RESEARCH AND DEVELOPMENT IN GOVERNMENT

15 October 1953

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Washington, D. C.

Dr. Lawrence R. Hafstad, Director, Division of Reactor Development, Atomic Energy Commission, was born in Minneapolis, Minnesota, 18 June 1905. He was graduated from the University of Minnesota in 1926 and received his doctorate in physics from Johns Hopkins in 1933. He was associate physicist at Carnegie Institution of Washington, D. C., 1928 to 1933, and in 1931 with Dr. Tuve was winner of an award by the American Association for the Advancement of Science for Research for the development of the million-volt vacuum tube. His work also included research and development in propagation of radio waves; the measurement of the height of the radio-reflecting layer and its relation to magnetic storm; atomic disintegrations; and artificial radioactivity. He, with two colleagues (Dr. Richard Roberts and Dr. Merle Tuve), demonstrated uranium fission for the first time in the United States in 1939 in Washington following reports from abroad that German scientists had split atomic nuclei. In 1940 Dr. Hafstad started work on the proximity fuze for the Army and Navy and in 1946 was awarded the Medal of Merit by the Secretary of the Navy for his wartime activities in connection with the development of ordnance devices. He has been on leave from Johns Hopkins University where he is Director of Research of the Applied Physics Laboratory. Dr. Hafstad is the first Director of the Reactor Development Division of AEC, charged with the program of designing and developing nuclear reactors for the practical application of atomic energy for power, for propulsion of ships and aircraft, for production of isotopes, and for research on reactors themselves.

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MR. BAUM; Admiral Hague, gentlemen: Our speaker this morning, Dr. Lawrence R. Hafstad, Director of the Reactor Development Division of the Atomic Energy Commission, is primarily a scientist. He is known for his contribution to national scientific advancement.

However, what is equally important to us is that Dr. Hafstad is an administrator and a coordinator of scientific research and development. For a number of years he has been a member and has served as chairman of the Interdepartmental Committee for Research and Development.

This morning Dr. Hafstad will discuss the coordination, administration, and conduct of research and development in Government agencies.

Doctor, it is a pleasure to welcome you to the platform and to introduce you to this year's class.

DR. HAFSTAD: Admiral Hague, General Greeley, members of the Industrial College, and guests: The subject of today's lecture, as you have just heard, is the coordination of science, if you like, in Government. This is a subject which I would say any of those of us connected with research would have a normal professional interest in; but for the past several weeks discussions have been going on in regard to how this coordination should be carried out, which raises the level of interest to what I would call acute.

From your point of view, this subject is timely. From my point of view, it is delicate. It is for this reason that I bring out the fact that we are dealing with a "hot potato," and I hasten to stress the fact that I am speaking as an individual and not as the representative of an agency, and that I am not giving the official position on these controversial problems of any particular group.

First, let's take a look at the magnitude of the problem we are dealing with, in order that we may have a reasonable scale for the degree of interest we take in this particular subject. I will just run through some figures for you. These are figures from the National Science Foundation (NSF) 24 August 1952 so they are fairly recent. Taking them in terms of expenditure, the Department of Defense has expended in the last year 1.6 billion dollars in this field; the Atomic Energy Commission (AEC), 266 million dollars; the National Advisory Committee for Aeronautics (NACA), 88 million dollars; Department of Agriculture, 63 million dollars; Health and Welfare, 61 million dollars; Interior, 33 million dollars; Commerce, 17 million dollars; and all

other agencies, about 24 million dollars. The sum total for all agencies, then, is about two billion dollars.

Well, this is a lot of money, even in this day and age, but I think that, over and above the money, the subject we are concerned with has an even greater intrinsic importance, in that the research which we are doing now will determine our national strength, or military posture, if you like that term, as of some 5 or 10 years from now. So the subject is extremely important, both from the taxpayers' point of view and, particularly, from the national defense point of view, which is of interest here in the Industrial College.

So far I have been merely reciting facts and they should not be controversial. Let's not fool ourselves, however. The very fact that these costs have been isolated from a multibillion-dollar budget poses a problem that is the beginning of the controversy. With some such sum as these at stake, say 2 billion dollars, the question is no longer only: Can total defense costs be reduced? Now the question automatically raised is: Can research and development costs be reduced?

As soon as you ask that question, the scientists are up in arms. The answer is, "Of course not!" If costs are to be reduced, the activities must somehow be scrutinized, evaluated, and coordinated. This puts the fat in the fire. Now, there's a persuasive argument, supported mainly by industrial and practical scientists, that it is perhaps a mistake to allow so much attention to be focused on research costs. In any one major project, the research cost is small compared to the total and, with a little bit of effort and good will in bookkeeping, these costs could be totally lost among the incidental expenses of the project.

This might be a good idea, but I think there are several reasons why this is no longer practical, even though it might be advantageous in the sense of making in total even more money available for research. We might assume for the present that this would be all to the good. The reasons it is unlikely that this course can be taken I would say are the following:

First, the personal vanity of the scientist. The scientist has been in the forefront of the news in recent years. Frankly, he likes that. I don't think he would like the idea of having his activities buried and lost in the general activities of a project or agency.

The second reason is what we have come to believe is the need for a direct line of approach to the top of an agency or the top of an organization in the support of research projects. Personally, I think this is extremely important, because the significance of a possible new development in research or early development has an importance far beyond the dollar value of the activity and, unless the man with the idea has access to the top of the agency where the latter can evaluate

the broad issues at stake, the research idea is likely to be lost in the general review and day-to-day scrutiny of activities in the lower part of the agency. So we really should have a direct line right up to the top of the organization in support of research, and this of course brings out into the open the research costs.

There's a third reason why I think we can't bury research costs, and that is what I call the two-dimensional nature of any large-scale technical management. You all know that when you have a project, any kind of a large technical project, you can break the project down into fields, whatever the project is. Let's say it's a guided missile development. You have within the project different fields like the aerodynamics, the electronics, and all the other technical fields that are involved in making a successful project.

Or you can slice the overall activity in a different way, systems versus components. We have all had examples of that in our day-to-day work. Some of you may remember the Research and Development Board Council where we had Guided Missiles Committees and Electronics Committees. In the one case we were dealing with hardware items, and in the other case we were dealing with, if you will, a field of science.

Now, since any large-scale technical activity involves this two-dimensional approach to the problem, as they scrutinize the overall activity, management will always slice it both ways in order to see what is going on. The project engineers will naturally want to have all facilities for electronics, aerodynamics, mechanics, thermodynamics, chemistry, and all other research necessary to support their particular project. Each one would like to have a complete facility, or set of facilities for his own use. Managementwise, this is intolerable. Somebody has to scrutinize the various projects across the board and see whether all the electronics talent that is available to the agency as a whole is brought to bear on the critical problems of that particular agency. That's the third reason why, I believe, as soon as your technical problems become really large scale, you will have an area where research, even basic research, costs will be brought out in the open.

I have spent some time on this particular point, because I think that what we are up against is this choice--either we bury our research costs or we coordinate them; and, if we can't escape the problem, which would be very nice, then we will have to face up to the problem and tool up to get it done somehow or other. Since we seem not to be able to escape this problem, the only thing to do is to review the various available mechanisms we have to handle the coordination problem.

Now this is not going to be easy, and I cite the experience of the Research and Development Board (RDB) as an example of the kind of thing one is likely to get into and why this must be recognized as a very difficult problem. Compared to coordinating all research and development in the whole Government, RDB had an easy job. All they had to do was to coordinate the activities of the Defense Department. This was a

nice, homogeneous ball of wax and should have been easy. It didn't work, as most of you know, and bogged down in what I call the paper battle of the defenders and the eliminators of projects. The same thing will be involved if we take the same route in regard to coordinating the entire Government program, the 2-billion-dollar program, instead of just the defense program. So we need not fool ourselves that this kind of a job is easy.

Well, we might look over the different mechanisms existing in Government, or perhaps we might just start with the mechanisms that did exist in Government a few years ago when this problem first began to emerge.

There was the Interdepartmental Committee, which was set up as a result of the Steelman Committee Report at the end of the war. This Committee consisted of the heads of research for the different Government agencies but, being strictly a Government organization, it represented what I refer to as the bureaucrats in the business, and neglected the very potent university and industrial groups. For this reason it was not a good group to worry about nationwide problems.

Another possible group to do the coordinating job was the NSF, which has been talked about ever since the war and came into being a short time ago. This, as you will recall, was set up primarily to cover the needs of basic research, rather than applied research, applied research being the business of the different agencies. For this reason, the possibility that the NSF should be given a broader assignment covering all applied research and development as well as basic research was naturally resisted, and is resisted in many groups even at the present time.

This is where the controversy gets to be acute. There are other scientific coordinating committees and advisory groups, and so on, at these high levels. The most notable would be what is called the Buckley Committee, or now the DuBridge Committee. This was set up in recognition of the limited point of view of the Interdepartmental Committee. Since the Interdepartmental Committee did not represent the university and industrial groups, the chairman of that committee, the chairman of the National Science Foundation, the chairman of the National Academy of Science, and a few other distinguished scientists were brought together in a group which was a sort of advisory group for the President. This is perhaps our highest-level scientific group in the country. It is known as the SAC, for Scientific Advisory Committee. It is, however, strictly a part-time group, is available and useful on emergency problems, mainly in connection with Defense, and constitutes itself to handle ad hoc committee assignments; but is hardly a mechanism to take care of a continuing job such as the coordination of the entire scientific research and development program of the National Government.

Not one of these groups, then, is ideally suited to handle a job as big as the one we are talking about. If none of these groups is to do the job, what remains? Well, whether anybody does anything about this problem or not, the Budget Bureau is stuck with it; so in the Budget Bureau we have people who will isolate these costs and will face up to the question of whether or not they are justified. So the Budget Bureau remains as the place where this might be done. Very wisely, however, I think the Budget Bureau topside has decided that this is a highly specialized field, very technical and scientific, where it would be very difficult for it to get the talent and experience necessary to really evaluate these programs. So the Budget Bureau definitely prefers not to take on alone this chore of trying to evaluate these highly scientific programs.

Regardless of what the Budget Bureau does, there remains the Appropriations Committee in Congress, and it in the end will have to make the final decisions as to whether or not this money is appropriated. Here I would like to say, it is my impression that these committees are really very earnest and interested in their approach to this problem. They believe in research. As near as I can make out, they're very favorably disposed to it; but they're confused and puzzled by all of the requests for money that come in. All of them sound large, so it is natural for them to assume that there is a lot of duplication here which might be avoided, and it is difficult for them to get a convincing story as to why all of this must be done.

I think they have been rather patient in bringing this subject up year after year to see when the executive branch is going to do a job on coordinating research and development. What I am afraid of is, if they begin to lose patience, they will resort to the very neat device of not bothering at all about the technical details of this problem, and add one of their uniquely effective little phrases to the appropriation bill, usually starting with a lot of legal phrases like: "Whereas, provided and however," and ending, "no portion of this appropriation shall be used for the support of research." This would solve the coordination problem in a hurry.

This is the very real danger of the situation, and I think we really have to face up to the problem somehow or other, somewhere in the executive department, as to how this coordination shall be done.

The Budget Bureau, which is responsible for these things, a few weeks ago put out a tentative Executive order to see how we could approach this particular problem. Now, this is merely a draft order, and it came out and was issued to the different agencies asking for comments and suggestions. I will just run through this draft order and indicate some of the things in it which are mostly questions of wording, which were objectionable either to the agencies or the scientists who were about to be coordinated.

The point of view taken here is that the Budget Bureau will, or the President will, assign to the NSF the job of coordinating this research and development program. I will pick out individual sentences here which are the ones waving a red flag, so to speak.

"The Federal Government shall conduct or support only those scientific or research activities necessary to the discharge of statutory functions and responsibilities."

To a scientist, particularly a basic scientist, this is a very worrisome statement, because basic science, speaking literally, is never really necessary. Basic science is motivated by curiosity. You are trying to understand something. It may be desirable to understand something; it is rarely necessary, in the strictly legal sense. So we worry about this wording.

Moving on down to section 2 of the Executive order, it states: "The National Science Foundation, with the co-operation of the federal agencies engaged in research, shall evaluate scientific research programs." Now, this is just what the RDB was trying to do; evaluate scientific research programs. It took a very large staff and ran into a lot of controversy, and nobody looks with very much favor on the National Science Foundation's setting up a lot of committees and bringing in another echelon through which you have to defend a budget. So this wording, ". . . evaluates scientific research programs" is a red flag.

We move down a couple of lines and we find, "The National Science Foundation should take steps to eliminate undesirable duplication in basic research." On the surface this is sound advice, but to a scientist it is heresy. Science consists of duplication. I would like to cite as an example the well-known series of measurements on the charge on the electron which, some of you will remember, was for many years 4.774 times 10^{10} electrostatic units. Year after year and decade after decade scientists repeated these measurements and usually came up with numbers in this particular neighborhood, apparently largely because Milliken made the first measurement and nobody dared disagree with the matter. Now let us imagine a governmental committee reviewing a proposal to make a new measurement of the electrostatic charge. I am sure such a proposal would be thrown out automatically, because this constant has been measured at least 10 times, and had always come up with the same value. Further work would obviously be unnecessary duplication.

Only a few years ago, however, a scientist came up with a different approach to this experiment. He came out with a number of 4.80 or thereabouts. This does not sound like a big difference to you people, but this is a very fundamental physical constant, a very important number in the whole realm of physics, and since the time of the 4.80 figure, perhaps another dozen measurements have been made,

strictly duplications, and the number has been progressively refined and established more accurately.

Now, this is duplication of the most obvious kind, but necessary duplication. So in basic science it is just heresy to say that you are going to eliminate duplication. It doesn't make sense at all.

We go on down a little further and we find a statement: "The National Science Foundation shall be the primary agency for the institution of basic scientific research." What does "primary agency" mean? What is it intended to mean here? Is it to be the only agency that does basic scientific research? In that case, what does the Pentagon do? What does the Atomic Energy Commission (AEC) do? When we have all learned that advance in weapons depends so very heavily on the most recent advances in science, shall the NSF be allowed to tell me in the AEC that I am not to be allowed to measure the nuclear cross section of some reaction involving plutonium? Shall the NSF tell the Air Force or the Bureau of Aeronautics that it is the business of the NSF to measure lift overdrag ratios at Mach two or three or thereabouts?

Our military strength depends very heavily these days on weapon possibilities which come out of strictly basic science type of activities, and we can't give up those responsibilities very readily.

Now the feeling is that, under present management in the NSF, there is very little danger that this kind of a function would be taken over or that there would be any attempt to take this over. As time goes by, however, and new people come into the act, there is no telling at what point an "eager beaver" might take over the NSF and say, "The way I read this, it is my business to do all basic research and, as of tomorrow morning, I take over." This would be seriously disrupting to the research and development programs of the Defense Department, AEC, and the NACA, particularly, and these I mention as most important because our national defense is involved.

We go on down the line in this Executive order and find a statement: "The National Science Foundation shall, among other things, recommend to the President policies to guide other agencies in relieving universities and other such institutions of responsibility for research and development deemed more appropriate to industrial or government-operated facilities."

Here again we get worried, for just the reasons I have been outlining, because of the dependence of practical applications on university type of basic research. Many of our most important activities are now being carried out in universities on a sort of task-force basis. Are these to be stopped? As a matter of fact, I get a little bit confused, and I am a little surprised to find, for example, that our great military laboratories seem to be becoming centers of culture and science,

and our great universities are becoming weapon factories. But many strange things happen these days.

Well, I have given you enough of the reactions to this proposed Executive order to indicate why it is that this draft Executive order is controversial.

I will now try to bring you as up-to-date a status report on this problem as I can. Letters have been sent back to the Budget Bureau from the various agencies with comment. This group that I mentioned sometime ago, the Buckley Committee, or the DuBridge Committee, also was called on to advise in this matter, and it has recommended a revised statement. Their statement has been submitted to the Budget Bureau, I believe, and is being considered in connection with issuing another Executive order. This statement takes care of many of the concerns that I have mentioned about the other one but, in looking it over, it raises another set of questions for me.

If I look at the scientists' statements here with a Budget Bureau hat on, for example, I find a number of things which might be troublesome. First, I run into this statement which bothers a little bit; that is, that "The head of each agency engaged in scientific research shall satisfy himself that development shall be undertaken only after careful analysis of the underlying basic and applied research and other relative factors have been completed."

This is good. We certainly agree with that in principle. But, I think from the Defense Department point of view that if we need a new weapon of some kind and there is inadequate scientific data available for the completion of this weapon, I don't think it is realistic to say we will ask the NSF to do the basic research necessary while we sit down and wait.

There will be situations in which a need is to be met for a weapon, and in which the agency will want to take on whatever is necessary in the line of scientific development to get that particular job done. So I think this wording will be questioned by, let us say, the Pentagon authorities.

We move down the line a little further in this revised statement and we find in section 5 (d): "On the basis of studies provided for by the preceding subsection, the National Science Foundation shall, from time to time, recommend to the President policies for the Federal Government which will strengthen and advance the national scientific effort in basic research relating to such things as cost, availability of manpower, ... etc., as are necessary."

This again sounds good; but I don't think it gives the Budget Bureau or Congress, any too clearly, the benefit of comment on the expenditure of the money involved in various particular projects.

It seems to me that whatever coordinating group is going to work out this problem--and it seems that NSF is elected--should give the Budget Bureau and the Congress annually at least a broad critique, so to speak, of the activities in the various agencies. To me, it seems that a solution might be found along these lines. The NSF should not try to evaluate each and every project in which the different agencies are concerned. It should concern itself primarily with basic science but should not try to monopolize all of basic science. It should inform itself and scrutinize the activities of all the agencies, emphasizing its interest in basic science and satisfying itself that, first, the agency is doing enough, relatively, in the field of basic science, and, second, that the efforts are applied in the proper areas. Its conclusion should be available to the Budget Bureau and the Congress.

It seems to me that NSF should be able to satisfy itself, for example, that under present rules and regulations the National Defense Establishment would support basic science activities in the field of aerodynamics, let us say, and that the AEC would be supporting the basic science type of activities in the field of nuclear physics; but at the moment not conversely. Similarly, I think the NSF could, by proper scrutiny, satisfy itself that what was defended as applied research in the defense establishment was really applied research, and was not basic research carried out under another guise.

I don't think I need to take time here to defend the importance of basic research. You have had other lectures on that. I think the idea is accepted that good basic science is important enough so that, even though it is useless, it is worth supporting! The converse does not follow--just because an activity is useless, it is not necessarily good basic science!

This is the problem which I think the Defense Establishment faces: The very existence of the NSF, in my mind, should relieve the Defense Establishment of the constant pressures from some of my important university colleagues for support for basic science. If it is not obvious that this research contributes to the mission of the agency, with the existence of the NSF we can say with a clear conscience, "Go and talk to the NSF." The problem for the Defense Establishment is to scrutinize these programs and make sure that all of the research activities contribute to the mission of the agency.

I think an excellent statement on this question has already been put out by the Defense Establishment, and I would like to read it. The main business of the defense agencies should be applied research, but they should not be excluded from basic research. Here's the quotation: "The Department of Defense supports basic or fundamental research so as to provide a flow of fundamental knowledge of the sort that the military establishment needs now and in the future in connection with the practical problems of consistent development." That one I have already commented on. Second, "To maintain contact with the scientists, so the

scientists are encouraged to be interested in the fields of potential importance to defense. This contact serves to make the Services aware of new scientific findings which will provide a base for the mobilization of scientific effort in cases of severe emergency, and has an influence on the research and development programs of the Services."

I don't think a better statement could be made. I think this is exactly what the military agencies and AEC, which I consider a military agency, should be doing. They should be supporting basic and fundamental research for just these reasons, and I am glad to say that the present management of the NSF agrees with this.

This is not where the conflict lies. The conflict lies in the way in which this should be done; in the wording of the Executive order which comes out, and the degree to which the NSF advises the Budget Bureau and the Congress on the basic problems that are at issue here.

In summary, then, I would say that the situation at the moment is still in a controversial state. I believe that a new Executive order will be issued in due course, that the NSF will be selected as the mechanism for doing this job, and, finally, I think it is a job which we as scientists should support and cooperate with, rather than try to undercut, because it is a job which needs doing.

I think the real importance here is that both the Congress and the Budget Bureau have essentially said to the scientific and technical community, "Here's a coordination job which ought to be done by scientific and technical people. The NSF is a mechanism which permits you to do this your own way." Implied in this, I think, is the very real threat that, if this is not done by the scientific and technical community itself, either the Budget Bureau or the Congress will have to set up a staff to do this; I think it would be done in a less sympathetic way if we ever reached that stage.

I believe that's all I can report so far as the facts are concerned. This is a subject which lends itself, perhaps, better to discussion than to an explanatory lecture.

CAPTAIN HALE: Dr. Lawrence Hafstad is ready to answer your questions.

QUESTION: Dr. Hafstad, could you tell us a bit more about the composition of the National Science Foundation?

DR. HAFSTAD: After considerable discussion, the NSF was finally set up with 24 board members chosen from all over the country, with geographic distribution and also a distribution in the various scientific disciplines; so that there is this main board which meets about once a month, I believe, and passes on all the projects and policies, and so on, of the NSF.

Below the Board there is a general manager or director, and that is Allen Waterman, and his immediate staff. Under him are various divisions, the divisions of mathematics, physics, chemistry, biology, etc.

They have spent most of their money so far, I would say, in fellowship programs. They have taken over the National Research Council fellowship program and financed that, and they do finance directly a significant but not large amount of basic science. Their budgets have run from about 2 million, I think, up to about 5 million dollars at the present time.

QUESTION: Dr. Hafstad, after due consideration of the thought you expressed that duplication is desirable, I think there is still a very decided feeling among people generally that a lot of duplication exists that is not desirable. Going back to your Research and Development Board and its system of project cards or review of projects, you indicated it could be a rather complicated affair. Why could not the NSF establish a file of projects and simply take leadership in having those responsible for project research in various agencies on what appear to be similar matters get together and clarify their approaches, and then document them. Would not that serve in itself as coordination, without being so complicated as to be unwieldy?

DR. HAFSTAD: I think this is exactly what should be done and is being done, at least in the area of unclassified research. There is no reason why all the projects which each agency has, with all the various universities, should not be pulled together in a central file somewhere. By occasional meetings of the responsible research directors of the various agencies, they could compare notes on these. Among other things it assures that three or four different agencies of the Government don't contract with a single professor in a university somewhere for about 300 percent of his time, or thereabouts.

There should be many jobs to be done in what I call this coordinating activity. This is quite different from having veto power or control. Since it is a voluntary exchange, an interchange of information, I think it will work well, and does work. My answer, then, to your question is that it is already being done, and should probably be done on a better organized and larger scale.

QUESTION: Doctor, you mentioned basic research and applied research. In order to give us a little better perspective, what share of the 2 billion dollars that you mentioned goes into basic research and what share goes into applied research?

DR. HAFSTAD: I don't have any exact figure. A lot depends on the definition, but, as a rough idea, to get your thinking straight, I would say something in the order of 100 million dollars, or 150 million dollars, perhaps, is basic research, and all the rest is applied research.

QUESTION: Doctor, could we clear up some of this fuzziness about basic research by getting in other terminology? I mean, the public is irritated, or it's obnoxious to the public, to have something in a very indefinite area. It would be better if it could be tied in with some basic research. Is that the same as pure research, by the way?

DR. HAFSTAD: I think I will have to give a lecture on semantics.

STUDENT: In other words, the taxpayers would be willing to foot the bill, and the congressional people would better understand, if maybe some other basic research went into problem areas, instead of anything you want it to do. Can we find different terminology that would help us?

DR. HAFSTAD: I think we have tried hard to find different terminology. This leads partly to the confusion. Before the war we used to talk about pure and applied science. This was considered objectionable because the use of the word "pure" seemed to imply that the other was impure, which was not intended.

There's another category of confusion which comes in from the point of view of who is doing the talking, and what his attitude is. If you are talking to a production man, he thinks the engineering department is doing research. You see, he considers some of it as somewhat impractical. For that reason to him it is basic research--it is basic to his production. The engineering department thinks the research department is doing basic research, but they are really doing applied research, and the university professor thinks that the industrial research division is obviously doing applied research and only the fellow in the university is really doing basic research.

So you have a subjective problem in trying to define this. I believe the NSF has struggled with this problem and has come up with what I consider the only valid approach to the problem; and even it has its difficulties. You go right back to the motivation of the man doing the work, as to whether it is pure or basic or applied. If the man doing the work is motivated by curiosity and a yen for understanding and he has, at least, no urge to solve a practical problem, then it is basic research; but if he is doing this because he is trying to solve a weapons problem or something of that kind, or trying to make a profit, and somebody is willing to finance his activity on the assumption that the man will be successful or will make a contribution, then it is applied research.

This is difficult, because the actual activity of the man with the spectograph or instrument might be identical in the two cases. You might have the same man doing the two jobs, say, in the study of the spectrum of helium, going through the same operations in different rooms. One is pure, one is applied. That is part of the semantic difficulty.

QUESTION: I refer to your remarks as to the conflict inherent in the two-dimensional aspect of any large-scale project, hardware versus science. I understood you to say each should have its complete facilities, want its complete facilities, and so on, and the answer from the management viewpoint is coordination. I don't see how you can eliminate the duplication in that picture. Can you give us an example and tell us how you would bring the two together in a more efficient manner?

DR. HAFSTAD: I think I can. First I want to correct your statement. I think you said I indicated it was desirable that each project should have complete facilities. I think it is certainly desirable that they should, but I think from a dollars-and-cents point of view it is impossible in many cases to give everybody complete facilities.

Let's see if I can't give you an example from my own experience here, in order to make this thing as concrete as possible. Many of you know Admiral Rickover, and I consider him one of the best of the project engineers. He has lots of drive, insists on having everything necessary to carry through his project on schedule. In carrying through his project he has to have a large number of supporting activities on heat transfer and other areas, and I am faced, then with the choice of either giving him complete facilities in this area or having part of this work done in existing laboratories. The natural thing for him to do would be to build up these facilities in the laboratories of his own particular contractor; but I have similar facilities doing similar work at other existing laboratories like Argonne and Oak Ridge.

If all projects are given complete autonomy, as they would like to have it, then you run into difficulty with this same duplication problem we have been talking about here. When you go to the Budget Bureau they say, "Let's see; here are X million dollars in the area of heat transfer being spent in each of these projects, and you are also doing heat transfer work at Argonne and Oak Ridge. Can't some of these be eliminated?"

This is what you run into when you start looking across the board instead of up and down, as I usually refer to the projects. This is an inevitable situation from the management point of view. You have to look at it both ways and satisfy yourself that you are not unnecessarily duplicating expensive facilities--and how you evaluate, that's a matter of judgment.

I am not sure I have answered your question. Perhaps you have another variation of it.

STUDENT: Carrying on there, is it your idea that the NSF would be the appropriate agency for the answer to such question?

DR. HAFSTAD: I think they would, in the area of basic science. That's the field in which they are preeminently qualified; so, from my point of view, you have the choice of either trying to ignore this problem of basic science or taking a look at it. As I tried to

indicate, the scale of the activity is such that somebody has to take a look at it and certify that this has been coordinated; that there are not unnecessary expenses involved.

QUESTION: Doctor, can you state whether you believe in an ordinary laboratory of the Government, that a pure scientist, one who is noted for just pure science ability, should be upped in grade to be the administrator of the laboratory, or whether it is better to take a man who has only partial skill in the sciences and is partially an administrator and make him administrator of the laboratory?

DR. HAFSTAD: That is a difficult problem, as you know. We have been up against that for a long time. I am afraid in the end it is a matter of personality. My own conclusion is, if you have a good scientist--he ought to be a good scientist with reasonable administrative ability--I would make him the director, and then back him up with a professional administrator, in order to have a combination of the overall talents that you need. If you have a very pure scientist, really outstanding in that field, with, what is most usual, little or no administrative ability, then I think it is best to put the administrative man at the top and your scientist as the number two man. In either case the combination has to have both the abilities that you need. There is no use doing a good job in science and getting put in jail for bookkeeping errors.

QUESTION: The problem of finding the right organization to coordinate all the research activities in the United States is a real one, and I can understand the problem of selecting a proper organization to do it. It seems to me that with the diverse efforts in this line the problem of getting all the necessary information to the organization charged with that coordination is going to be a terrific one. Will the NSF, if that agency is given the responsibility, have to confine most of its coordination to a paper review of the projects, or are they going to have to have an organization go out and visit all the laboratories to see what they are doing? How will they inspect, let us say?

DR. HAFSTAD: This is one which you will have to toss to the NSF; but my guess is that the most we can do here is a paper review. If you once get into the problem of policing the activities, then you need both a large staff and a very competent staff; and I think it is just impossible and undesirable in the present situation.

STUDENT: Do you think the paper review of the projects as they are set up--I understand sometimes you can't tell what the project is, from its title--is going to be sufficient to accomplish the necessary coordination?

DR. HAFSTAD: It won't be ideal, but I think it will be sufficient, and it is so much better than what has been done in the past. I believe again that the Budget Bureau and the Appropriations Committee would be relieved if at least this much was done at the present time.

QUESTION: Dr. Hafstad, I am one of a number of people who feel that there is a great area between where research and development stop and procurement and production take on. Undoubtedly there are numerous important projects that, due to the type of interpretation, fall into the research and development budget. Don't you think it is going to be very necessary that there be a much cleaner definition of where research and development stop, if the programs are going to be reviewed by the NSF, to insure that important projects which may only, possibly within the military, be justified in another manner may not be completely deleted by the NSF review?

DR. HAFSTAD: You have put your finger on another controversial area. As you know, the transition from an idea in pure science to a weapon, let us say, is a continuous and gradual one. There are no convenient cutoffs where you may make a sharp curve. It is all in this area. A large amount of judgment will enter into the picture. I think our best defense against errors in this field would be to be sure of the experience and knowledge of the people in the NSF who are doing this particular job.

QUESTION: Dr. Hafstad, shortly after the last war there was considerable agitation for setting up a Department of Science. Dr. Bush, I believe, was one of the leaders in that movement. Assuming this proposed Executive order for the NSF is revised to your satisfaction, would you be satisfied to have them administer the research and development program, or would you prefer to see a department at Cabinet level do that job?

DR. HAFSTAD: I don't know how to answer that. I think I would rather see it grow up first. It is a terrifically tough problem. I believe everything we need to do at the present time can be done with the step now foreseen, and we can cross the other bridge when we get there. I am a little frightened at the thought of a Department of Science, I think, largely because I am frightened by any proposal for a monopoly based on a field of knowledge. All of Government, and all of industry should use all of science, so far as I am concerned. I don't quite see how you can pull part of it off and set it up by itself. I am skeptical of the Department of Science approach.

COLONEL BARTLETT: Doctor, a broad question: Would the objectives of NSF be basically determined by NSC? In other words, what is the relation under this proposed system between the guidance given by NSC--how does it enter into the picture, and, more specifically, in the field of foreign research? Is any portion of your 2 billion dollars

spent overseas by foreign research agencies, or do we get as a part of our research information from friendly nations on what they are doing on their own?

DR. HAFSTAD: So far as I know, an absolutely trivial amount of this 2 billion dollars would be for foreign research. By and large the field of basic science is inclusive, and foreign nations get through scientific and technical journals what information we develop, and we get what information they develop; so, in general, in the field of basic science, there is free exchange of information.

Now, this, too, has its problems because, particularly in those areas close to military fields, you might want to start classifying a little deeper into the area of basic science than you would want to normally in fields not useful to the military. Again we have an area of conflict.

To answer your question about NSC, I don't believe that it is involved in this argument as yet, and probably won't need to be, if we can iron out our differences between the operating levels, let us say, of the agencies and the Budget Bureau. If we ran into an impass where a ruling was made that no defense agency should do any basic research, I think this would, and should, become of concern to NSC.

QUESTION: Doctor, some industries spend research and development money geared to a yardstick of their amount of sales. We had a speaker who indicated that 1 percent or less of their annual sales was expended for research. I wonder if any study has been made as to what the Government should spend on research and development, say a percentage of the gross national product, or some similar factor which measures the progress of our country.

DR. HAFSTAD: I think considerable thought has been given to that problem. I toyed with it some years ago. My objection to it is that the percentage approach has what I call a built-in phase angle error. By that I mean, especially in the defense business, we ought to have our most vigorous research program five years before the day the war breaks out. When the war breaks out we should switch to production and it is too late to do research. If you can invent for me a predictor, I think this would be a very logical way of doing it. What we ought to do now is to spend 5 or 10 percent for research of the money that we will be spending for weapons, come the shooting war. This is where we have trouble. Do you get my point?

STUDENT: Yes, sir, very well.

QUESTION: Dr. Hafstad, my question concerns attitudes. We have been reading in the papers about the attitude of scientists to regimentation and restriction on the disclosure of information. What is

the attitude of the science fraternity on research? Does the NSF have any legislation? Has Congress passed a law--is it interested in basic research? Another part of the question on attitude is the attitude of industry and the other research laboratories toward a Government-owned agency, the NSF, asking the, "What is your program?" So, first, what is the attitude of the scientists themselves to regimentation, shall we say, by setting up a foundation to regulate science, in a sense? Second, how are they going to work on the attitude of the people?

DR. HAFSTAD: That's another big subject. I would say the attitude of the scientist can be indicated by this. I am told--I don't know who the individual is--that one of our good scientists out at the Argonne laboratory, which I happen to be responsible for, finds it impossible to think great thoughts because, in looking out the window he sees a fence around the building. This is the security fence. This is objectionable. I don't quite know why he doesn't pull the shade down! I think this shows the attitude of the scientist toward this regimentation.

In general the scientific fraternity doesn't like to be working under security restrictions and would prefer to get the money with no strings attached. However, to be honest, I have to say he does like to get the money and, since the defense agencies and the AEC have the money, the scientist is in a tough spot. What he would like to have is all the money that goes with applied research, and all the freedom that goes with pure research. How to get both is a rough problem for him. If the NSF could suddenly become rich so that it could finance all the scientists that need support in the country, with no strings attached, this would be ideal. But short of that, scientists individually have to choose between money coming from the rich defense agency with strings attached, or money coming from the NSF or industry with fewer strings attached. There is no ideal solution.

QUESTION: Doctor, using your atomic energy field as an example, who determines how much time and energy is to be expended on the development of atomic weapons as against the development of atomic energy for purely civilian purposes?

DR. HAFSTAD: This one is easy. We have a full-time commission to make such decisions. It makes the decisions, so far as the agency is concerned, and defends its decisions before the NSC, the President, the Budget Bureau, and the Congress. This division and this slicing of available money is the responsibility of the commission.

CAPTAIN HALE: Doctor, year after year we call on you and you always come back with flying colors. Thank you very much.

DR. HAFSTAD: Thank you.

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