowledge of how to coordinate others' efforts. He will speak to us this orning on the subject of "Coordination of Research and Development." Dr. awrence R. Hafstad.

DR. HAFSTAD: General Vanaman, gentlemen: It is always a pleasure to e here. I really enjoy talking to these joint groups, the staff-college roups, the war-college groups, and so on--because you people are forced o face the broad national problems in exactly the same way that we civilians ho tackle these military problems to try to help out the Military Establish- ent are forced to face them. So I feel I am among friends when I talk to group of this kind. I also feel that the greatest promise for increasing he military strength of this Nation lies in these staff colleges, these oint activities, where active and usually younger officers come together, iscuss their mutual problems, and try to work out joint strategy, joint actics, or joint supply, whatever the problem may be.

The subject for this morning is on the Research and Development Board nd the research and development program. That is a big problem too. nd most of the problems that you people attack are big problems of that ind.

There are many good things about the Research and Development Board. ndoubtedly, there are many bad things about it too. One of the good ings about it, however, is that most of the senior people connected ith it are on temporary assignments. Radios were mentioned a few minutes go. I have always thought that a radio is really a miracle. One of the ost important things about it, however, is that it has a switch on it hich makes it very easy to turn off. The Research and Development Board as a turn-off switch too. All of the senior people are on a leave-of bsence basis. They have temporary assignments, and I am in that situation s well. Next July I shall go back to Johns Hopkins University in some apacity or other.

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A by-product of this is that, as I speak to you about the Research and Development Board, I can speak very frankly. I am not in a position where I might have to defend the organization or try to sell a bill of goods that this is the way to handle the research and development coordination problem. I shall speak very frankly and hope that you will accept what I say in that particular vein. I think it will be much more helpful to you if I give you my personal opinion rather than what, perhaps, might be official dogma.

The function of the Research and Development Board, as given by law, is to prepare a unified and integrated program of research and development. We are supposed to eliminate gaps in the program and to eliminate undesirable duplication.

This is a pretty big order. I think all of you know that the total effort in the research and development game, measured in dollars, comes to about 550 million dollars. If you take research and development dollar and divide by about 10,000 or 12,000, you come out with the number of people who are involved. This is a figure you ought to tuck away in the back of your heads, by the way, because there is a remarkably fixed relationship between the expenditure of money and the number of people. This is important because, whenever you see a program laid out for research and development to solve a brand new, important problem, you will find that some group is asking for another 100 million dollars. In the back of your heads, just divide by 10,000 and get the number of technical people who are going to be needed to carry out the program; and, if any of you have had any connection with recruiting campaigns, you will understand what you are up against in trying to staff that new organization.

Research and development have become so popular in the last several years, largely because of their contributions in the late war, that both in government, in the Military Establishment, and in industry outside, there is a tremendous demand for good people. Just think of television, for example. This is a young giant which has come up only in the last few years. My friends in the electronics industry inform me that the television industry is growing even more rapidly than the radio industry grew in the early days of its existence. Here is a brand new industry also demanding best available in technical talent.

In this atmosphere, then, with a shortage of technical people and an international situation requiring that we have the strongest research and development program we know how to devise, we are going to try to focus the energies and the talents of this Nation upon the most important problems the military have to face.

The program must be planned in various stages. The most important thing to get squared away, however, is the objective which is to be laid out. For this, we must have guidance from the military, the Joint Chiefs of Staff. We must have somebody tell us what are the really

important military problems that have to be solved. This comes from the military. Then we must have available to us a group of technical experts, usually civilians, but there is no law against the experts being in uniform if they can contribute to the problem. We have to get the advice and consultation of the technical experts. Finally, some consideration has to be given to the dollar cost of carrying out the program.

All of these factors have to be brought together in some way in order to solve the coordination problem for research and development. A mechanism has been set up, that is, the Research and Development Board. Frankly, I think the mechanism is pretty good.

The problems we are tackling are really staggering in their complexity, hence it is not surprising that the influence of the Research and Development Board on the actual program is not so pronounced as many people think it ought to be. Big things move very slowly. I think it is only by steady pressure and by gradual influence on the program that we can accomplish the thing that we hope to do.

We have mentioned the factors that we have to bring together in order to do a coordinating job on a research and development program. We have available by law a board which is to be responsible for doing this job.

Note that the Research and Development Board is a military board. As you know, it has a civilian chairman, Dr. Bush; but the Board itself is composed of six high-ranking military officers--two Army, two Air Force, and two Navy. By and large, these officers are so chosen that they represent the research and development sections of each of the Departments, on one hand, and more or less the user point of view, on the other. So we have both the developer point of view and the user point of view from each of the Departments in the Military Establishment; which should furnish well-balanced judgment, so far as the decisions are concerned.

This Board is supposed to make the decisions as to the distribution of effort, relative emphasis to be placed on projects, and things of that kind. We mentioned the fact that the program involves an expenditure of about 550 million dollars. We have tried to break this activity down into projects. There are 18,000, plus or minus, individual projects that have to be sorted out and assessed as to importance. Clearly, the Board, which represents the authority, is not going to have time to read up on and study all of those projects. It must have some kind of mechanism backing it up in order to sharpen the decisions that have to be made, a mechanism to bring out the pros and cons and bring up for decision before the Board those problems which are of greatest urgency.

In order to handle this, we have set up a committee structure. Again, the committees are chosen largely according to the urgency of the problems that arise. All of you know that the guided-missiles field in an active and glamourous field. We have set up a Guided Missiles Committee to function in this important area. All of you know that electronics

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has become extremely important in practically all military activities--communications, radar, early warning, air navigation, and what not. So we set up an Electronics Committee. We had to set up, obviously, an Atomic Energy Committee in order to keep up with the developments there. We have committees in practically all of the critical areas involved in research and development.

There is a booby trap involved in this, however. I have already mentioned the Guided Missiles Committee and the Electronics Committee. Now, the Guided Missiles Committee is an end-product committee. It is designed to deliver a weapon. A guided missile is something that the military can use in their activities. The Electronics Committee is an entirely different kind of animal. Electronics is a technical field; it is a science, if you like. A guided missile cannot be made without leaning heavily on electronics, and the Electronics Committee cannot cover its entire field without becoming involved in at least part of the guided-missiles problem.

These are the difficulties that we encounter in actual, day-to-day operation. It is not an unusual situation at all. You have seen it in your own experience in your respective Departments. In the Navy, for example, there is the Bureau of Ordnance. That is end-item. We have the Bureau of Ships. That is end-item. But the Bureau of Aeronautics is a field. It could be end-item if it were confined to airplanes, but it actually includes the whole field of aerodynamics. Similarly, in the Navy, electronics has been assigned to the Bureau of Ships. Yet the Bureau of Ordnance has many activities which involve electronics. The same thing applies to the Signal Corps. By and large, it is supposed to be concerned with end-items, but it is bound to be largely responsible for the electronics activities of the Army. These are the overlaps and interactions which we encounter in running the Board.

Let me ask for the slides, and I will show you what the structure is before we come to the question of how these problems work out in practice.

Chart No. 1.--This is just to call your attention to the origin of the Research and Development Board. Note that back in June 1940 the NDRC, a purely civilian agency, was established. It was converted to the OSRD in June of 1941. The OSRD is now defunct. Do not allow yourselves to be confused by the fact that many of the people who worked for OSRD now reappear, in some capacity or other, attached to JRDB and RDB activities. These organizations did not grow out of OSRD in any way. They arise from the JNW. During the latter part of the war, it was necessary to set up, under the Joint Chiefs of Staff, a Joint Committee on New Weapons and Equipment. This committee was concerned with the problem of introducing into active combat use some of the new items developed during the war, partly by NDRC and OSRD people and partly in the Service laboratories themselves. Out of JNW grew JRDB, which was set up by joint action of the Secretaries of War and of the Navy. In July 1947 this became the RDB, set up by statute, that is, by public law.

PREDECESSORS OF THE RESEARCH AND DEVELOPMENT BOARD

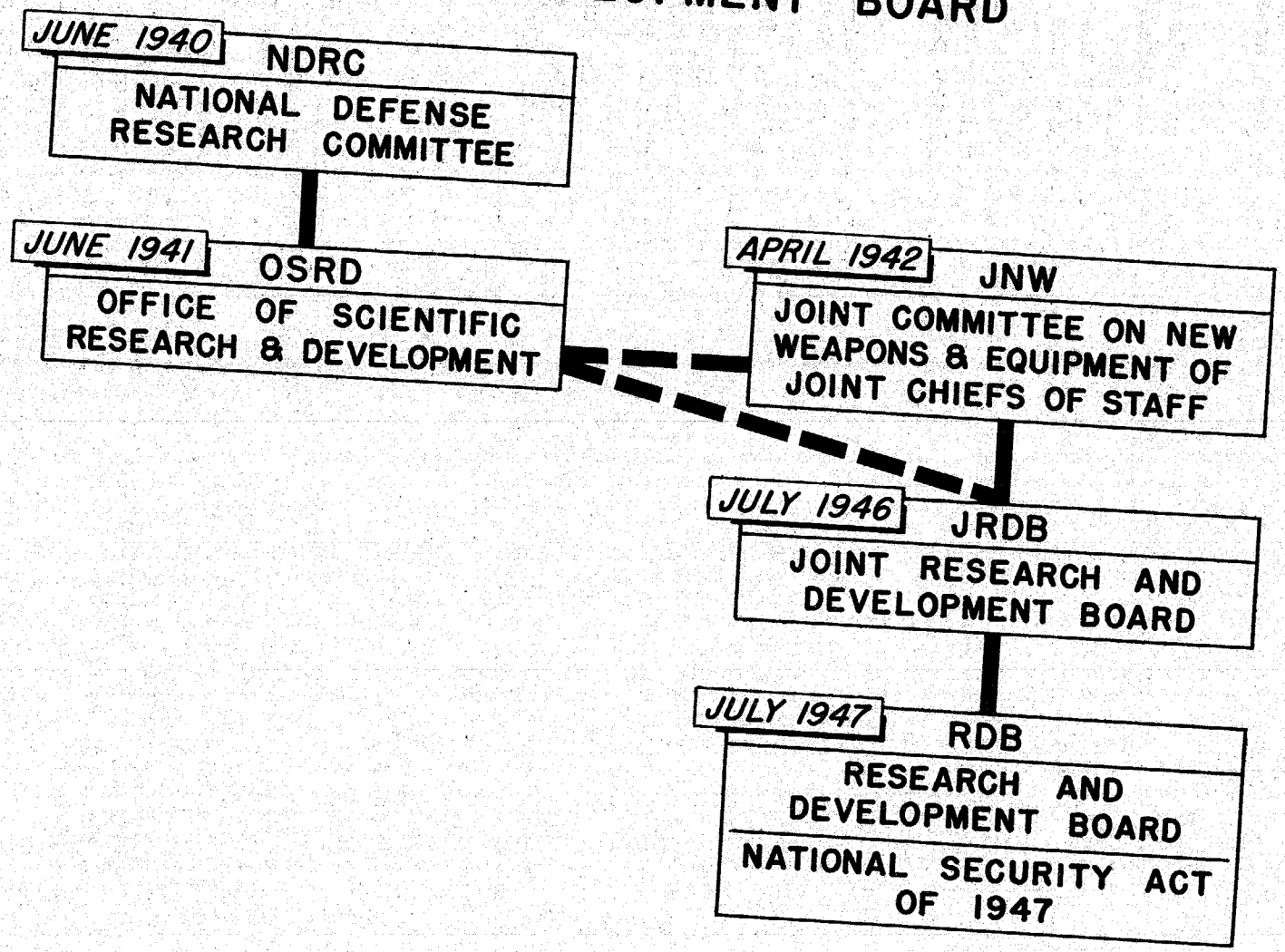

Chart No. 2.--The present Board consists of Dr. Bush as the chairman, Devers and McAuliffe of the Army, Mills and Price of the Navy, and McNarney and Craigie of the Air Force. All of these gentlemen are known to you.

Chart No. 3.-- This shows the committee structure I mentioned a few minutes ago. Under the Board, there is the secretariat, which I head. It is a staff agency to the Board. Under the Board and reporting to the Board, not to the secretariat, are all of the committees: Committee on Aeronautics, Atomic Energy, Basic Physical Sciences, Chemical Warfare, Electronics, Equipment and Materials, Fuels and Lubricants, Geographical Exploration, Geophysical Sciences, Guided Missiles, Human Resources, Medical Sciences, Navigation, Ordnance, Ad Hoc Committee on Scientific and Synthetic Analysis, and Special Committee on Technical Information. In addition, there are special committees and panels with which I need not bother you.

I think that just listing these names indicates to you the complexity of the problem of breaking down all of the activities of research and development going on in the Military Services and of somehow or other bringing to bear on these programs the joint wisdom of a group of military and civilian people.

I mentioned the fact that the Research and Development Board is definitely a military board. The committees are also military organizations. They are usually composed of three civilians, with a civilian chairman, and two officers, usually high-ranking officers, from Army, Navy, and Air Force.

So far as voting procedure is concerned, the military outvote civilians. This we consider desirable rather than otherwise, because the whole purpose of this structure is to bring civilian brains to bear on military problems. The civilians are present, first, to bring their own expert knowledge of the fields to the decisions that are made in the committees and, secondly, to act as a balance wheel, umpire, or referee in case of marked differences between the three Services. The hope is that most of the problems will be ironed out in the committees. If there are disagreements, however the procedure is such that a single dissenting vote in one of the committees will toss the problem up to the Board itself. This is important because it is essential that an organization such as the Research and Development Board be able to act with decision. It should not be able to pass the buck or avoid making a decision on a difficult problem, because the effect of no decision is to stop a program. It is better to get some kind of decision; for this reason the whole mechanism has been set up. The intent is to force decisions on critical issues.

Note, then, the possibility of a dissent by any one of the committee members. We go even one step further than that. Several different agencies may be interested in the same field. In the Army, for example, the Signal Corps and Aberdeen might both be interested in electronics problems and want to have representation on the Electronics Committee.

As you all know, it is very cumbersome to have too large a committee. So we have invented a mechanism whereby, while the number of committee members is definitely limited, any agency with an interest in a given field may have an associate member, who may attend the committee meetings The associate member does not have a voting right. The intent is to keep discussion down and to make the committee operate as effectively and promptly as possible. The associate member may, however, enter a dissenting opinion. His dissent is just as valid as that of any one of the committee members; and, again, the issue is passed up to the Board where it can be resolved.

It may interest and amuse you a little to know that in the voting of the Board a decision requires a five-to-two vote by the Board. If you will stop to think a minute, you will see that this essentially prevents any any two of the Departments from ganging up on the third. A vote of four to two, for example, is not considered decisive. In that case, the chairman has to vote with one group or the other in order to make a decision.

All through the Board mechanism an effort has been made to get decisive action.

Chart No. 4.--A key to the effectiveness of the operation of the Board is the caliber of the civilians whom we can persuade to serve as chairmen on these committees. In Aeronautics, we feel very fortunate in having Dr. George Baker, Professor of Transportation, Harvard School of Business Administration. His special virtue, however, is that he was part of the Finletter Commission, which spent six months last year studying the aeronautics problem. He was thoroughly indoctrinated in all of the problems of the air services in connection with that study.

On Basic Physical Sciences is Dr. W. V. Houston, President, Rice Institute. Chemical Warfare, Dr. Noyes.

This gives us an interesting example of how we can effect coordination. Dr. Noyes, in addition to being chairman of this particular committee of the Research and Development Board, is chairman of the advisory group to the head of the Chemical Warfare Service. This insures our not having two groups of civilian experts giving the military contradictory information, which could be somewhat embarrassing.

In Electronics, we have J. A. Stratton of MIT; Geographical Exploration, Wright; Geophysical Sciences, Roland Beers; Guided Missiles, Fred Hovde. Many of you know him. He worked on rockets during the war and did a good job. He is now president of Purdue University.

Human Resources is an interesting committee. It was started with some feeling of skepticism. There was a recognition of the probability that human problems had not been given adequate consideration in the large amount of research that had been carried on by the Military Service There is one area in which during the war we learned that it pays big

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Major General L. C. CRAIGIE,
Director of Research and Development, Office, Deputy Chief of Staff for Materiel, USAF

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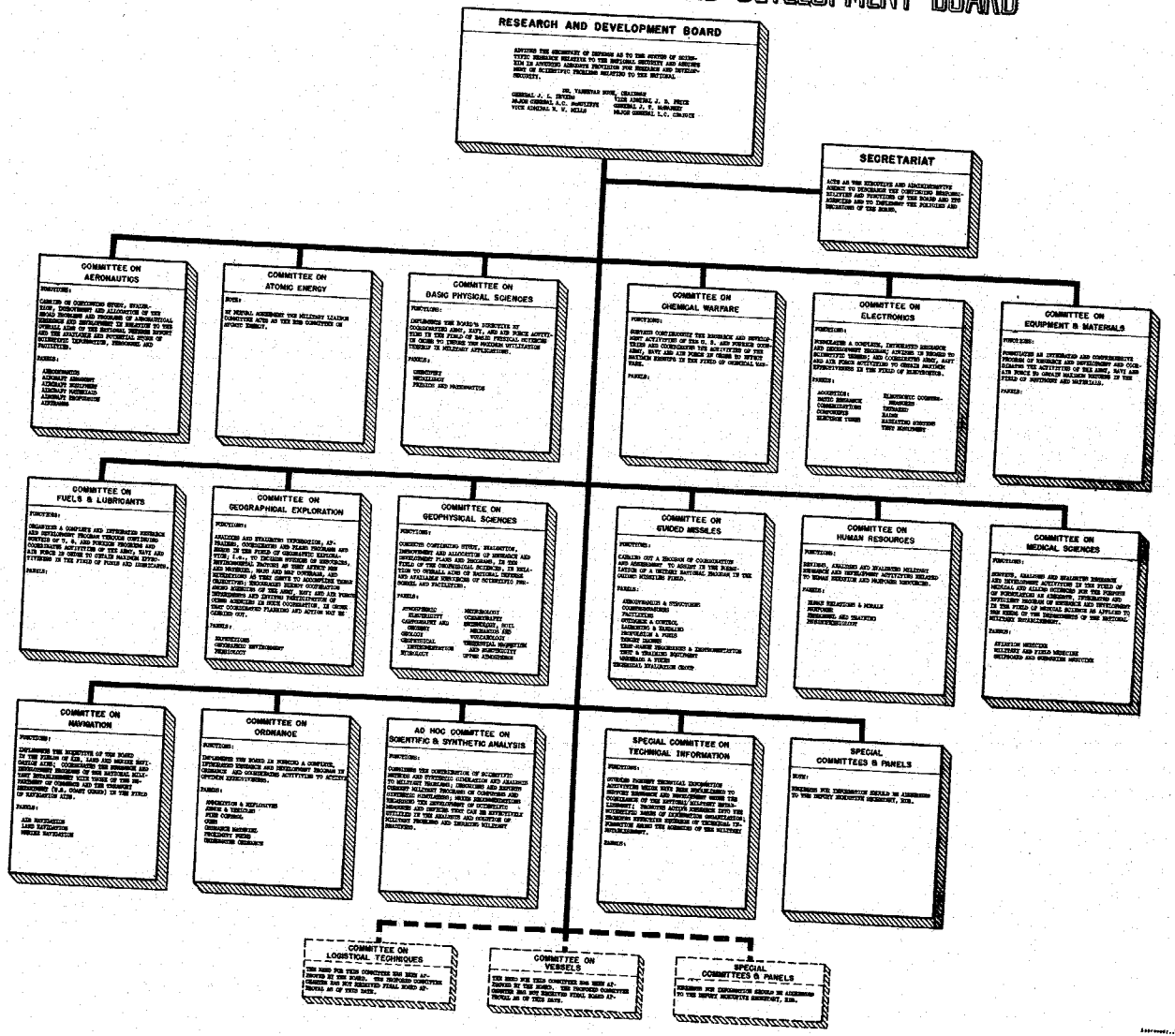

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COMMITTEES
of the
RESEARCH AND DEVELOPMENT BOARD

COMMITTEE	CHAIRMAN
Aeronautics	Dr. George Baker Professor of Transportation Harvard School of Business Administration
Basic Physical Sciences	Dr. W. V. Houston President, Rice Institute
Chemical Warfare	Dr. W. A. Noyes, Jr. Professor of Physical Chemistry, University of Rochester
Electronics	Dr. J. A. Stratton Director, Research Laboratory of Electronics, Massachusetts Institute of Technology
Geographical Exploration	Dr. John K. Wright Director, American Geographical Society
Geophysical Sciences	Dr. Roland F. Beers President, Geotechnical Corporation
Guided Missiles	Dr. Frederick L. Hovde President, Purdue University
Human Resources	Dr. Donald G. Marquis Chairman, Dept. of Psychology Univ. of Michigan
Medical Sciences	Dr. Francis G. Blake Sterling Professor of Medicine Yale University
Navigation	Dr. M. J. Kelly Executive Vice Pres. Bell Telephone Laboratories, Inc.
Ordnance	Mr. F. C. Crawford President, Thompson Products, Inc.
Technical Information	Dr. Detlev W. Bronk President, Johns Hopkins University

dividends to make a careful study of the interactions of man and machine. In fire-control apparatus, for example, the degree of attention that the operator can give to his problem depends, to a large extent, on how long he can remain comfortable and whether the wheels that he has to hold and the cranks that he has to turn are so designed that they allow for a minimum of fatigue. This interaction of man and machine is one of the problems which led to the establishment of the Human Resources Committee. When a pilot is operating an airplane at high altitudes or under conditions of high "G," we have another problem involving the interaction of man and machine. That was another problem which led to the organization of the Committee on Human Resources.

We got together a very vigorous group under this committee, and it has gone far beyond these two problems. It comprises one of our most aggressive and active committees. I believe that, over the next several years, you will hear much more of the work of the Human Resources Committee. The chairman is Donald Marquis.

Medical Sciences is obvious.

Navigation is an interesting one. Most of you know that the problem of aerial navigation has been causing trouble for the last 20 years or so. For the last 15 years an attempt has been made to set up some sort of civil air navigation network over the United States. A few of you know that there is a marked conflict between the requirements of the civil air navigation network and the military navigational aids. This arises apparently, if you will allow me to oversimplify a little bit, from an entirely different attitude and approach to the problem. In the commercial airlines, you will remember, the captain is usually a senior, highly paid man. He is like the captain of a Navy ship and expects to retain full responsibility. He is usually the senior man available when a big ship is about to land, and it is natural for the civilian airlines to attempt to place responsibility on the captain of the ship as he is coming in. This leads to a demand for instrument landing systems where the captain in the cockpit gets as much information as he can about the traffic in the neighborhood, about various local obstacles, and things of that kind and carries the ship in. The military approach, as all of you know, is usually the opposite. Probably the beginning of it is the carrier landing techniques where a man on the carrier assumes control of the plane and either waves it in or waves it on, as the case may be. Ground-controlled approach has been adapted to landing on ground strips as well, and in this case the responsibility is usually placed in a senior officer on the ground and the man in the plane comes in according to instructions.

Now, these two systems are essentially mutually exclusive. It is unthinkable that we could set up a complete network throughout the Nation to take care of military traffic and a separate one in the same airports essentially to cover civilian traffic. If you add to this the requirement that a similar network is needed to give early warning of approaching enemy planes or intruders of any kind, you will see the complexity of this entire problem. There is no easy solution to it.

This problem was attacked independently by a civilian group under CAA and by a group under our Electronics Committee. Out of the considerations of these two groups arose a recommendation for not a solution to the problem, but a plan for attaining a solution to the problem. It involves, obviously, close cooperation between the military and the civilian agencies interested. The solution seems to be--and we hope it works--to set up a practically autonomous board to tackle this problem under the Department of Commerce. But in order to make sure that the military interests are covered, in addition to the CAA (civilian) member, there is one military member from the Air Force and another from the Aeronautics Bureau of the Navy. This board, set up with practically autonomous powers under the Commerce Department, is supposed to tackle the very difficult problem of solving this interaction between military and civilian air-navigation problems.

Those aspects of this problem which are purely research and development and do not involve operation come under this Navigation Committee of the Research and Development Board. Dr. M. J. Kelly, who is the executive vice president of the Bell Telephone Laboratories, is the head of this committee. He should be qualified.

In Ordnance, we have F. C. Crawford. Many of you know him. He is president of Thompson Products.

Technical Information, Dr. Detlev Bronk. He is the chairman of the National Research Council and, as of very recently, the new president of Johns Hopkins University.

I have dwelt at some length on these civilians because they carry a heavy responsibility. I emphasize, however, that all of these men are in this business to aid the military. The whole purpose of this thing is to help the military solve their problems, not to take the decisions away from them.

Chart No. 5.--The Research and Development Board itself has this secretariat. There is an Army secretary, a Navy secretary, and an Air Force secretary. They are essentially my counterparts. Together with the deputy executive secretary and the heads of two divisions, Programs and Planning, we constitute the Executive Council of the Board, which takes care of all of the routine business.

You may be interested in a little more detail on the Programs and Planning Divisions. Clearly, we need information on all of these projects which are going on, particularly fiscal information. The Programs Division collects all of this for us. We also need information on foreign developments. Part of our problem is to make sure that the American developments come along at a rate at least equal to that of developments in foreign countries; and to help us in planning our own programs, we must have as much information as we can get about what is going on in foreign countries. So under the Programs Division we have a group which concerns itself with collecting information on foreign developments, of course,

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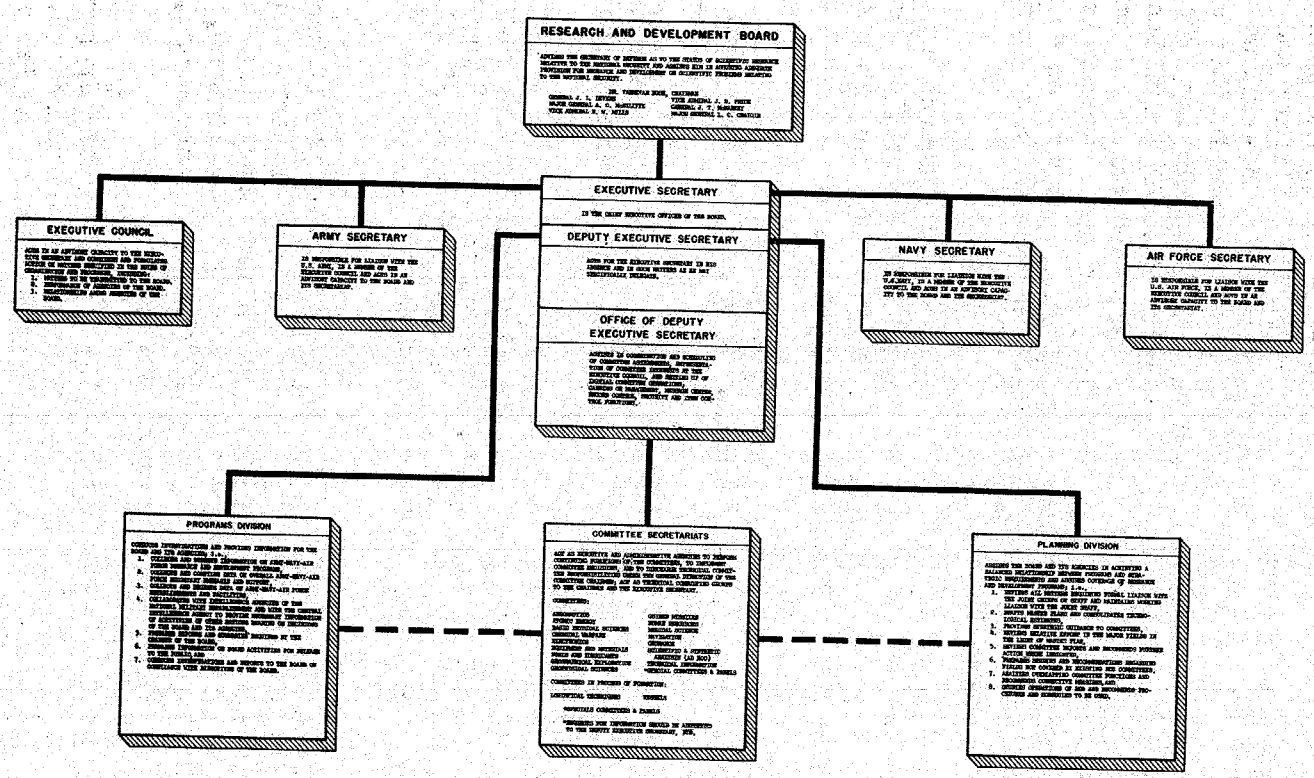

Approved: E. B. Fitzhugh
Date: Sept. 16, 1955

through the existing military intelligence channels.

The Planning Division has a different kind of job. Clearly, all of these committees are concerned with problems in their own areas. It is to be expected--it is entirely natural--that each committee should develop an enthusiasm for its own type of activity, and that each committee should be prepared to fight and win a war with its own particular specialty. Somewhere all of these enthusiasms have to be brought together in order to make a reasonably integrated plan. The Planning Division has the job, then, of taking the reports from each of the committees, sifting them out, reorganizing, rearranging things, and presenting for the consideration of the Board itself an integrated plan representing the best thinking of all of the committees. The Planning Division also has to tie into this planning such information as we get from the Joint Chiefs of Staff, which is called strategic guidance.

Now, in principle, I think you see that this mechanism takes care of most of the needs which might arise in getting a complete and integrated plan.

Chart No. 6.--This is not particularly important. It is just one of the project cards, which gives a minimum amount of information on each project. We have, as I mentioned before, about 18,000 of these cards to sort out and organize.

I have no further charts.

As I indicated in the early part of the lecture, we have a pretty complete and effective mechanism for tackling the problem of getting a coordinated program. There are serious weaknesses, however, and we are not yet completely successful by any means.

I think one of the greatest weaknesses lies in getting a measure of the activity which is now going on. This sounds as though it should be easy, but it is not.

If we boil down our problem, I think it would fall into three parts. First, we have to find out what is now going on in all of the agencies of the Military Services in the line of research and development. Secondly, we should make up our minds what should go on, what shifts in emphasis should be made. Thirdly, we should have some way, after we have made our recommendations, of following through and seeing that these recommendations are carried out.

All of this sounds very simple and logical. In practice, however, it is not so easy. We have, as you know, three different Departments, each with an entirely independent and different system of bookkeeping. It may be somewhat of a surprise to you to find that even such a major question as to whether overhead should or should not be included in the records

has not yet been solved. In the Air Force, which has the advantage of starting out more or less anew, the bookkeeping is such that the cost of overhead, that is, the cost of buildings, grounds, supervision, and so on, is charged to research and development. One can find, at least roughly, a figure for the total expenditure for research and development in the Air Force. In the Navy, for reasons of tradition, the research and development money has been kept in a separate budget for only the research and development activities themselves, not for buildings and other overhead. If we compare the programs of the Air Force and of the Navy on a strictly dollar basis, we get very misleading results. The Army is in the same boat. It, too, has a different system of bookkeeping It is more like that of the Navy, at least in that all overhead is not included. We will get different figures, again, depending on how overhead is defined. If the time of the officers who are working on the projects is included, the total costs are going to be quite different from what they would be if the time of military personnel is not included

Still worse is the task of trying to measure the amount of activity in a certain area. For instance, we are all agreed that the antisubmarin problem is a very difficult one and a very important one to solve, and quickly. We ask, what is the current activity? How much effort are we putting into the antisubmarine problem? Well, there are the budget figures, but they don't mean very much because activity is measured by current rates of expenditures and we don't keep books on current rates of expenditures. We keep books only on the budget and the total amount of money which is left in the budget. We don't keep current expenditures. Now, the General Accounting Office keeps records of expenditures; but, as you know, the GAO audits come at least six months after the expenditur are made. So what measure can we use as to the current effort on our ant submarine problem and how are we to judge whether it is adequate? As you can see, it is not a very simple problem.

One of the naive solutions would be that we take our project cards for all 18,000 projects, and demand that the Military Departments keep separate and complete records of expenditures on each project. This would involve a complete overturn of the bookkeeping systems in the Departments. I think it would be unintelligent, anyway, because we don't need such detailed information on the projects. Besides, projects change from time to time. Most of you know, I am sure, and I certainly learned during the war, that a project can shift from a very promising one to a practically useless one if one key scientist resigns. Even with the best of planning, the projects are going to change in importance from day to day and month to month.

In order to handle that situation, it is quite clear that the agency chief, the head of the bureau that happens to be involved or the head of the laboratory that is running the program, must be given a wide degree of latitude in the expenditure of funds. This is unavoidable in a resear and development program. It is almost axiomatic that in research and

SECURITY CLASSIFICATION

RESEARCH AND DEVELOPMENT PROJECT CARD (NEW PROJECTS) 2. SEC. 3. PROJ. NO. 6-64-10-002

1. PROJECT TITLE: Chemical-Biological Information Center

4.

5. REPORT DATE: 4 Feb 47

6. BASIC FIELD OR SUBJECT

7. SUB FIELD OR SUBJECT SUB GROUP

8. COGNIZANT AGENCY: Medical Corps

9. DIRECTING AGENCY: MC AMRDB

10. REQUESTING AGENCY

11. PARTICIPATION AND/OR COORDINATION

12. CONTRACTOR AND/OR LABORATORY: National Academy of Sciences

CONTRACT/W.O. NO.

13. RELATED PROJECTS

14. DATE APPROVED: June 46

15. PRIORITY

16.

17. EST. COMPL. DATES: RES. / DEV. / TEST / OP. EVAL.

18. FISCAL EST'S. $

19.

20. REQUIREMENT AND/OR JUSTIFICATION

It is highly desirable desirable that one central agency perform the necessary services listed below for the War and Navy Departments and the Public Health Service in order to avoid the duplicate testing of compounds.

21. BRIEF OF PROJECT AND OBJECTIVE

The Chemical-Biological Information Center is to collect and assemble information relative to the chemistry and biology of compounds and to develop coding methods for chemical and biological effects so material may be organized and classified into readily usable form; to secure compounds from various sources and to test them to determine their biological effects on various forms of life and the mechanisms underlying these effects; to render advisory services on the biological effects of known compounds; and on its own initiative to suggest programs or projects to be undertaken on contract and to make recommendations on the scope, institutions and investigators of proposed contracts.

Class. No. Z

22. JRDB SN. MED-67 | PC. | IC & P. 9 - 10 | I. | I. | C.

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evelopment, you have to pick a good man and give him his head, give him trong support. The same thing applies to the head of the agency that is esponsible for research. We cannot plan research from any central or-anization like the RDB and specify in detail how it is to be carried out.

I want to assure you people that, so far as all of the senior people n RDB are concerned, there is no question in our minds about this: There s no intent to intrude in the operations activities of the Departments. DB is a staff agency. At the same time, some control has to be maintained. he best way I could express it would be something like this: The agency hief has to have full authority and freedom to change his attack on a iven objective. He should not be allowed to change the objective itself. f we can get that kind of thinking across, I believe we can still have a oordinated program and not interfere with the freedom of action, the ecisions, and the day-to-day operations of the working groups.

I have talked a bit longer than I expected. I have probably left many uestions unanswered. I think I shall just turn the meeting open to iscussion. I shall be glad to try to answer any questions that you eople wish to raise. Thank you.

QUESTION: You made the statement, I believe, Doctor, that the voting n a certain project must be five to two to be decisive. That includes he civilian chairman. Does the chairman vote on each issue or only when t is necessary?

DR. HAFSTAD: Only when it is necessary. Most of the decisions of he Board have been unanimous. The reason for this proviso is that, f the chairman feels that two Services are ganging up on the third, e may vote with the minority. This makes the vote four to three, but t is not enough to decide the issue, which then goes to the Secretary f Defense for resolution. It is a precaution that was made necessary r the problems in inherent unification.

QUESTION: You said that one of the big drawbacks is this accounting r funds. Is there any progress being made in the solution of that oblem?

DR. HAFSTAD: It is the kind of thing that moves slowly, but we are king progress. The only way to handle it is to arrange for the counting officers from the three Departments to join our people to see we can sort out from the existing procedures some mechanism whereby we n find out what is going on, without a prohibitive amount of work on the rt of the officers. I think a solution something like this can be rked out: We want to know by committees and by areas of activity how ch money is being spent, but we need that only for planning purposes. variance of plus or minus 10 percent would be permissible. Those of u who are technical people and engineers are used to the idea that you n't have to get all numbers with great precision. Unfortunately, book-epers are not built the way engineers are, and they say, "Either you t the information to the last penny or you just can't have the information.

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It's just not available." We have to break this impasse somehow. I thi the way to do it is this: On major projects, where the bookkeeping is not kept in such a way that we can sort out the expenditures, the projec officer could sit back and say, "On this contract, my guess is that 30 percent is going into electronics, 10 percent into aerodynamics, and 18 percent into guided missiles or something else, etc."

That is sufficient for our planning purposes. If we can get that kind of thinking across, we will be in the clear. As a check on this, however, we would have to make quite sure that the actual records were checked some months later in order to be sure that we aren't getting phony information; but I don't think that is too difficult.

QUESTION: Sir, all three Services are doing work on guided missiles. I wonder if you would elaborate on what means the Board has to insure th those efforts are coordinated and duplication prevented.

DR. HAFSTAD: That is a very pertinent question. It is one of our major headaches. I think the answer to your question is essentially thi So far as the technical factors are concerned, the Board mechanism could function and could come out with clean decisions as to which project should be pushed and which should be held back. The missing information is what we call the military worth of the different guided missiles. So long as they are feasible and the groups carrying on the projects are competent, the Board, by itself and of its own information, is not in a position to say that one project should be dropped and another carried on. We need help from the Joint Chiefs of Staff. They must tell us, fr the military point of view, whether it is more important to have a 500-mile guided missile with such and such accuracy to bombard a town than it is to have an airplane and whether it is cheaper to do it by guided missiles than it is by airplane. Questions of that kind are involved in assessing the military value of these devices.

The people who are making them are all convinced that their particul device is going to win the next war, so we don't get any help by going back to the developers and asking, "Is this device useful?" They are al wonderful. We must go to the user groups, we have to go to the military people who have to fight these things in battle to decide which are the ones that are going to pay dividends.

For my own amusement, I have had this calculation made: Assuming that there won't be many "A" bombs available and that, therefore, the guided missiles have to be used to carry TNT, at what range does the cost of making the guided missiles to carry 2,000 pounds of TNT, let us say, exceed the damage done to the enemy when the thing lands? Puzzle about that one a little. Here are 2,000 pounds of TNT flying 500 miles, falling in a city, usually in a residential area, and blowing up a half dozen houses. Let us rate each one of them at $10,000 or $20,000, it doesn't matter very much one way or the other; there is the damage to the enemy. Now think of the cost to ourselves of making that guided missile. Think of the complexity of the thing, of the technical talent, and critical materials that go into it. At what range would you guess

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now we would begin to lose money, where we would begin to hurt ourselves more than we would hurt the enemy by shooting these things at them?

QUESTION: Do you have the answer to that?

DR. HAFSTAD: I will give you a rough one. It is about 300 miles. Don't take this as gospel truth. I have not made the calculations taking all factors into account. I am sure there will be times when you would want to handicap an enemy going through a certain town and it might be worth a great deal to bombard them, but it is not a foregone conclusion. The point I want to make is that any weapon that you can devise and fly against the enemy must hurt him more than it hurts you. It is this kind of thinking that we need in order to solve the guided-missile problem.

CAPTAIN ROWLEY: There is further development of that point, I believe, in Dr. Hafstad's lecture of last year on "Guided Missiles," which is available in the ICAF Library.

QUESTION: You have told us how the Joint Chiefs of Staff pick out the major areas of urgency in which they want something developed. Could you tell us how other projects get filtered into this system? How do these 18,000 projects arrive in the system? From what sources do they come?

DR. HAFSTAD: The facts-of-life answer to this question would be something like this: The projects arise spontaneously in the lower levels of the developing agencies. They grow like weeds all over, and at various levels the senior people get together and try to beat down a few of them. Then the rest of them come on up through and get to the RDB level. We look them over again and try to separate the plants from the weeds. Now, we get help, as I indicated, from the objectives laid down by the Joint Chiefs. The problem that we face, then, is to take the needs of the military as given by our strategical guidance from the Joint Chiefs, look over this array of 18,000 projects, then try to fit the two together as best we can. It is a jigsaw puzzle. Those projects which fit into the needs of the military are clearly the virtuous ones and should be supported. Those that don't fit into the needs of the military should be eliminated, not in order to save money but in order that more emphasis and effort might be put behind the really urgent problems.

Trying to sort these things out is a thankless job. We have not solved it as yet, but I believe we are making progress in that direction.

QUESTION: I would like to know how these committees work. You have some very important people as chairmen. Dr. Kelly from Bell Telephone and Fred Crawford from Thompson Products certainly have a full-time job with their own companies, and I know they are very busy. How much of their service is lip service, and how do the committees actually work?

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DR. HAFSTAD: That is a very pertinent question. I think the secret, if there is any, in our attack on the problem is that we provide each committee with a pretty strong secretariat, which is part of my staff. There is a civilian executive director who himself is supposed to be an expert in the particular area; and in each of the important committees, at least, there is attached to him one officer, usually of colonel level, from each of the three Departments. There is a full-time staff, therefore organizing the materials and bringing out the pros and cons of the problem in the full-time secretariat. The problem then is supposed to be presented to the committee members for their judgment. They are not supposed to have to work at the problem. They are not supposed to have to take their own time to dig through all of the reports and read up on the problem. The information is supposed to be digested for them. And people like Kelly should be able to come in and give their judgment on critical problems from their own broad background, not from the facts which they would have to read about in reports.

I would like to add a little more to answer you very frankly on this committee setup. Some work fairly well and some are pretty weak. My own conclusion is that, if we have a good chairman and a good executive director we have a good committee. If either one is weak, we have a mediocre committee. If both are weak, the thing isn't very effective. We have committees of all types.

QUESTION: Doctor, how does RDB approach the planning and development of new research facilities?

DR. HAFSTAD: We are struggling with that. The beginning of this problem goes something like this: Our Programs Division, through the Departments, collected for the first time, I believe, the total requests for facilities by the Departments. This added up to the staggering figure and this is actually now contemplated; it is not a matter of future proposal off in the distance somewhere--of 40 million square feet.

Another figure you should stow away in the back of your heads is that in research and development activities, about 200 square feet are needed per active person. Take 40 million and divide by 200, and you come out with the number of people you have to collect from somewhere in order to use all of these facilities one shift one day.

This merely points up the magnitude of the problem. The honest answer to your question is something like this: We do have a mechanism for considering each new facility as it is proposed. If it amounts to less than $200,000 leave it to the judgment of the military people responsible for it. If it is more than $200,000, it does require a study by the Board mechanism. Usually the secretariat gets the justification for this proposal from its sponsor. We insure that the other two Services know about the proposal to build the facility. We satisfy ourselves that all

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of the people who might be doing exactly the same kind of work or who have facilities to do the same kind of work are aware of this new proposal, and we at least have their assurance that they could not easily carry out the proposed work; in other words, that there is definite need for the new facility. In addition to that, we have to satisfy ourselves that this facility will definitely contribute to the research and development program in some area that is recognized as important. In this case, it is no different from the project itself. If you once agree that a certain project is important enough to be pushed, you have to back it up with adequate facilities. So we come back again to the evaluation of the project itself, and here the weakness is some way of getting a measure of the military need for the project.

That is the best answer I can give you.

CAPTAIN ROWLEY: That sounds very much like the type of screening Mr. Arthur Hill was doing for Mr. Forrestal, Secretary of the Navy during the war, relative to the essentiality of facilities for public works construction.

DR. HAFSTAD: It is the same problem.

CAPTAIN ROWLEY: I presume that the same thinking has carried on up.

DR. HAFSTAD: It is essentially the same mechanism. You have to get people as well-informed as you can and depend on them to give you the best judgments.

I think it is unfortunate that so much money is required for modern research facilities. The amount of money invested in wind tunnels and things of that kind is staggering. It is too bad more of it cannot go into the research rather than into the facilities, but it is just not in the cards in modern times.

QUESTION: How far does the Board go in its control of the overlapping and duplication within the three Services, particularly in respect to development--there is probably not very much in research--and how is that control effected?

DR. HAFSTAD: The control is not very tight, perhaps not as tight as it should be. I think it would be wise to break down all of the activities into two categories. I would call them research and early development, and then late development or the hardware stage.

Most of you know that it is the hardware stage that is really expensive. Any research project has expenditures that go like this: In the early part of it, there are a few people thinking hard about it and doing a lot of paper work. As it gets into the prototype stage, it becomes more and more expensive. I believe that guided missiles are a good example of this.

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We should be very generous with support for research and early development because we need progress in this field, and this activity, in itself, is not particularly expensive. When we get to the stage of prototype manufacture, however, we begin to eat up the money. If we could eliminate one useless hardware project before we invested the money in it, the amount of money we would save could do a great deal more research and early development and pay bigger dividends.

If we could invent or devise a mechanism whereby just before we went into the hardware stage, the military worth of a project would really be evaluated by a hardboiled, critical group, we could save a lot of money and sharpen up the program tremendously. At the present time projects start as relatively cheap research projects. As they progress, they get into the hardware stage, and the sponsors push them for all they are worth. There is no mechanism for selection. The disadvantage of this procedure is that everybody is scrambling for more money; and when cuts have to be made, they are across-the-board cuts. Everything is put back 8 percent or 15 percent or something of that kind. This is an unintelligent way of doing it. Some projects must be more promising than others. We hope we can devise ways and means whereby a few big projects could be cut and many essential or important small projects supported. I hope we will be able to do it. We haven't done it yet.

QUESTION: Dr. Hafstad, would you care to comment a bit on how coordination is effected between the Research and Development Board and other government departments or industry? Specifically, in respect to guided missiles, the NACA have quite a guided-missiles research project.

DR. HAFSTAD: We have two mechanisms for that. The direct and most effective one is to invite the outside agency to have associate membership on our committee. In the case of NACA, for example, Hugh Dryden was on our Guided Missiles Committee and is now, I believe, on our Aeronautics Committee. He doesn't have to tell us anything, and we have no legal means of forcing him to tell us what they are going in NACA. It is an independent agency. But, being Hugh Dryden, he is perfectly willing to make available to the committee such information as may be helpful to its members when they are making their decisions as to what should or should not be done. This is the direct way. Interlocking membership is the direct answer to your question.

In addition to that, we have a formal mechanism. You will remember that about a year ago the Steelman Report was prepared by an interagency group of government scientists. It recommended that a permanent committee be set up; this has been done under Dr. Wetmore of the Smithsonian Institution. Clearly, the Military Departments have representation on this committee, in addition to the Department of Commerce, Interior, and all the rest of them.

In order to make sure that we keep our lines clear, the RDB is represented on the Wetmore Committee by myself, as the civilian representative of the Military Establishment, and by three officers who are

also members of RDB. We four can, when necessary, have a caucus and decide what the position of the Military Establishment shall be on the major problems which come up before the Wetmore Committee.

There has been an example of this just recently. The draft-deferment problem, particularly as it affects scientists, has been a hot problem for the last several weeks. It is a problem on which the Wetmore Committee was called upon by the President to report. Our little group, representing the opinion of the Military Establishment, reported to the Wetmore Committee in order to make sure that the story which went to the President via the Wetmore Committee carried the Military Establishment's point of view on this, as well as the story that came through the Office of the Secretary of Defense. This is the formal mechanism, then, for interaction and coordination.

QUESTION: That is about the same kind of question I was going to ask and couldn't wait until you got back to Johns Hopkins to ask it. We have been exposed to a good deal of literature on the so-called National Science Foundation. I would like to ask you if you believe there is sufficient wasteful duplication in research and development nationally to justify a large establishment such as the National Science Foundation. Or do you believe that the Wetmore Committee is the answer?

DR. HAFSTAD: As you know, I will answer any of your questions frankly. I assume I am among friends here.

First, I think you have a misconception as to the functioning of the Wetmore Committee. It is a staff activity and not an operating activity, and so it is essentially an advisory group to the President. Legislation would be required to permit them to let contracts or spend money. So the Wetmore Committee is out.

Now, the present story on the National Science Foundation goes something like this: At the end of the war there was rather general recognition that some means had to be found to support basic science, which is usually 10 or 20 years ahead of military needs. Dr. Bush proposed the National Science Foundation at that time, but, unfortunately, his proposal was involved with and came at essentially the same time as legislation on atomic energy. You will remember that there was a big to-do and a lot of flurry just at the end of the war, when Bush, Conant, and what I would call the mature scientists were supporting the first bill for the control of atomic energy and all of the young scientists turned out against it. Their rebellion against this atomic-science legislation reacted on the National Science Foundation legislation, which Bush was pressing at that particular time; and the whole thing went down the drain. I think it was a serious loss, but it was our own fault. As scientists, we didn't handle it very well.

Since the National Science Foundation flopped at that time, and it was widely recognized that something had to be done to reactivate science in the universities, the ONR group stepped into the breach. This was done

with the knowledge and support of Congress and the Military Establishment. ONR of the Navy was organized and has done an excellent job. To be frank with you, however—and many people might not agree with this statement—I think it should be recognized that it is serving two functions. The first is its normal, regular military function of making sure that Navy research does not stagnate, that it stays in the forefront of scientific developments, and has at least associated with the Navy program some small group of scientists who are as longhaired as the best of them. This is what I would call the military function of ONR, and it is the Navy functi In addition, ONR is carrying a national load. It is acting as an interim agency pinch-hitting for the nonexistent National Science Foundation.

I believe that, when this whole setup becomes mature, each of the other Departments, the Army and the Air Force, must and will have small groups of essentially the same kind as ONR, encouraging, getting acquaint with, and establishing contact with, scientists doing very forward-lookin research. I believe, however, that the heavy bulk of the ONR load which it is now carrying, the national load, should be shifted to something lik the National Science Foundation.

Now, you raise the question of whether there is sufficient duplicatio to justify a National Science Foundation. The answer to that one is, I think, a pretty clear "no" on this basis: Owing to the war and the very high taxes that wealthy people are now paying, money available for endowments for research institutes, for endowed universities, and other places of that kind has shrunk practically to zero. So if this kind of activity is going to be carried on, we will have to do one of two things. We will have to change the tax laws in order that money will again be available through private channels to support this kind of work. This, I think, by all odds, would be the best, but I am afraid it is politically impractical. In the absence of money of that kind, our only recourse is to tak government money directly and make it available through some mechanism such as the National Science Foundation to support forward-looking resear

I have no hesitation in saying that, contrary to popular opinion, the United States is not strong in basic science. If any of you doubt that, just go to lectures given by our atomic scientists and see how many speak with a foreign accent.

QUESTION: Britain has something called the Defense Research Policy Committee, which, I think, every six months sets up a list of items in order of priority from a defense point of view. This policy or report, after being passed by the Chiefs of Staff, then becomes mandatory in all research establishments. I wasn't quite clear this morning whether there is any similar system in this country. I understood that the Chiefs of Staff put up their requirements, but I didn't gather whether there was any priority amongst these items or whether they were all lumped together I wonder if you would enlarge on that.

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DR. HAFSTAD: I would be very glad to do so. I would first like to make this comment: I was in Britain in the early days of the war, when we were just getting started with military research in this country. I was over there with Charlie Lauritsen. Some of you may know him. It was our considered conclusion that Britain was one war ahead of us, so far as its handling of research and development problems by the military was concerned. I believe that that situation still exists. Somehow or other we must fight one more war to catch up with Britain in this sort of thing. If they can hold back for a while, maybe we can do it. Civilian experience with military problems in Britain has matured to such an extent that there is no hesitancy on the part of the military there to give to an essentially civilian group, Sir Henry Tizard's, both the coordinating function, which the Research and Development Board here has, and the operating function. In this country those two things are definitely separated. Sir Henry Tizard sits with the British equivalent of the Joint Chiefs of Staff and joins in on their deliberations and discussions. In this country Dr. Bush, for example, does not have such close interaction with the Joint Chiefs of Staff. The Joint Chiefs and the Military Departments are the operating agencies. The Research and Development Board is advisory and a staff agency to the Secretary of Defense. It is an entirely different and separate setup.

QUESTION: It is the Chiefs of Staff who lay down the priorities?

DR. HAFSTAD: That's right.

QUESTION: I assume that the Research and Development Board selects and determines the qualifications of the civilian members of all these committees. Does the Board exercise a similar function with regard to the military members, or does it accept any military members offered by the various Departments?

DR. HAFSTAD: We are playing it this way: It is quite true that the civilian members are chosen usually through the work of the civilian staff but nominated ultimately by Dr. Bush. The civilian's name is presented to the Board, and usually about two weeks are allowed for the members to check around in their own shops to find out what the reaction to that particular civilian is. Unless there are good reasons to the contrary (and there usually are none), the nomination is accepted. So, essentially, the civilian members are nominated by Dr. Bush, subject to the approval of the Board.

The mechanism for the military members is that the military secretary—you will remember there are three of them who are essentially my counterparts—usually checks in his shop to find an officer with a suitable background, and he makes the nomination, which is checked again by the Board. There is no civilian veto except that we work so closely together and have gotten so well acquainted that we usually talk over the officers who are proposed and usually know of their attitudes toward research and development, and essentially we either agree or put up a go-slow sign in certain cases.

QUESTION: Going back to the question on guided missiles, in respect to which you explained the necessity for deciding at what point a guided missile would no longer be worth while, I would like to ask where that study is made. I know that the Services have rather expensive organizations working along that line. I was wondering whether the Board has a similar agency or whether it depends upon the studies that are made by the agencies working for the Services.

DR. HAFSTAD: The answer to that one is that the Board is doing everything it can to encourage such studies within each of the Departments Most of you know that the Navy has the Operations Evaluation Group, which was organized during the war and continued since, and is giving very valuable service in this particular area. The Air Force has two groups, one under Dr. Brothers and another under the Rand contract, doing similar evaluation studies. The Army is just now organizing its unit to work in the same area.

One difficulty is that the problems are so many that all of them cannot be given adequate attention. The second difficulty is that, even after these studies are made by the different Departments, it is entirely conceivable that each study will have a certain slant or a certain emphasi depending on the Department in which it was made. In due course, some mechanism will have to be set up for a top evaluation board of some kind to take all of the available information of this kind from the Department supplemented as necessary, and come out with recommendations. This is going to be a long, slow process.

CAPTAIN ROWLEY: Dr. Hafstad, standing up here and answering these questions in his own excellent, inimitable manner, probably handles his problems in the Research and Development Board in the same way. Thank yo Dr. Hafstad, for your very fine lecture.

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