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The purpose of this symposium was to explore and alleviate the problems in federal laboratory-university relationships, and to point out and encourage greater development of the opportunities inherent in these type of relationships. Participants included 37 federal and university officials. Statements on the "federal viewpoint" and the "university viewpoint," and a summary of the patterns and problems in federal laboratory-university relationships are presented. Following this, 4 general topics are discussed: 1) use of federal facilities for training university graduate students; 2) formal education and training for laboratory professional staff; 3) joint research activities involving university and federal personnel; and 4) interchange of professional personnel between universities and federal laboratories. Appendices contain examples of several cooperative federal lab-university programs. (DS)

PROCEEDINGS OF SYMPOSIUM ON EDUCATION AND FEDERAL LABORATORY-UNIVERSITY RELATIONSHIPS

HELD OCTOBER 29-31, 1968

at the

MUSEUM OF HISTORY AND TECHNOLOGY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C.

ISSUED MAY 1969

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY
AMERICAN COUNCIL ON EDUCATION

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FOREWORD

As a Nation, we, in the United States, have invented a uniquely successful system of support of graduate education and support of the universities. As a result of these achievements our system has become a model to the entire world--not just in respect to the magnitude of what we do, but in the vitality and success of the enterprise. One of the things that is noted everywhere in Europe, for example, is the relatively free movement of people between Government laboratories, Government posts, industry and universities. This is a pattern which is really unique and a source of considerable strength.

In respect to funding, the Federal Government spends about one and one-half billion dollars in support of the conduct of research in universities. On top of this, it spends about three and one-half billion dollars in Federal laboratories. In the past several decades the support of research and development in this country has grown at a dizzy pace, and a generation grew up thinking that that was the normal way of life. This period of what I call heady growth has resulted in enormous advances in medical research, in maintaining a strong military posture in the face of a wildly changing situation, in ensuring the most productive agriculture in the world, and in the great adventure in space, which is still continuing. I stress all of the foregoing and the tremendous amount achieved because in some ways I think that this exuberant period is over, due in part to the enormous pressure on the Federal budget, but also in part to additional considerations.

In view of the foregoing, how we utilize the universities and the Government laboratories for their mutual benefit, and what the patterns might be which would strengthen the qualitative performance of our whole scientific system, are important issues. We know that from the standpoint of the laboratories there is an importance to the freshness that comes when either people come into the laboratories with new points of view and different experiences or when their own people go out and join temporarily or for a while other organizations. We know that any good laboratory has or should have a constant preoccupation with the problem of retraining and strengthening its personnel through a variety of kinds of educational programs, which may or may not involve the universities. We know that from the standpoint of the universities, facilities available in the Federal laboratories may be very important to faculty members and students. We know that universities have a laboratory where things aren't highly problem oriented, and going to a laboratory where things are done from a different point of view has something intellectually to contribute to university people. In short there are different kinds of problems which can and should be mutually strengthening and stimulating. The purpose of these Proceedings is to explore and alleviate the problems and to point out and encourage even greater development of the many opportunities inherent in Federal laboratory-university relationships.

DONALD F. HORNIG

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EDUCATION AND FEDERAL LABORATORY–UNIVERSITY RELATIONSHIPS

Tuesday, October 29 A.M.

DR. GEORGE W. IRVING (Chairman, Program Committee): Good morning.

Even with the preponderance of men here this morning, I see at least one lady so I will say "Ladies and Gentlemen." This morning we are starting the first session of a two-and-one-half-day symposium. The symposium is a joint one of the Federal Council for Science and Technology and universities. The subject is "Education and Federal Laboratory-University Relationships." I am George Irving, Administrator of the Agricultural Research Service in the Department of Agriculture, and I served as Chairman of the Committee that developed the program we will follow for the next two and a half days. Not on your program, but most important, nevertheless, to this group and in this place, is a gentleman I now present to you. I would like to introduce to you this morning the Secretary of the Smithsonian Institution, our host for these sessions, Dr. S. Dillon Ripley.

SMITHSONIAN INSTITUTION--WELCOME

DR. S. DILLON RIPLEY: It's a great pleasure to welcome Dr. Hornig, Dr. Astin, Dr. Long, Dr. Irving, and the other members of the organizing group of this research community here in Washington. I'm delighted to be able to be here and to welcome you to the Smithsonian which for its entire history has been a meeting ground between universities and governmental research enterprise. For many years both the National Academy of Sciences and the American Association for the Advancement of Science have had their headquarters here. Government research bureaus such as the Weather Bureau, the National Advisory Committee for Aeronautics, the Fish and Wildlife Service, and others have had their origins within the Smithsonian and were spun off into independence after demonstrating their ability to accomplish significant Government missions.

From its private endowment income the Smithsonian is at heart, as you know, a private corporate establishment. The Institution from its earliest years made small grants for university research--a faintly suspect activity to many including the third secretary, Samuel Langley, who considered that colleges and universities were exclusively for teaching where it would be foolish to believe that research could ever gain a foothold. The Institution has prided itself in serving as an auxiliary to universities in their progress to the forefront (at present) of the Nation's efforts in research as well as higher education.

One important episode in the history of government-university relationships is worth citing as an illustration of the Smithsonian's role. In the 1890's officials of the Agriculture and Interior Departments

mounted a strong effort to draw graduate students to conduct research in the unparalleled facilities maintained at Washington by Government bureaus. Sound familiar? The National Education Association and the Washington Academy of Sciences voiced their support. The American Association of Agricultural Colleges and Experiment Stations, as it was then called, set up a Committee on Graduate Study with representatives of both universities and government to promote the scheme. The Committee petitioned the Smithsonian to establish a central office to promote the use of Government laboratories for graduate research and study. In their words the goal at that time was an effective plan by which graduates of the colleges and other qualified persons should be guided by the Smithsonian Institution in advanced studies and research in connection with the facilities presented by the Government bureaus in Washington. Several regents of the Smithsonian of the time led by Alexander Graham Bell advocated the establishment of a position for an Assistant Secretary in the Smithsonian for research training in the Government departments, and a Bureau of Graduate Study at the Institution.

In 1901 this move was climaxed by the enactment of legislation providing that facilities for study and research in the Government departments, the Library of Congress, the National Museum, and similar institutions hereafter established should be afforded scientific investigators and duly qualified individuals, including students and graduates in institutions of learning in the several states, under such rules and regulations as the heads of the departments and bureaus mentioned might prescribe. This scheme for a major program of graduate study in Government laboratories floundered for lack of funds and in the decades that followed both Government and university research departments came gradually to dwell on their institutional differences rather than on their similarities of interest. This meeting today marks the first major exploration of this theme since the turn of the century. Seems incredible to think of it, doesn't it? Since 1901, it's long overdue.

I'm especially pleased that the Smithsonian is able to play host on this very welcome occasion with its historic overtones. Let us never forget the historic bases on which we act and on which we base, I hope, our programs for the future. On coming to this Institution in 1964 I saw the effects in many quarters of our having lived a too largely separate existence independent of the universities. The Smithsonian established an education program with its own administrative staff and began to offer stipends to visiting investigators to pursue their own research. It entered into discussions with a number of universities who proved most willing to explore and embark on a wide variety of cooperative educational arrangements. In this we were guided by the experience of the National Bureau of Standards and the Atomic Energy Commission and also the excellent working relationship which unites our astrophysical observatory with the astronomy department of Harvard and other nearby institutions like MIT. We designed and published what is, I believe, the first regular series of analytical digests of staff interests and facilities in a governmental establishment drawn up especially to guide

university investigators to opportunities for collaborative effort. Copies of these Smithsonian research opportunities are available at the registration counter. They are distributed now to libraries and graduate deans' offices in the universities, and separates in the established disciplines are sent to departmental offices throughout the United States as well as abroad. We've been tremendously pleased with the result of this program. Over 40 cooperative agreements are in force with universities throughout the Nation and offerings of the equivalent of 315 credit hours of instruction, 138 academic appointments made, and 53 Ph.D.'s earned within the Smithsonian in the academic year ending in June of 1968. We believe that our research environment has been tremendously enhanced by these activities. The Director of our Office of Academic Programs, Phil Ritterbush, who designed much of this program and has overseen its development, is here today as a participant in the symposium. I hope that those of you who would like more information about these sorts of activities of the Smithsonian will be in touch with him. I'm especially glad also, Mr. Chairman, that the Smithsonian Institution can play host this evening to university and Government representatives from the Washington area at a reception here in this building honoring the participants in this symposium.

The universities and Government research establishments of this area constitute a unique aggregation of intellectual interests. We are beginning to act like a community as well. Recently the Institution commenced distribution of an Academic Calendar announcing lectures and seminars. Our register of names and addresses is still in its infancy, but I think you will be interested to know that this Academic Calendar now reaches 8,000 scientists and scholars in both universities and Government research establishments throughout the Washington Metropolitan area. Think of that number. That's a really staggering number of people who have expressed interest in knowing about these academic activities. This experiment in professional communication is evidence of our continued recognition of the depth of the interest which we share with kindred institutions. I strongly hope that this symposium will become a landmark occasion in the widening recognition of the community of interests which unite all our research establishments. Thank you very much indeed.

DR. IRVING: Thank you very much Dr. Ripley. We appreciate having your remarks on the background of your institution and also appreciate very much your welcome and the hospitality you are showing the group here today.

The symposium idea that we are to launch today was considered not only desirable but even necessary by the Federal Council for Science and Technology's Committee on Federal Laboratories, of which Dr. Allen V. Astin, Director of the National Bureau of Standards, is Chairman. It is appropriate, then, before we begin the orientation talks this morning to hear a few words from Dr. Astin about the Committee and about the symposium.

Dr. Astin, who hails from Salt Lake City, did his undergraduate work in physics at the University of Utah and holds graduate degrees in the same discipline from New York University. His researches have involved dielectrics, optics, electronic instrumentation, including radio telemetering, and meteorological applications of these disciplines. He is a member of the National Academy of Sciences. He served in the European Theater of Operations during World War II where he was liaison between the U.S. and U.K. Armed Forces on the application of proximity fuses. He has been with the National Bureau of Standards since 1932. He was appointed Associate Director of the Bureau in 1950 with responsibility for coordinating the Bureau's operations with those of other departmental agencies. Dr. Astin has been Director of the National Bureau of Standards since 1952. Among other things during this period he has had the opportunity to plan and direct the moving of the National Bureau of Standards from its Washington location to Gaithersburg, Maryland. These experiences I think fit him admirably for the Chairmanship of the Federal Council's Committee on Federal Laboratories, and it is in that capacity that he speaks to us now. Dr. Astin.

INTRODUCTORY REMARKS

DR. ALLEN V. ASTIN: Thank you very much, George.

It is my privilege to give a few credits for the development of the symposium. The idea really stems from a subcommittee of the Committee on Federal Laboratories, chaired by Dr. Burroughs Mider, then of the National Institutes of Health, now of the National Library of Medicine. This subcommittee was studying the problem of education and the Federal laboratories and their activities led to the report by that name. In the development of the report a great amount of the effort was derived from visits to 75 Federal laboratories under a task group headed by Mr. Walter Kyser of the U.S. Geological Survey. The specific suggestion for a symposium was endorsed by the Federal Council for Science and Technology when it considered the Committee's report and accepted it. Dr. Hornig also suggested that in developing a symposium we should enlist the cooperation and interest of the universities through the American Council on Education. Dr. Logan Wilson of the ACE designated Drs. John Morse and Lawrence Pettit to work with the Committee on Federal Laboratories in developing the plans for the symposium. We also had the active and valuable contribution of Mr. Leslie Williams representing the American Society for Engineering Education and Mr. Christian Arnold of the National Association of State Universities and Land-Grant Colleges.

The actual development of the plans for the symposium was carried out under three committees: a Program Committee, chaired by Dr. Irving, developed the ideas for the specific topics to be discussed and the selection of the speakers; participants in the symposium were selected by a Committee on Invitations headed by Ed Glass, Department of Defense;

and local arrangements were handled by an Arrangements Committee headed by George Auman of the National Bureau of Standards. We are, of course, deeply indebted to Secretary Ripley for the use of these fine facilities for our meeting and for being host to us at a reception this evening.

Finally, I would like to extend my thanks to all of you for your willingness and interest in participating in this symposium. We are interested in much more than just an exchange of ideas here. We hope that this symposium will lead to activities and action programs which will really strengthen the cooperative relations between universities and laboratories for their mutual advantage and for the Nation's benefit.

We are interested in appraising this symposium. We hope to do this in two ways. In each of your kits is a brief questionnaire in which we would like to have you express your views of the symposium after its conclusion. You can either complete the questionnaire here or take it with you to your residences and mail it to us in the envelope provided. We hope that you will return this questionnaire within a week following the conclusion of the symposium. In addition, it is our present plan to have an evaluation of what happens as a result of this symposium perhaps a year or so from now, so that, if our present plans are carried out, each of you will be queried later, in an effort to find out if anything useful actually resulted as a consequence of our being here this week.

Again, let me thank all of you for your willingness to participate. I am confident that, working together, we can come up with some useful ideas and activities for better cooperative relations. Thank you all very much.

DR. IRVING: Thank you, Dr. Astin.

Our first program speaker is Dr. Donald F. Hornig who was born in Milwaukee, Wisconsin, but left soon thereafter to go to Harvard where he received his degrees in chemistry. He served on the faculties of Brown University, of Metcalf Research Laboratory, and of Princeton University, where he became Chairman of the Department of Chemistry in 1958. His research fields include molecular and crystal structure, infrared and Raman Spectra, shock and detonation waves, and fast chemical reactions at high temperatures. He is a member of the National Academy. He was appointed and confirmed by the Congress as Special Assistant to President Johnson for Science and Technology in 1964. He serves as Chairman of the President's Science Advisory Committee and is Chairman of the Federal Council for Science and Technology in which capacity he now addresses us on the Federal viewpoint concerning Education and Federal Laboratory-University Relationships. Dr. Hornig.

THE FEDERAL VIEWPOINT

DR. DONALD F. HORNIG: Thank you very much.

On behalf of the Council for Science and Technology I would like to welcome all of you here to this symposium. It is a pleasure for me to see how many people have come from long distances as well as from the Washington area to attend this symposium. It is always my feeling that rather than lofty generalities it is well to get the people who know something about the subject together to discuss the need of it. For that reason, I'm going to be relatively brief this morning and help you catch up on the schedule.

I have been away from Washington and so the only title that was given to me was "The Federal Viewpoint." It was very helpful in the introduction to learn the Federal view about what, because this is the question I had asked myself. No matter what the Federal view was about, I was faced immediately with a very difficult problem, because when there are a dozen or more Federal agencies involved in the prosecution of science and about twice that many congressional committees, it takes a considerable degree of clairvoyance and powers of synthesis to present anything that could be called "The Federal Viewpoint," if there is one. Perhaps we should call it "The Federal Viewpoint As I See It." The thing that cheered me up though on looking at the program was the temerity of Dr. Long who will follow me, because if there is a problem in presenting something called the Federal viewpoint, the problem in presenting the university viewpoint certainly surpasses it.

I hope I don't find myself too much in the position of the speaker at a ladies' luncheon meeting who when asked what the subject of her address was, said, "Well she didn't really know, but something interesting usually turned up while she talked."

More seriously, I think the question of the position of the Federal Government in everything scientific is now important because the Federal view of the laboratories, the universities, and science in general can and will play a decisive role in the way that science is utilized in the service of the Nation. It is going to play surely a decisive role in the directions of the development of science and in the health of universities. This of course follows basically from fiscal considerations.

The Federal Government spends about one and one-half billion dollars in support of the conduct of research in universities. This is the research that is an integral part of the advanced education of future scientists and is the principal source of the new knowledge on which the future of all our activities depends.

On top of those two, it spends about three and one-half billion dollars in Federal laboratories--defense laboratories, atomic energy laboratories, the health laboratories, agricultural laboratories, space

and aeronautical laboratories, and so on, and, finally, a few basic science laboratories which house major national facilities such as telescopes and accelerators. Now I don't want to quibble as to just where "Federal laboratories" stops. We have a variety of administrative arrangements for the operation of laboratories under contract with which you are all familiar. The actions of the Federal Government will this year and in the years to come determine the health of the whole system. Not just by how much it spends--there is a certain preoccupation with that question nowadays for good reasons--but just as much by how it spends it and in what way.

This whole situation, in which the Federal Government funds three-fourths of all the research and development, means that the Government plays a preponderant role in the support of graduate education. In addition, something like half of all the graduate students in the sciences are supported by Federal funds either on fellowships, traineeships or as research assistants. Most of this has come to pass in the last two decades, although there has been a century of support and involvement of the universities in agricultural research. It has been a heady period for the sciences.

Largely as a consequence of the spectacular achievements by scientists, including the so-called pure scientists during World War II and the revolutionary contributions they made, there was a new sense after the War of what science meant, not only to the military but in its potential for the development of the country. In the period immediately after World War II the rapid growth of the various institutes in the NIH and the atomic energy laboratories went forward. In the two decades since then the support of research and development grew at a dizzy pace, doubling every five years or so, and a generation grew up thinking that that was the normal way of life. This period of what I call heady growth, culminated, of course, in the great adventure in space, which is still continuing.

I don't think there can be much question that the country profited by this investment, and I think it should be called an investment rather than an expenditure in many ways. We have, as you all know, the most productive agriculture in the world. Our military establishment has gone through not one but three revolutions even since the war: the thermonuclear revolution, the missiles revolution, and the electronics solid state revolution--that includes computers. And it has stayed on top of this wildly changing situation. We have moved from having the atomic energy just a very potent weapon but from practically zero base to where the United States is now developing a commercial nuclear power industry which is second to none in the world, in fact that dominates the world scene.

I don't need to recount to you the enormous advances in medical research. This has been a period in which we have had what I suppose you might call the DNA revolution. At any rate there have certainly been

enormous advances in our fundamental understanding of the life process and there is enormous promise now of new approaches to the conquest of disease.

I stress the fact that there has been a tremendous amount achieved across the whole spectrum because in some ways I think that this exuberant period is over, and I'm afraid that most of you know that only too well. The immediate reason, of course, is the enormous pressure on the Federal budget which is not confined at all to science. I think you are all aware of the Expenditure Control Act of 1968 which compels the President to cut the expenditures this year by six billion dollars from the amount submitted in his budget. We all know the pressures that have forced this retrenchment. The whole question of R&D expenditures is being reviewed within the executive departments and the Congress and is being rethought by the public. The kinds of questions being asked, of course, concern the objectives of research and development programs and the budgetary contexts. There are questions asked about the urgency and the immediacy and the degree to which, no matter how good they are, they might be postponed just a little bit. A new kind of question is being asked about the costs and harder questions as to whether what we expect to get from research and development justifies the very large investments. Increasingly questions are being asked about the organization of science and the extent to which there is or is not a need to coordinate a plan for the future. We've got to face these questions seriously because they are addressed to us as serious questions. Everyone of you has strong views of his own about all of them. The problem is to convey those views in coherent fashion over and over and over again to all the non-scientific people who will listen. In the first place we have to recognize that--as a result of the rapid pace of growth--we did grow in an ad hoc way over these two decades. In succession we put together a magnificent medical program, a magnificent atomic energy program, an enormous expansion in the programs of the military services, and a space program which leads the world. Each of these was essentially ad hoc. We invented a uniquely successful system of support of graduate education and support of the universities in this country. As problems turned up, we invented solutions. ONR invented a kind of research contract in the late 1940's that got rid of the notion that a research contract had to be the purchase of services from a university. But there are some problems for which we have not invented suitable answers. For example, if you want to build a building and you are in a university, the nature of the application and the form you have to fill out is widely different for a variety of different agencies. To deal with problems like this we undoubtedly are going to have to somewhat rationalize the Federal science system. Of course, at this point I can make all sorts of observations about what is going to have to be done because it's going to be the responsibility of my successor to actually do something about it.

Nevertheless, on the whole we have done extremely well. I've had an opportunity to discuss the development of American science both in the universities and in the Federal Government. For example, in the OECD--that's the Organization for Economic Cooperation and Development--there

have been two meetings with so-called Ministers of Science, in which these problems were discussed. And what comes through, of course, clear as crystal, is that we have become, as a result of our achievements, a model to the entire world. Not just in respect to the magnitude of what we do, but in the vitality and success of the enterprise. That showed up even more so in the OECD review of science policy which has been published--the so-called confrontation where the rest of the OECD members examined how we did things in the United States. And then, after sending some examiners around to follow up the review with personal discussions, many of the organizations subjected me and a number of my colleagues, some of whom are here, to an examination which brought me back to the days of my Ph.D. oral. What shows through all these discussions is that to the rest of the world this period in the United States has been a model.

I've just come back from Australia and over the weekend was in Canada discussing their problems with the Science Advisor to the Prime Minister. The same fact keeps on coming through: we have had a uniquely successful experience from which they would like to derive maximum benefit.

Well, what are some of the elements of our success? This period of American history has been marked, of course, by enormous vitality of our scientific enterprise at all levels. It has been a period of high creativity, high ingenuity and an enormous amount of enterprise, and this, of course, is quite central. We've achieved, perhaps as the result of the ad hoc way we went about it, a high degree of flexibility as compared to any other country I know of in the world. One of the things that is noted everywhere in Europe, for example, is the relatively free movement of people between Government laboratories, Government posts, industry and the universities. This is a pattern which is really unique and a source of considerable strength. Universities are probably the most rigid element in our whole structure, and the least prone to innovation. I say this advisedly as a university man. Nevertheless American universities show up very strongly in the world on this score in terms of interdisciplinary programs of all sorts and in terms of flexible internal administrative arrangements by which auxiliary research institutes have been assimilated into the fabric of the universities in many places, in a whole variety of ways. Despite my rude comments, which I hope won't be taken amiss, the American university system is incomparably more flexible than any other I know of.

How does all this relate to this conference? I think there are two problems. One is that expenditures on all of research and development this year will be level or, altogether, possibly two or three percent down from last year and, of course, including inflation this is a little bit more so. Some agencies and some parts of programs have had to cut their expenditures much more than that. So what one sees in the country, although the average may be down only a few percent, is a number of very real problems. On that score I must say that at the moment the prospects for Fiscal 1970 which begins in July 1969 don't look particularly better than for this year.

Quite aside from the problem of funds, there is a very large problem of how to use money better and how to improve our whole conduct of science. I think we are all aware that for any given expenditure of funds individuals vary over a range from zero to infinity in what comes out. As we look at many organizations there is a range of productivity among organizations that far exceeds the five or ten or fifteen percent that we are talking about in budgetary terms. It would be totally wrong to ignore the fact that if we could somehow make a large part of our total industrial-university-Federal laboratory system perform as well as its best parts, this would, in its effect on the American scientific and technological enterprise, be much larger than the budgetary stringencies that we're talking about.

How we utilize the universities and the Government laboratories for their mutual benefit, and what the patterns might be which would strengthen the qualitative performance of our whole scientific system, are important issues. We know that from the standpoint of the laboratories there is an importance to the freshness that comes when either people come into the laboratories with new points of view and different experiences or when their own people go out and join temporarily or for a while other organizations. We know that any good laboratory has or should have a constant preoccupation with the problem of retraining and strengthening its personnel through a variety of kinds of educational programs, which may or may not involve the universities. We know that from the standpoint of the universities, facilities available in the Federal laboratories may be very important to faculty members and students. We know that universities have a laboratory where things aren't highly problem oriented, and going to a laboratory where things are done from a different point of view has something intellectually to contribute to university people. In short there are different kinds of problems which can and should be mutually strengthening and stimulating. There are lots of problems in arranging for joint work and that will be one of the subjects of this week.

Sometimes there is a tendency to feel that a Government laboratory should be a university just like that. It can't. Universities in turn have very firm notions as to the ways in which it's possible to carry out programs and I'm sure there is more flexibility than is usually conceded.

But we don't have to approach this de novo. In fact, there is present in this room a wide variety of ideas and experiences. The idea of cooperative efforts between Government laboratories and universities is not a brand new one. Lots of such arrangements and a variety of kinds exist. What is important to me about this symposium is that there are two ways to approach this problem. One could go on from the very fine work of the Federal Council Committee which is responsible for this symposium to drawing up and putting together a commission or something to draw up a master view as viewed from the top. The other approach is to get together the people who have the ideas, who have the practical experience, who have encountered some of the difficulties and have solved some

of them. Persons who at the very minimum can exchange views on what the difficulties have been and what the successes are and how they might be extended, and at the very best, to go beyond comparing notes to really doing something further in organizations of all kinds. I myself don't see how this symposium can help but be an important contribution to the evolution of this problem and I wish you well. Thank you.

DR. IRVING: Thank you Dr. Hornig. We appreciate, at the outset, the picture you have given us. I think it's a very fitting and appropriate start for the subject matter of this symposium to get a view of what we're up against now and what we are likely to be up against in the near future with respect to the support of science and technology in government. Before we have discussion, I think it would be best to wait until all three of the morning's speakers have been heard from, and then to entertain your questions and comments.

We will proceed next to Dr. Franklin A. Long who did his undergraduate work and Master's work at the University of Montana. He received his doctorate in physical chemistry from the University of California at Berkeley. He later taught at the same institution. His researches and international activities emphasize reaction kinetics and nuclear chemistry and he worked during World War II on propellants and jet propulsion devices. He participated as a member of the Harriman mission to Moscow which successfully negotiated the Nuclear Test Ban Treaty. He is a member of the National Academy of Sciences and from 1964 to 1967 was Chairman of the Division of Chemistry and Chemical Technology of the National Research Council. He was a member of the President's Science Advisory Committee. He became a member of Cornell's faculty in 1937 and was Chairman of the Chemistry Department 1950 to 1960. Since then and now he is Vice President for Research and Advanced Studies at Cornell. Dr. Long speaks to us on the University Viewpoint with respect to Education and Federal Laboratory-University Relationships.

THE UNIVERSITY VIEWPOINT

DR. FRANKLIN A. LONG (Cornell University): Thank you Mr. Irving.

In response to Don Hornig's point about the temerity of the title I recall that the Russian language apparently doesn't have articles. You don't get into these confusions. If you would read my title as "A University Viewpoint" you'd probably be a little bit closer. As a matter of fact, my own working title was a little different, it was "Interactions Between Universities and Federal Laboratories." And if I wanted to give you a one-sentence summary of what I want to say, it is this: There are now some interactions between universities and Federal laboratories; there ought to be more interactions, but in order to get more interactions you have to work at it. This is what I shall try to say at some length.

I was recently sent a bulletin showing the very extensive self-study that the Federal laboratories have done for themselves. The facts are that universities are in a self-studying mood these days, too. You only have to read the newspapers to know that all is not precisely well with the American university system. And if that's not enough I'll mention Columbia and Berkeley. Fortunately a number of universities are asking themselves why, and are really studying the whole problem of how they relate to the world. Certainly one component has been how do they relate to the outside communities, and especially how do they relate to the big groups of professionally trained people such as are in the Federal laboratories? What I want to do is talk a little bit about the characteristics of universities in the first place, and secondly to make a few comments about both opportunities and perhaps problems about increased interactions. It will be pretty personal. My model implicitly will be Cornell University. I notice a number of very experienced and eminent academic colleagues in the audience. I'm sure if I misstate the case they'll be only too ready to correct me.

When I use the word university, I am explicitly thinking of the large, complex United States university of 10,000 or more students; the kind that is sometimes given this rather horrid title, the multiversity. I say that because it is true, what Dr. Hornig said, that American universities are a good deal different from the universities around the world. Those differences and the particular characteristics of American universities are important, I think, to this discussion. It is typical of American universities that they are involved in both undergraduate and graduate teaching. It is also very characteristic of the American university that it covers an exceedingly wide spectrum of subject material extending from the humanistic studies through the hard sciences, the applied sciences, into the professional schools, and so on. Organizationally, their particular character is the large multi-professor department assigned almost total responsibility for the teaching and research of a large chunk of knowledge such as physics, chemistry, computer sciences, and the like. This is a characteristic that has some problems. It is also interesting that in recent years new mechanisms have been springing up in universities to try to handle better the interdisciplinary problems that are becoming so important, so that there has been a quite remarkable proliferation of centers, institutes, and other things that permit better handling of interdisciplinary problems. I'm not saying good handling, merely better handling.

Another characteristic of the American universities, which I think is important to this discussion, is the degree to which they have become outwardly oriented and the degree to which their focus is out into the world broadly. Put another way, the ivory tower concept really is quite inappropriate. Some of this outward orientation of universities comes to them in almost an automatic fashion by virtue of the fact that there is a steady flow of new students through them, and students bring new ideas and new interests and new thoughts. Any university benefits by this turnover of new young people. But, in fact, it goes well beyond

this. Everybody in this room is conscious of the concept of the peripatetic professor who is testifying to a Congressional Committee or serving on Federal advisory committees or beating the hustings for Senator McCarthy or whatever. And I have to confess that university administrators are not much more stay-at-home either. So that this outward orientation which is a very important characteristic of the American university is, I think, important to this discussion.

Now as to what universities take as their responsibilities, that, too, has had a lot of discussion in recent years. My own university president, James Perkins, has been very eloquent in discussing this, and he has repeated with great clarity and detailed analysis the fact that one can say that the university has really commitments in three areas--in education, in research, and in public service. The problem in the university, one can almost say, is how do you allocate resources among these three? It may very well be that it is the ability to handle that problem that distinguishes the very best universities from the not quite very best.

As to what the first priority is for universities, I don't think there is really any doubt. It is and must continue to be education. I am myself persuaded that education in universities is good. Not perfect, by a long, long ways, but it is good. It is a lot better than it was 10 years ago or 20 years ago or 50 years ago. And I must say that some of the influx of money and equipment in new buildings that Don Hornig was talking about has had a great deal to do with it. Graduate work in the United States might even, on the average, merit the categorization, excellent. Where there are defects--and there are lots of defects in the university educational system--my own belief is that they are not so much in the mechanics of the system as they are in the rather more subtle, philosophical questions of relevance and goals. What are the relevance of some of the programs to the needs of youth? And so on. But even though I don't believe we do awfully well in them, I think education at the undergraduate and graduate levels is good. The new thing, of course, is postdoctoral education. It has been a very rapidly growing component of the university. It is especially to be found in the sciences and engineering, and the fact that it has grown so rapidly in these, attests, among other things, to student interest in it. And it is a continuing component.

The place where universities do least well, and that ought to be of importance to these discussions, is in the further training of already committed and trained scholars--the retreading, if you want. The phrase that is sometimes used is "continuing education." I myself, with my own university in mind perhaps, have a feeling that here is an area which ought to be of great interest to the Federal laboratories, where universities should play a significant role and in which the universities don't do as well as they should. In fact we need some help in knowing better what we ought to be doing.

The second of these three things that the university takes on as obligations is research. It is a fact that universities in the United States are really deeply involved in research, and that has become an important characteristic in this post-war period. I think the coupling between research and graduate education is now very fully established and that it's both right and proper. I think the commitment of universities to research is a strong plus and something that has benefited their educational programs very substantially. That's not to say there aren't some troubles, because of course there are. One is: How much is enough? It is a fact that the boundary line between enough research to do a good job in graduate education and "empire building" that leads to excessive research is a somewhat fuzzy one, and university groups on occasion fall over it on the wrong side. I won't say what is the wrong side. I think myself a far more important comment is that universities on the whole don't do as well in applied research as they do in basic research. Well, one might say, "Isn't that inherent in the beast? That basic research is sort of the development of new knowledge kind of thing?" That would be all very well if it weren't that universities do have colleges of engineering, colleges of agriculture and so on. These places really do need applied research and the teaching mechanism. The fact that, in my judgment, we do rather less well in applied research is important.

It follows, of course, that we do particularly badly as a group, in my personal opinion, when it comes to applied research which verges on development. While it's true that a Stark Draper can run this magnificent Guidance Laboratory at MIT and do great things in development, I really think that is the exception, not the rule.

This leads into the third category, that of public service. It is perfectly obvious that if you have a group of people developing new knowledge, concerned with new knowledge and with the ways of the world, as our universities are, that they will be interested in public service. On the other hand, I think given the character of the universities and their structure, one can strongly suspect that there are very real and very serious limits to where in the public service area universities can be effective. My own feeling is that they are at their best when they are playing an advisory role and in efforts where the comparative objectivity of the university people is involved; and are probably at their worst in program management.

I've noted primarily the pluses and minuses of American universities and it is, I think, quite interesting to see how extensively the things that I have been saying indicate that Federal laboratories and universities complement each other. I think it is a fact that a number of the things that universities do rather badly are things that Federal laboratories (using that term, incidentally, in the very broad sense that Don Hornig did) do well. I think that the large mission-oriented laboratory with quite explicit commitment to a given field really is particularly effective in developing applied research and then going beyond that into

the development and even management of programs, particularly programs with a large technological content. I do think that the fact that the big Federal laboratories are good at things at which universities are not so good means that there ought to be a role for synergistic cooperation. And this is what the whole meeting is about, or at least I presume and trust it is.

There is another slightly different way in which I think these two groups, the universities and the large Federal laboratories, can and should complement each other, and this is in their coupling to the outside world. I mentioned that the American universities are substantially outwardly oriented. You see the danger in that. The danger is that we will get too outwardly oriented, that we don't take care of our first priority job, that of education. I personally am inclined to suspect, and I will be interested to hear about this later, that the danger in the large Federal laboratory may just possibly be the opposite. It may be that under the pressure of mission-oriented goals, of commitments to action programs--perhaps under the constraints of tight budgets--that there is a tendency for such laboratories to focus very intensively on the program at hand without perhaps enough attention to the outside world of new ideas. The lack of an automatic procedure for an influx of new people that the universities have, may also contribute. So I would like to think that this too is an area in which universities and Federal laboratories might complement each other.

Given these generalities let me turn to the very specific questions of what can the universities do for the Federal laboratories and, reciprocally, what the Federal laboratories can do for the universities. The better way to put it of course is, what are the types of interactions which can honestly be expected to be mutually beneficial?

I'll be very brief on how universities might be able to help Federal laboratories. I'm not an expert on this and I will only comment very generally that I would like to think that the help might appear in the fields of education, in the fields of contribution of basic research, and especially in collaborative programs of applied research. Educationally, of course, there has always been some use by Federal laboratories of universities for formal training of their young people, and that is fine. It ought to go on and I'm sure it will. I myself think the more interesting area will be for the universities to do more in the area of continuing education. I hope that that might be an area where we ought to be and can be useful. Similarly, the universities ought to play a role as a particularly interesting outside group for the Federal laboratories to associate with to enhance the flow of new ideas and new people.

In research I can't help but assume that research people with common interests will in fact get together. They always seem to and I expect they always will. I don't feel that this is a matter of great concern. It is becoming now quite commonplace to find that some prize or another, in the latest instance the Nobel Prize, will be awarded

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jointly to a couple of people--one from a Federal laboratory and one from a university. This clearly indicates that they are interacting at a basic research level.

In the public service area the Federal laboratories can, I would like to believe, benefit by some of the innovative ideas of university professors and not have to accept the ones that they don't like. It seems to me that university people might, from the Federal laboratory standpoint, be considered a sort of resource available to help out on applied and mission-oriented programs when they show up.

Well, clearly the theme of this is that there are things that I personally believe universities might do to help the Federal laboratories. I feel much more comfortable talking the other half of it; namely, how can the Federal laboratories help the universities? This isn't that I think it is a one-way street, it's just that this is where I know more. So you will pardon me if I now shift over to: How can the Federal laboratories be of assistance to the universities?

I support as a fact that coupling and interaction will be strongest in the areas of science; of basic science, applied science and perhaps the professional schools. So it's that category of the universities that I suspect I'm talking about. One thing that the Federal laboratories can supply, which from the university standpoint will be of the greatest importance, is a better coupling of the applied teaching and research programs within universities to the world of real applications and real development. Almost without exception the people in universities in these areas complain that their students don't see enough of real problems, of applied things as they are being done in 1968, that too often we are a few years behind the procession. There is a very strong interest in such groups, certainly at Cornell, in mechanisms to couple to real world programs of applied research and development as part of the educational process especially. Now it's clear that some of this coupling should be with industry but I think equally some of it ought to be with Federal laboratories. I really think this is an area where Federal laboratories could be a very great help to universities.

Don Hornig mentioned another area perhaps better established, although I don't believe we've done as much in it as we should, and that is the area of utilization by university people, particularly students, of special facilities that the Federal laboratories have. As someone who has been involved for many years with the Brookhaven Laboratory I am especially conscious of the utilization by university people of such special facilities as the accelerators and the high-flux neutron source and so on, but there are many other things in the AEC program--reactors at Oak Ridge and Argonne for example. And by the way it is my impression that the AEC laboratories have done rather well at programs with universities whereby university people use these facilities. I am not so conscious of how well some of the other laboratories with magnificent facilities, such as Langley with wind tunnels and shock tubes and the NASA laboratories at Huntsville and Houston with their space research

facilities, have done. These are magnificent facilities, and methods to make them available to interested university groups, especially students, is surely an interesting area.

The other area that we have mentioned which I think is of great importance--and it is really important in both directions--is to have a good deal more interchange of people from Federal laboratories into universities and from universities into Federal laboratories. I can't help but think that in all of these things that will be a great help.

This sounds like a lot of things we might do. I think an important thing to say is I don't really think doing these things is all that easy. The Federal laboratories have a set of goals and programs, and this is clearly their first priority. Equally, the universities have got some first priority things in research and education, especially education. So the problem is: How are you going to get adequate communication, information exchange, and especially people exchange between groups which have their own programs? I'm sure the answer is that you can only do it if people work at it. I was deeply impressed by what Mr. Ripley had to say about what the Smithsonian has recently been doing. It illustrates that if you put your back to it you can do a very great deal. I don't think that there is any doubt incidentally but that the key mechanism is the people-to-people mechanism; something that is pretty much at the operating level. I think we do have some mechanisms in the professional meetings, the continuing education programs, the joint research effort which can go on and be expanded. On the other hand, I do think, somewhat in line with what Mr. Ripley said, that we probably need somewhat more formal mechanism for communication exchange. I would like to suggest that this ought to be a special responsibility of the Federal laboratory. I don't say this because I think that their need is any greater or I don't put my finger on them because I think that they're obviously more qualified in terms of people and interest. It is rather that, looked at from the standpoint of the university, Federal laboratories have substantially tighter and more efficient organizational structures. It is a characteristic of the American universities that they are pretty diffuse and decentralized organizationally. That kind of organization is not the best, I believe, for supporting continuing programs in a good way. I think organizationally the Federal laboratories may be in a position to be more effective.

Now, I have a few other comments to make. It's often said that Federal laboratories ought to have more graduate students in them. Well, you know, it's easy to sign on to that kind of statement. I want to caution that I don't think there's going to be an enormous growth in graduate students in Federal laboratories. I think there are a lot of pressures, some of them legitimate and some of them possibly not, which lead university professors mostly to keep their graduate students at home. They have to do with the intermingling of formal courses with research, the importance of seminar programs, the importance of the training you get from informal group discussion with large numbers of your colleagues, the breadth of subjects available in universities, and

so on. For all of these reasons I believe that graduate students will come to Federal laboratories primarily for special facilities and not in very large numbers otherwise.

The situation, I think, for postdoctors is very different. I think that greatly increased postdoctoral education in Federal laboratories is obviously appropriate and almost surely desirable. It is a way in which new young people with new ideas can come into a Federal laboratory almost automatically. They have facilities and people that make it appropriate for university-fresh Ph.D's to come in and get further training, and I do think that merits very great support.

I don't think I want to spend any more time, except very briefly, on other kinds of programs. I will note in passing that I've been greatly impressed at the effectiveness of the Brookhaven facility and it does seem to me that not only do the university people benefit, but I'm pursuaded that so does Brookhaven. I think other laboratories might take a look at that.

The final thing I want to comment on is consideration of more physical transferring of units of Federal laboratories to or very near to university campuses. I think this has had a lot of interesting results and I think it might merit fairly serious exploration for more programs. The great example of this, of course, that one's mind instantly turns to is the JILA program between the National Bureau of Standards and the University of Colorado at Boulder. From the standpoint of a visitor, or perhaps from somebody who has been intellectually seduced by Lew Branscomb, this looks like a great program and one that might very well serve as a model for many more. I became conscious of the potential with a rather interesting program buried in the middle of the Cornell campus called the Federal Nutrition Laboratory. It contributes facilities for Cornell people to use and contributes teachers to Cornell programs. As a kind of a footnote, some of you will know that a Cornellian, Bob Holly, got a share of a Nobel Prize a few weeks ago. And the facts are that the actual work for which Holly got this Nobel Prize was mostly done in the Federal Nutrition Laboratory at Cornell. It's been a great plus to us. We've looked at other arrangements of this sort, with Naval Research Laboratory, for example, and I really think that needs more serious exploration.

If I were to summarize these remarks, I would say that I am persuaded, there are a great many possibilities for increased programs. I do think that you don't get them automatically. You have to have work and effort that can best be carried out I believe, at the working level. I think that's where the initiation ought to be. But the laboratories' administrations can play an important role. They ought to. I think that more openness and receptivity for the JILA-type program might be a very good thing.

I'm sorry that Don Hornig has left because if I wanted to make a final comment as to what would make all of this go better, I would carry

you back to the time when we had an eminent English chemist come to Cornell to give an eminent set of lectures called the Baker Lectures. There was a reception for him and the Dean's wife was a rather gushing woman and she cornered this man whose name was Ingold and she said, "Professor Ingold, how nice of you to come to Cornell and give lectures to these Cornell students." And Ingold nodded his head and she said, "Doesn't it please you to feel that you are coming from a different country, to spread a different area of civilization to these students?" And another nod. "And weren't these thoughts of being a missionary for intellectual activities and contributing your bit to these interchanges of people and ideas--wasn't that important to you?" And Ingold nodded his head again and said, "Yes, and also, of course, there was the money."

DR. IRVING: Thank you very much, Dr. Long. I hope in the sessions that follow, that we will grapple with a number of the suggestions that you have made for assisting Federal laboratories in helping universities, and universities in helping Federal laboratories--the opportunities, the problems, and perhaps the resolution of some of these problems. We thank you for this overview of the problem in general.

I can't overlook the opportunity Dr. Long has given me when he mentioned the Federal Nutrition Laboratory on his campus. It is, if you'll pardon my saying it, a U. S. Department of Agriculture laboratory.

The final paper on the morning program is to be presented by Dr. Charles V. Kidd, a Princetonian who also holds a doctorate from Harvard. He has served and has been honored in government and science and technology in a wide variety of posts, including such as Chief of the Office of Research Planning at NIH and later Associate Director of the National Institutes of Health for International Affairs. He serves as consultant to international organizations, to universities, to private industry, and to private organizations. Dr. Kidd has devoted himself most intensely to science policy. He is the author of a book, as many of us know, "American Universities and Federal Research." He is currently Executive Secretary of the Federal Council for Science and Technology, from which point of vantage he is well qualified to give us an overall view of the different patterns and problems of the several agencies of government concerning their educational activities and university relations. Dr. Kidd.

PATTERNS AND PROBLEMS

DR. CHARLES V. KIDD (Executive Secretary, FCST): Thank you, George.

Following Dillon Ripley and Don Hornig and Frank Long on this subject reminds me of an incident in Jean Kerr's household. She had a small daughter who was selected to take part in a school play at a progressive school. They wanted to teach these children their religious and cultural

heritage, so they had a play on the Garden of Eden. The little girl was extremely pleased that she was chosen to play the leading role of Eve. Things went well until she got back from school that evening when the play went off. She came back crying bitter tears. Her mother was surprised and asked her what went wrong. She said, "The snake had all the lines." So I don't know how many lines are left on this subject.

But I'll run through some things that seem to me to be relevant and just state for discussion the proposition that there are forces at work that are going to extend collaboration between the Federal laboratories and universities regardless of one's general philosophical position on the question. The first is one that Dr. Hornig mentioned. That is, rapid increases in budgets are probably not going to be resumed in the forseeable future. Unit costs are probably going to go up--both the Federal investment in academic research and the investment in laboratories in all probability. That means that Congress, I would guess, is going to take a greater interest in the efficiency with which this large block of resources is used. Don mentioned the expenditure of $3½ billion annually in the Federal laboratories and about $1.5 for academic research. These figures aren't precise, but they are precise enough to indicate a continuing, and, I would guess, an increasing degree of Congressional oversight on just how effectively all these resources are used. We can only hope that this oversight would be undertaken perceptively and intelligently. There's going to be more big science. It will extend over more fields, encompassing the biological and social sciences. Much of the big science will not be particularly well suited to the university environment, because it is large scale and it must be administered in an organized way. The more big science there is in non-university settings, the more the universities will have to be linked to the non-university laboratories.

Another fact that seems to me to be relevant is that we will be paying greater attention to large scale research on urgent social problems. I would guess these are going to require new organizational forms and new relationships between universities, Federal laboratories and the contract laboratories. This has been true in the past as we increased expenditures rapidly in such fields as defense, space, atomic energy and agriculture. As we go into more extensive research on these emerging problems, it seems to me evident that a lot of the research will be of the same character; that is, large scale and not particularly well suited to the university environment. Much of the research on housing, education, transportation, pollution will be large, organized, and interwoven with operating programs in a way that would not make them fit particularly well into the university environment. In this connection it does seem to me that we should define Federal laboratory fairly broadly. That is, some cities are going to be laboratories and some school systems are essentially going to be laboratories. And some undertaking in the regional medical programs and the rest of the new initiatives in the health field are essentially large scale social experiments which will certainly need university-Federal laboratory collaboration. Conversely, as Frank said, the emergence of these critical and urgent problems is going to

force the universities to continue to adapt and change as they have in the past; to arrive at a moving equilibrium between this difficult problem of involvement and relevance to the problems of society, and the maintenance of an adequate degree of detachment on the other.

On the academic side, the problem of maintaining high quality graduate education in the sciences will put the universities under pressure not only from the budgetary point of view. The number of graduate students is going to increase and postdoctoral education is going to increase. This seems to be a prediction that isn't particularly chancy to make. Unless there is a radical change of the trends over the last 50 to 80 years the number of Ph.D's produced will continue to double about every ten years, and a period of doubling every seven years, such as we've experienced in the past, isn't at all unlikely. I would imagine that the universities are going to have to muster appropriately all the forces that they can command including those of Federal and contract laboratories, to deal with the steady pressure of rising enrollment.

Now, it is certainly a subject for discussion as to how much of this is appropriate; under what auspices and for what specific segments of graduate work the Federal facilities are relevant and usable. That will be a topic of discussion later. The effect of these forces may not be as consequential as I foresee, but the net effect of all of them is certainly cumulatively all in the same direction; that is, strong pressure on both the universities and the Federal laboratories to invent and use flexibly and widely a large array of collaborative arrangements. And as I see it, much more is involved than effective collaboration and improvement of efficiency simply in a narrow unit cost basis. Many of the problems for which the Nation will demand a strong effective search for solutions, can't be approached except through the sharing of material and intellectual, physical, and organizational resources of the universities and the Federal laboratories.

One factor that ought to make this symposium productive is the richness and the variety and the effectiveness of the activities now scattered around the Federal Government. Just about everything seems to be in operation in one agency or another. The problem seems to be not so much inventing new approaches to Government laboratory-university relations as to secure the optimum adoption and effective operation of devices that have already been tried at least once. There is a large store of practical experience, much of it gathered the hard way, by the people in this room. Now, innovations are no doubt going to be needed. For example, this whole question of university consortia to deal with large scale problems has been approached only in a very tentative way. But if we were able to adopt easily and flexibly all of the devices that have been tried experimentally, we wouldn't have much of a problem. So that certainly one of the hearts of this symposium is to put on the table the barriers and the difficulties. Now I won't run over what has been tried. JILA has been mentioned. We have various schemes for appointing young doctors for two year fellowships and we have special research associate programs. You are all familiar with these devices.

At least some of you are familiar with some of them. And I imagine everybody will be familiar with all of them by the time this meeting ends.

Now, the variety and inventiveness of activities linking university and Government laboratories is certainly a triumph of laboratory management over conventional approaches to training and education, and in many respects a triumph of management over bureaucracy. Because you are all familiar with the practical problems that have to be resolved when you embark on an unorthodox way of bringing universities and Federal laboratories closer together. What has happened so far reflects great credit both on the laboratories that have been innovators and on the universities and the individuals within the universities who have provided the initiative and ideas and resources to make these developments possible. Now with respect to the barriers let's run over some of the things that seem to have impeded wider collaboration--often in the face of clear need and even the desire on both parts to establish more effective relationship.

One problem, and this I thought was one of the central findings of the study on Education and the Federal laboratories, was that the nearer the Federal laboratory to the research end of the spectrum, as contrasted with the development end, the wider the degree of collaboration with universities. It may well be, as Frank Long pointed out, that there are some Federal laboratories heavily engaged in developmental work, particularly classified work, where it will be quite difficult to establish extensive networks of relations with universities. There are also practical budget problems. Another thing that we have to face is that some laboratory managements have not been particularly interested in pushing beyond the standard of laboratory management techniques.

Another barrier that really is important is the absence of adequate delegations of authority to many laboratory directors to act fully and decisively in carrying out an optimum level of education and training, particularly in setting up relations with universities. Some of this arises from undue centralization at the headquarters within the agencies; some derives from an accretion of bureaucratic difficulties. For example, some candidates selected for long term training have gone so far as to make arrangements for housing, schools, and so forth, at universities, and then had to cancel out because of delay in getting headquarters approval. This sort of thing is simply a reflection of a deeper continuing problem that has been pointed out before in the work of Allen Astin and the Committee on Federal Laboratories. That is, there needs to be an adequate degree of allocation of operating authority to the laboratory director. I think that we have, in all probability, procedures that are too intricate and extended in getting approval for individual requests for education and training. There are other barriers arising from requirements in other agencies that effectively deny opportunities for staff members either to teach or to take credit courses whether during or after hours. Staff members of some agencies can receive honoraria for teaching and lecturing and others can't. Some employees can take courses on government time and at government expense and in other agencies they can't.

This sort of imbalance speaks for itself and demonstrates the existence of problems to be solved. By and large I would say that the statutory limitations, although they exist, in total are not as serious as administrative barriers. These range from broad policy positions of management to detailed administrative requirements.

I would say the most serious legal deficiency or certainly one of the deficiencies, is the absence of what you might call a Senior Visiting Program that would enable the Federal laboratories to tap experts that they want from universities and other places from within this country and abroad. Allen Astin has been one of the chief advocates of such a program and he may well want to discuss this later.

Now speaking of what this symposium can do, it would be most helpful to Allen Astin, to his Committee on Federal Laboratories, and to the Federal Council for Science and Technology if these barriers could be assessed. We need an analysis of what ought to be done. We would like to know whether the recommendations in the report that forms the working document for this meeting are sound in the view of those who face the real working day-to-day problems in the laboratories and universities and whether there are any new ideas that ought to be pushed. We look on this symposium actually as an extension of the study and not a ratification or simply an examination of the facts and the recommendations brought forth in that report. We need to pay attention to what's said at this meeting.

Best wishes for a good meeting.

DR. IRVING: Thank you, Dr. Kidd. There was no collusion here despite the fact that we started a little late and Dr. Kidd winds us up a little early. But it does give us ample opportunity before we adjourn for lunch to make comments or to ask questions of the speakers in this morning's sessions.

DR. MILLMAN: My question is directed to Dr. Long, and is related to Dr. Hornig's comment about the natural conservatism of the universities and to Dr. Long's statement about the desire in recent years for the universities to become more outwardly minded. The question I would like to direct is in connection with graduate students and about their involvement in Government laboratories, or industrial laboratories for that matter too. Dr. Long made the remark that there was probably going to be very little of this. I was wondering whether this mode of operation could be reexamined. I mean, after all, this is not the first time we have heard complaints about universities in this regard. Most of the universities provide excellent training in physics, chemistry and mathematics. The complaints have been that often the motivation for these science students to tackle real world problems is not there, except in a few institutions. In order to stimulate this kind of motivation wouldn't it be preferable to get the graduate students as soon as possible

after they are through with their courses into Government or industrial laboratories and not keep them close to 100 percent at the university? And so, I wonder whether this is not the right time to reexamine the degree of involvement of our graduate students in real world problems.

DR. LONG: Well, in answer to the final question, of course it should be reexamined. And I really wasn't trying to make a comment as to what ought to be, but rather what my prediction is, which is a somewhat different thing. The prediction was based on the tendency of university professors to hold their students around them as a kind of working group. The students, the professor, plus a postdoctor or so, plus a half dozen graduate students, has turned out to be a unit that seems to add a lot of effectiveness to programs; and these people just do, in practice, tend to hold on to it.

Clearly more can be done. More can be done in the first place by programs which bring graduate students to Federal laboratories for shorter periods. I mentioned that we had talked a little bit with some Naval Research Laboratory personnel about a joint program that might have been in Ithaca on plasma physics. That didn't work out. But a consequence of it was that NRL made available spaces for graduate students from Cornell to come down and spend summers using special facilities in the NRL area as a component of their work. That's been very satisfactory and I'm sure one could do more. I might note that when I mentioned the postdoctorals I was thinking of the postdoctors budgeted by the Federal laboratories--not on loan from the universities. And there it really is the money, it seems to me. It's for the Federal laboratories to find the amount of money that can support significant numbers. So that I should be pleased indeed to see more.

I might also note that the problem, looked at from the university standpoint, is more interesting and more urgent as one goes to the applied fields. The tendency to believe the best education can be done in the confines of the university is especially true in the hard sciences and in basic biology. When one gets to engineering or agriculture, I would say it's very much less.

DR. IRVING: Are there other comments or questions?

DR. JACK MILLER (Columbia University): Dr. Long, do you see any hazards or dangers in the type of increased university-Federal relationship that has been pictured?

DR. LONG: Well, there are some obvious hazards that I didn't even bother to mention. I think they are evident. I'll repeat them. It's clear that the problem of work by students especially in classified laboratories is awkward. Many universities, Cornell is one, have quite

flat rules that say that students may not work on classified thesis programs. So that represents a barrier to certain kinds of things. I have not believed them to be terribly important, but somewhat.

There are hazards, clearly, always when you mix two groups with fundamentally somewhat different goals and pressures. Lots of the Federal laboratories have an important mission orientation which is what Congress expects of them; what their budget covers. Universities have on their side a commitment to education. You can always worry whether these groups will not be to some degree incompatible in their philosophy. I'm sure there's a hazard. I'm sure this hazard is enormously minimized if they're physically in proximity. That is why I stress the fact that I think these programs will most often be effective if they're sort of people-to-people, if they're people at more or less the same working level. If a group of people, to go back to my other example of plasma physicists from Cornell and from the Naval Research Laboratory, get together, the chances are pretty good that they will have a rather clear mutual understanding of their limits. If the thing is worked out by treaty by top management it might run into trouble.

DR. IRVING: Are there one or two more questions? Yes sir.

DR. ZOLA BRONSON (National Science Foundation): I would like to make a general observation for Dr. Long to reply to, but actually it's directed more to the university people. Specifically, the tenor of the remarks so far has been addressed to improving university-laboratory relations for the purpose of encouraging and providing higher education leading to advanced degrees. I think we're ignoring the large unwashed mass--to use a common figure of speech--the rank and file of our laboratory professionals who for one reason or another do not want and do not necessarily need advanced degrees, but who do need continuing updating education. There's a great need and opportunity in the university-laboratory relationships to provide for these needs; they are very sparse at the present time. By and large, however, the universities seem to shy away from this type of effort.

DR. IRVING: The point raised was this. Much emphasis is being given to graduate-postgraduate university instruction. What about those who are not of such intellectual level but who, nevertheless, can use and need university training in specialized fields. Is that your point?

DR. BRONSON: Well, it's the matter of refreshing and updating or retreading. Dr. Long used the words in passing, but then seemed to associate continuing education with advanced degrees only. Updating is not necessarily aimed at advanced degrees and there is a terrific need for this type of academic resource.

DR. LONG: Let me take exception to the last remark. As a scientist who's recently been administrator, I feel a real need for retreading. I did mention that universities have not done awfully well on continuing education and I'm really thinking of my own university. I can testify that we haven't. My strong belief is that those programs have got to be worked out in rather close conjunction with the users. It is quite possible that some failures by universities in advanced or continuing education have been because they develop the program in isolation. The only suggestion I have is that if one wants to get into a program like this, the first thing to do is to get the groups together so that the one can say this is what we need and the university can say that this is what we have the competence to supply. It may be that it won't be the University X but College Y which will be the right one for him. But I'm sure the first thing to do is to get together and talk specifics.

DR. IRVING: One more.

DR. JOHN TOLL (State University of New York): Let me just express a point. We've been talking about taking people from the universities to the Federal laboratories to do their research. I think it is just as significant to see graduate courses offered at the Federal laboratories whenever there is a critical size there, and then when students get to the appropriate state, bring them onto the campus for a year or two for intensive research and to complete their doctorates. This, I think, is a pattern that can be extended much more. It has been done in many areas such as the Oak Ridge Program; there have been many arrangements with Federal laboratories in the Washington area with the University of Maryland which has provided both people for national laboratories and bringing students to the campus. But I think this can be done much more than has been done in the past, and it has the advantages that it builds a link between the research groups. Since a man goes back usually to the same laboratory, you've got a link which then builds many more transitions between the groups. In fact, the plasma group you're talking about is just one that has made this kind of relationship. I think this is a pattern which should be extended as much as possible.

DR. IRVING: Thank you.

DR. LONG: John Toll made me realize that there was a comment that I wanted to make but didn't. It is this. In many places of interactions between Federal laboratories and universities, and this especially holds if they are close together, things may work especially good if there is something in the way of a reasonably formal treaty whereby the Federal laboratory takes explicit responsibility for a certain area. Let me illustrate. One can imagine a laboratory in the Washington area contributing to the graduate program of, let us say, Georgetown University in physics by saying, 'We happen to have a set of theorists in our

laboratory and we're prepared to take real responsibility for the theoretical work in physics in the Georgetown setup. We're prepared to commit ourselves to give courses, to take care of graduate students and, in this sense, become a part of the show." You see, if one only operates on a kind of casual visit or visiting professor basis you may be able to rely on him, but you may not. Then each crowd will feel they have to duplicate facilities. If you are going to avoid duplication of facilities, then you need some sort of formal arrangements. I think that in lots of areas there could be real mutual benefit by formal arrangements. The universities could save money and could frequently get better people than they could otherwise get. The people in Federal laboratories could participate in a very integral way in academic training. It just seems to me that it might be an avenue worth more exploration. Obviously it works best if there is geographic proximity. It's not general, but for those cases it ought to be interesting.

DR. IRVING: With your permission, we will call this the conclusion of the morning session. I want to thank the speakers, Dr. Astin, Dr. Long, Dr. Kidd, Dr. Hornig and Dr. Ripley, for starting off this symposium and for their most relevant and excellent presentations this morning.

Tuesday, October 29 P.M.

USE OF FEDERAL FACILITIES FOR TRAINING UNIVERSITY GRADUATE STUDENTS

DR. IRVING: The session this afternoon concerns the use of Federal facilities for training university graduate students. It is in two parts. The first part concerns training in Federal laboratories. Part two concerns training in federally related contract laboratories.

The moderator of part one, who will introduce his panelists after he makes his own presentation, is Dr. Gregory Hartmann. Dr. Hartmann is a physics graduate of the California Institute of Technology and a Rhodes scholar with a degree in mathematics from Oxford. He holds a doctorate in acoustics from Brown University. He taught both at Brown and at the University of New Hampshire. His research interests have emphasized explosives development and phenomena associated with weapons effects. He has been a pioneer in nuclear weapons effects and has been responsibly involved in all of the earlier Pacific nuclear tests. Dr. Hartmann has played a principal role in developing the Naval Ordnance Laboratory. He has been Technical Director of that Laboratory since 1955. In recent years he's been interested in the important role played by professionals in the Federal Service. It's appropriate then that Dr. Hartmann will moderate part one of this panel on training in Federal facilities.

PART I: TRAINING IN FEDERAL LABORATORIES

DR. GREGORY K. HARTMANN (Naval Ordnance Laboratory, White Oak): Thank you very much.

This panel, which has six individuals on it, is going to cover the subject of the use of Federal facilities for the training of graduate students. We are not talking here about the use of Federal facilities in postdoctoral programs, nor in senior visiting programs, nor in the kind of social service which is represented by the retraining of older Federal employees. I'm going to group the panelists into three pairs. It turns out that two of the panelists seem to be polarized between universities and the Federal establishment in the area of agriculture, two in life sciences, and two in physical sciences. There is a pattern to this which must have been a conscious choice of the Program Committee, but the arrangement on the program doesn't indicate this because the names are pretty much randomized.

I'm going to try to get through with my statement and the statements of the six panel members in time to allow something like a twenty minute period for questions. So if you will be kind enough to make notes of these and hold them until the end, we'll appreciate that.

I'm going to redefine Federal facilities a little more narrowly than we heard this morning. For this purpose, I would include all federally owned and operated laboratories, centers or activities which are engaged in some sort of research and development in support of the mission of some agency or department of the Government. In the Department of Defense alone there are at least 80 such large activities. Since the Department of Defense employs half the professionals in the classified Civil Service, it is safe to say there are upward of 200 large and not so large activities which form a substantial market for graduate students and which in all self-interest should interact with the sources of these products--the universities. Since the key ingredient in any laboratory is the professional staff, I am going to include the staff as well as the physical plant and equipment in the definition of Federal facility.

I shall also follow the lead of the pilot study and not attempt to distinguish between training and education--a distinction that has long since lost its validity especially with the passage of the Government Employees Training Act in 1958. Many of you will know that in days of yore training was reserved for animals and education for people. Today, however, it is quite acceptable to train people and to educate them at the same time.

The training of graduate students is the responsibility and province of academic institutions which must prescribe the curriculum, judge the results of study, accept the evidence of scholarly attainment and recognize the meeting of a set standard by awarding an academic degree. Even the universities have to meet standards set by other universities in order to be able to award accredited degrees. How then can a Federal laboratory contribute to the training process unless it is somehow a part of the university?

Before going into that, I would like to note that all is not crystal clear when we talk of the role of the university. Some departments may feel that the student must live and work on campus in the academic atmosphere engendered by close association with his fellow students and professors. There is generally a minimum residence requirement which I suppose is tribute to this feeling. On the other hand, many universities essentially have no campus, teach courses at night to part-time students and in some cases accept thesis work done elsewhere. The early model of the struggling graduate student who is paid a subsistence wage for part-time assistance to the university has given way to today's affluent young man who is sent to school by his employer or who is asked to work on a topic as part of his job, this work doing double duty as a thesis topic by prior arrangement with the university. We now have a bewildering variety of work-study schemes, cooperative student programs, advanced study assignments and the like which have tended to blur the time-honored image of the graduate student as someone wholly devoted to serving a single master at the fount of learning.

Let me list a few of the ways in which Federal facilities are being used in the training of graduate students insofar as their use is acceptable to the university. Almost all of these ways are methods which have been used at, for example, NOL and many other places. I've made simply a catalogue without attempting to make a canvass of all the other Federal institutions which may have additional ways as well. There is:

- The use of Federal space, either after hours or on a split-time basis, for holding classes or lectures in off-campus courses, that is, courses given in the laboratory at no charge.

- The licensing of Federal employees by the university as teachers or lecturers.

- The assignment of professorial or other rank to Federal employees to serve as thesis supervisors for advanced degrees for work done in-house.

- The loan or transfer of specialized equipment or instrumentation to universities for the pursuit of projects of mutual interest involving graduate research.

- The part-time or summer employment of university staff or graduate students. This may result in experience which contributes to graduate training either directly or indirectly.

- The granting of contracts for work done in the university by graduate students under the supervision of a professor.

- Obtaining the consulting services of university staff members on research projects where graduate students are working.

- Allowing the use of specialized equipment for graduate student research; for example, large magnets, x-ray analyzers, accelerators, or what not.

- Participating in seminars--presentations made by Federal employees to graduate seminars.

- Joint research projects; perhaps Project Themis in some of its aspects.

- Cooperative student programs, work-study arrangements, and the like.

All of these ways (and there are doubtless more) have arisen, I suspect, through the basic need of laboratories to develop their own employees by graduate training, or to make employment in these laboratories attractive to young professional men and women who wish to advance

through the opportunity for training. Therefore the Federal activities have done these things as a means to an end; namely, to further their own ability to accomplish their own mission which does not in itself include the furtherance of graduate education. But one can ask a broader question with economic and social implications. Federal facilities represent an enormous investment of taxpayers' dollars and can be said to belong to all the people of the United States. The progress of our society depends on professional competence and the source of this is the graduate schools. Should not, then, the Federal facilities have an obligation to further this precious commodity by aiding the universities not just to carry out their missions, but in the interest of all the people? Stated another way, should not the mission of each Federal facility be expanded to include this function in an active manner? This would mean that a facility would not only assist its own employees in obtaining a graduate education, but would have an obligation to assist others who were not connected with it at all. The details of priority and funding would have to be settled between the laboratory and the university where such matters were substantial. The educational mission of a Federal laboratory, if granted, would presumably have to be a secondary mission, but it should nevertheless be understood either implicitly or explicitly.

In the same vein, the use of an existing national resource to solve or help solve a national problem may be a more economical and speedy approach than the creation of additional specialized Federal laboratories. Most large laboratories, by virtue of their interdisciplinary skills, are capable of attacking problems outside the scope of the relatively narrow mission which caused them to be established. Such resources and spin-offs should be used, not stifled. Potential assistance to graduate education may be such a resource.

While discussing these thoughts with some of my colleagues, it was suggested that there may be a basic driving reason why there is in fact, and should continue to be, a cooperative effort between the universities and the places that employ the products of these universities. The need can be laid more or less directly to the technological explosion which has given rise to a demand for closer interaction between basic research, applied research and engineering skills. As a consequence engineers have found it necessary to obtain higher degrees, and scientists have been involved in developmental programs. This explosion has brought a much tighter dependence between the scientific community and those who foot the bill; namely, the general public. In the past the gap between the public and those who carried on research and taught was large, corresponding to the gap between knowledge and applications. Things are very different now. The future as far as mass production and mass consumption of technical know-how is concerned may lie in the extension of work-study arrangements; that is, learning more closely connected with practice--not only for its more immediate benefits but also as a means to learning. This may be one reason why, for example, medical schools have always been closely tied to hospitals. In a similar way the process of acquiring research and engineering techniques may be best served by combining

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academic exposure and practical application. Our problem is evidently to make effective use of this possibility without degrading the contribution from an academic atmosphere to the learning process, nor causing the destruction of long-range scientific research and learning by the pressure of our daily needs.

This concludes the remarks that I had planned to make and I'm afraid they are rather general. Perhaps now we can come to some examples and descriptions of specific experiences. Our first panelist is Mr. Alan Freas.

Mr. Freas was educated as a civil engineer from the University of Wisconsin. He is now Chief of the Division of Solid Wood Products Research, Forest Products Laboratory in Madison, Wisconsin, and he has been associated with this sort of business either in the university or in the Forest Products Laboratory throughout most of his career. He was, for an interim, Instructor in Civil Engineering at the University of Wisconsin. So he has gone from Government to university and back. With that I would like to turn to Mr. Freas.

MR. ALAN FREAS (Forest Products Laboratory): I should, perhaps, introduce this presentation by a few words on the Forest Products Laboratory and its mission. The Laboratory was established in 1910 on the campus at Madison, Wisconsin, in cooperation with the University of Wisconsin. It is a part of the Forest Service of the U.S. Department of Agriculture.

The Laboratory plays a national role in forest products utilization research and thus has a wide-ranging program. Its mission may be stated briefly: "to conduct research that leads to greater social and economic benefits for the people of the United States and of the world, through the better utilization of their timber resources."

The diversified research program is, for administrative purposes, separated into five technical divisions dealing with all aspects of the utilization of wood. One division deals with those aspects which relate to the quality of wood, their characterization, and the ways in which quality may be changed by natural and other causes. A second deals with the processing and protection of wood in a form which can still be recognized as wood. The processing, of course, deals with such things as cutting, drying, gluing, and the like, and the protection with improving resistance to fungi and insects, fire and weather. A third division deals with the manufacture of fiber products, principally paper. A fourth deals with engineering aspects, including structural utilization, while a fifth deals with the chemistry of wood.

I include this information to indicate the scope of our interests and thus the range of disciplines in which we do have an interest. With this wide ranging program I feel that we have a great deal to offer graduate students.

The Graduate Program

I was faced with a choice of exactly how to present some of the things with which we are concerned, and I am going to spend the bulk of my effort on the graduate program which was established at the Laboratory in 1954. This program, among other things, puts fresh ideas into our research program, keeps our scientists in touch with a new generation, and serves as a valuable recruiting device. The student, of course, must have a good academic record suitable for admission to the University of Wisconsin Graduate School. He must have interests related to some phase of the Laboratory's research. With the broad scope this opens up a rather large area. Assuming these prerequisites, admission to the program depends on acceptance by the Graduate School, arrangement of a mutually agreeable research program, and qualification by the Civil Service Commission.

The participant actually becomes a part-time employee of the Laboratory on a career-conditional appointment. These appointments generally are in the GS-7 grade for those working toward the masters, and GS-9 for those working toward the Ph.D. The stipend for the nine-month school year is set at the level current at the University of Wisconsin for research assistants. This year it is $2,700. This is a maximum which the man can earn. He is expected to put in enough hours at the Laboratory to cover this, but any hours he puts in beyond that are not credited toward pay. The figure of $2,700, however, is net--with funds added to cover social security, income tax, and the like. As perhaps a bonus, we are able to offer full-time work during the summer.

The use of the career-conditional appointment has definite advantages over other types. For one thing, it allows for advancement to a higher grade (to GS-9 in one case or to GS-11 in the other) as the individual progresses, whereas other types of appointments do not permit this. Further, the student accumulates creditable service based on the number of days he works at the Laboratory.

Experiences at the Forest Products Laboratory

I mentioned that this program was started in 1954. In that time, some 52 students have participated in the program, with as many as 12 at one time. Currently, with budget limitations we have only two. The range of disciplines with which we have been involved is indicated by the following figures. Among engineers--mechanical, civil, electrical--we have had 24; chemists--organic, physical, analytical--8; chemical engineers, 5; plant pathologists, 3; bacteriologists, 2; foresters, 8; and botanists, 2. Of these 52, nine (17 percent) have become full-time Forest Products Laboratory employees. So to some degree we have been successful in using this as a recruiting device.

Other Aspects

In addition to those on the WAE or "When Actually Employed" appointments that I have just described, we have, from time to time, accepted graduate students from the University of Wisconsin for thesis work without appointment to our staff. Beyond this, we have accepted a considerable number of research associates, both pre- and post-doctoral. Of these, a high proportion have been from overseas. In fact, some 20 countries have been represented by 57 research associates since 1956.

Summer Student Employment

Perhaps not directly tied to graduate training, but certainly indirectly, is a summer student employment program intended to provide selected undergraduates an opportunity for experience in an actual research environment--selecting a problem, planning and accomplishing a study, and writing a brief report. A copy of this with our evaluation of the student goes back to the major professor. This has been an excellent program which has recently been adversely affected by the Civil Service Commission requirement of competitive written examination for eligibility. Some of these students, I might point out in passing, have gone into our graduate program.

Teaching Activities of Staff

One final point, a number of our staff hold appointments at the University of Wisconsin and assist with courses in our field. Such appointments permit increased participation on M.S. and Ph.D. committees and the like. Thank you very much.

DR. HARTMANN: Thank you Mr. Freas.

The other half of this agricultural part will be presented by Dean Pound, who is the Dean and Director of the College of Agricultural and Life Sciences, University of Wisconsin. Dean Pound has, in my opinion, a very great claim to be a Dean of an agricultural college. He apparently started out at an early age in Texas where he eventually became the operator of a six hundred and twenty-five acre vegetable-cotton farm in the Rio Grande Valley. He was educated at the University of Arkansas and received his doctor of philosophy degree in plant pathology from the University of Wisconsin. He is the author of approximately one hundred technical research publications in plant pathology. He has also been for many years in very close proximity to the Forest Products Laboratory. He will cover some interaction with that in his remarks. Dean Pound.

DR. GLENN S. POUND (University of Wisconsin): Mr. Chairman, Gentlemen. I think I should first of all voice a disclaimer for such a heritage out of agriculture. While my nativity was there, educationally-wise I came up through a liberal arts background and have really no formal association

to agricultural education as such. I consider it a particular privilege, however, to participate in this symposium as a representative of agriculture. Agriculture as you know is a shining example of an effective, cooperative program between the Federal Government and the States. For over one hundred years this cooperation has been a part of a national policy for agricultural education and research and it has been implemented through the USDA land-grant college mechanism. While the spirit of true partnership has not prevailed in all situations, cooperation has been traditional and it has been highly successful.

I think we should state again, as was stated this morning, that a Federal laboratory and a State university are very different institutions in their missions and in their organization. The Federal laboratory has a highly mission-oriented research program and its administrative rules and regulations are designed to service this program. The administration of the laboratory is subject to requirements of the Civil Service Commission and to the department to which it belongs. The university's primary mission--certainly within the context of our discussion today--is manpower training, and much of its operational machinery is designed to meet the students' needs. These basic differences in mission and operational machinery require some adaptation in bringing the two institutions together in a cooperative graduate training program.

There are two key conditions, I think, which are basic to effective use of Federal laboratories by universities for graduate education. The first of these is that there prevails at each institution an administrative attitude conducive to a pooling of manpower and laboratory resources and that each institution will be willing to adjust its administrative procedure to accommodate joint programming. This says in effect that the primary concern is complementary program resources, and that such items as source of salary and institutional loyalty are of secondary importance. I recognize that one owes particular loyalty to the institution which pays his salary and that there are some problems attendant to persons of another institution participating in one's departmental affairs. But these things can be worked out if the administrative philosophy at each institution will permit it. If two institutions are going to effectively program together, they must avoid building fences around themselves to protect their territorial integrity.

The other condition basic to cooperative work is that there exist mutual interests and objectives between the scientists of the two institutions. Many levels of cooperation can exist without this, but only with such mutual interests will there be a truly cooperative integrated program. And I would hold out for such a program for graduate education.

Let me turn now to the University of Wisconsin and the Forest Products Laboratory to use the existing cooperative program in graduate education as a framework for some general remarks. Mr. Freas has just discussed the program from the viewpoint of the Laboratory and particularly the graduate education of employees of the Laboratory. For over

fifty years these two institutions have been working together under a cooperative agreement. The University of Wisconsin considers the Forest Products Laboratory as a great academic asset to its environment. The willingness of the Forest Products Laboratory to relate itself to the University means a significant increase in resources, both manpower and equipment, for graduate training. The opportunity for students to do thesis research in a functioning laboratory with the quality of scientists and physical facilities which the Forest Products Laboratory has for wood products research is of inestimable academic value. The University recently sold twelve acres of very, very precious land to the Laboratory for its expansion. This is a reflection of the high esteem that the University holds for the Laboratory. Unfortunately the University of Wisconsin has been too slow in developing its academic forestry program to a point where it could stand beside the program of the Forest Products Laboratory.

Presently the University offers the title of Lecturer to fifty-five members of the Laboratory. The Graduate School offers a doctoral program in forest products which is administered by a committee of scientists from both institutions. In addition, our Department of Forestry offers a joint major in forestry and forest products, utilizing certain courses taught by Forest Products Laboratory personnel. Our Graduate School catalog lists the Forest Products Laboratory much as a department and describes its program areas in some detail. Finally, as Mr. Freas has pointed out, a number of our university departments have had graduate students involved in training in one or more of the five program divisions of the Laboratory.

The general format of handling students is that a University professor serves as the student's academic advisor and the Forest Products Laboratory scientist as his research advisor. While this functions quite well, it differs from the arrangement for most students. The normal University arrangement is that the student is in the hands of his major professor for both course work and research advisement. This necessity for a division of the advisement function points up the need and value of having laboratory scientists more closely tied-in to the University departments.

The title, Lecturer, is used by the University because it does not create any tenure problem for the University which bona fide professorial titles would. The word lecturer, however, leaves something to be desired, for within the University community, it pegs the laboratory scientists as being different. Some of our departments do extend professorial titles to certain USDA scientists stationed on the campus and functioning wholly within our departments. In these cases the tenure problem is avoided by a written record established at the time of appointment. I personally am interested in exploring with the Forest Products Laboratory and with our faculty divisional committees which pass on tenure appointments to see if such a format could be used for Forest Products Laboratory personnel. A professorial title would be used for selected scientists who would carry a more significant academic role in joint training programs than under

the present formula and whose academic credentials met University standards. The Lecturer title could be maintained for those having a more peripheral relationship. Recent liberalization by the Civil Service Commission would seem to make it easier for laboratory scientists to carry a greater academic role than in the past. I would hope that the Laboratory's mission, as interpreted by its administration, would permit a move to a higher level of cooperation. I would hope also that some of the Laboratory scientists would be interested in this level of cooperation. It would be good if there were mutual efforts and cooperation in the areas of recruitment, curriculum planning, teaching, student advising, and cooperative research. It would be good if salaries could be shared between the two institutions. We know that cooperation exists ultimately only where the personalities involved want it to exist. But the thing that is important is that administration should never get in the way of this cooperation's happening.

There are some problems which center around the stipend and the working arrangements for the graduate student. When a student becomes a part-time employee of a Federal laboratory on a career conditional appointment, the arrangements are subject to the requirements of the Civil Service Commission. This may mean a requirement to put in x number of hours per week in research or scheduling working hours in such a way as to avoid overtime pay. In actuality, the normal graduate student may need to spend his first year essentially full time in course work and his last year full time in research. Thus it is difficult to follow a rigid work schedule. The University mechanism takes this schedule into consideration and averages out one's time over a period of three or four years. Putting the student in an adjusted work schedule as is done now gets around some of these problems. If the University carries the student for the early years during which this schedule is largely course work and he shifts to the Laboratory for his latter, more productive, research years, this creates an imbalance in the research output sheet of the two institutions. It would be helpful if the Federal laboratory had a closer understanding of the need for financial support during the more academic years as well as during the research oriented years. What would really be most effective would be for the Federal laboratory to be able to invest research dollars in students' stipends without reference to employment status. In the normal university situation, a student accepts a stipend for research on some specific topic that falls within the broader research area of his major professor. He is not, in that situation, paid for service rendered. The WAE formula serves the Federal laboratory in that it is an effective recruiting device, and it is therefore within the mission of the laboratory. My hope would be that the mission of the Laboratory might include a general assist in graduate education and that scholarship aids rather than salaries would be used. We must recognize that there is an inherent weakness in any institution's employing people and giving them security of job before they are trained.

Students housed in the Federal laboratory and working on an employment basis are deprived of certain intangible values of association with a full mix of graduate students. Students learn as much, perhaps more, from other students than they do from their professor. Also working in the laboratory forces compliance with work schedules and rules which may fit a purely research laboratory but which are difficult to adapt to an academic schedule. Academic programs have a great deal of irregularity of schedule. They always have had and they always will. It is extremely difficult at times to manage research and study to fit an eight to five working day. Laboratories and libraries need to be open most of the twenty-four hours. What I am trying to say is that a bureaucratic approach to academic life is both stifling and inefficient. The rules and regulations imposed by the Federal laboratory need to take the students' problems more into consideration. Otherwise the greater freedom by the university assistantship will make it difficult for the laboratory to find graduate students.

DR. HARTMANN: There's a great deal of truth in what you say. Now we should move along to the life sciences.

Our next speaker comes from our host institution, the Smithsonian Institution. Dr. Wallen has a most extraordinarily active vita. He was educated and spent the early part of his academic career in Oklahoma State University, with some time out to get a Ph.D. in Zoology at the University of Michigan. He is also, I would say, a rather unique member of this panel in that he was a fighter pilot on the USS Saratoga during World War II as a member of the Navy Air Corps from Pearl Harbor to October 1945. He spent considerable time with the Atomic Energy Commission, first in the capacity of foreign training officer and later as a marine biologist in the Atomic Energy Commission. He joined the Smithsonian Institution in 1962. The subject of limnology, I thought perhaps at the beginning that this was a new kind of animal, it turns out is simply oceanography as applied to streams and lakes, if I may say so. Also it is not limnography, it is limnology. Dr. Wallen has, as I say, been extremely active. His activities range from malacology to Montgomery County and from PSAC to Pakistan. With that I think I will let him tell us as much as he can in the limited time alloted.

DR. I. E. WALLEN (Smithsonian Institution): I can't resist the opportunity of mentioning aquaculture, having just heard from two agriculture specialists, and of saying that the principal interest in the oceans is now more equivalent to agriculture than it's ever been before--even including an attempt to develop sea-grant colleges to match and follow the examples of land-grant colleges.

The Smithsonian Institution, as most of you must know by this time, is sort of neither fish nor fowl. It is an establishment created by Congress with both a private side and a Federal side. After substantial argument in the Congress of the United States some hundred and twenty years ago, it was agreed that the Smithsonian would have a very specific

mission which is the increase and diffusion of knowledge among men. In operating within the Federal Government facade the Smithsonian is responsible as a kind of management operation with a series of museums and research activities. I think in this sense it has always been recognized by the Congress and by the Secretaries of the Institution that we should be rather heavily involved in education. In fact, in 1901 we served as the principal agent for opening the Smithsonian and other Government facilities to graduate students. We have had since the very early days of the Institution a rather large number of graduate students. Last year we had about 53 Ph.D. students on our campus. Until fairly recently these students came almost entirely at their own expense. With the advent of Sputnik and with some increase in science interest in the Federal Government, we have been able to support some Ph.D. students and some undergraduate students, but we still have a rather large number of students who come on their own.

In 1964 we entered a new phase of our arrangements by signing an agreement with Duke University to make joint appointments of staff members of Duke University and of the Smithsonian to the faculties of the other organization. Since then, since we obviously can show no favoritism, and because of the varied interests of our faculty, we have signed such agreements with some forty universities. These arrangements provide primarily for the sharing of staff under a series of arrangements, most of which were mentioned by Dr. Hartmann. For example, we have quite a large number of faculty members on our staff who are also faculty members of universities. These are sometimes full-time appointments and, in the case of the Smithsonian Astrophysical Observatory, some of our staff members are the Heads of Departments of Universities at the same time as they are Smithsonian staff members.

A second way in which we participate is by permitting our faculty members to be listed in college catalogues so that a graduate student may have the opportunity if he wishes of choosing a Smithsonian person as his thesis director. In such cases we normally expect that the student would complete his course work at the university. Then he would come to the Smithsonian where we would expect to employ him full time during the time that he was doing his thesis. This turns out to be mutually extremely beneficial because in many cases we have unique collections and these unique collections can be studied best here. In some cases we can loan our collections, but in many cases we find it rather difficult because valuable materials are lost.

Another kind of participation in education is when full support of a faculty member is given by his university but he is assigned for a period of time at the Smithsonian. In that case he may or may not bring graduate students with him.

The fields that we cover are primarily biological, geological, physical and chemical. In other words, we cover the general fields that a university would primarily cover in science. We do some work in the

science related activities but somewhat less. We publish what is the equivalent of a college catalogue, Research Opportunities, which is intended to encourage students who have their own support or students or faculty members who wish to make application to us, to come and join the staff. We are attempting to recognize that because of our public-private side we have a somewhat unique capability in bridging the gap between universities and government. And we are trying, insofar as is practical, to test out any idea that seems to be worthwhile in the ways of university relationships. We would like to think that the facilities of the Smithsonian are strictly national facilities in the sense that they are accessible to any qualified person in the United States.

Because we have special competencies with one hundred scientists on our staff who are primarily concerned with the classification of life science objects, we are a principal repository in the area of taxonomy. This is a shortage area in the Federal Government as has been concluded by various panels and so we have found it necessary to get into the education business primarily because of this shortage in the systematics area. We have been unable to find specialists in many of the marine groups in order to meet the stepped up activities of oceanography, and we've made special efforts to establish fellowships and to bring in individuals who were willing and capable of directing graduate research and who could, if they chose, bring graduate students with them.

In order to ensure that we maintain the kinds of standards that the universities maintain, we make no effort to establish new standards as such. We take the standards of the university, discuss them with the university authorities and accept those standards or, if possible, make our qualifications somewhat more rigid, depending upon the availability of students.

A steering committee mechanism within the Institution has been established which is responsible for the evaluation of applications, the maintenance of quality and the guidance of graduate training. Special seminars are provided during which we give some indoctrination on the nature and kinds of opportunities in the Institution and give the faculty members a chance to present their own topics.

Funding comes from three different sources. We have an Office of Academic Programs, which provides the administrative structure for education and training activities which involve congressional funds. We receive some appropriated funds for education and we add some to that from the various offices and bureaus of the Smithsonian. If an individual bureau needs a particular individual, he may employ a person part time or may seek a graduate student who may be under direction of a person in the bureau or at a university and fulfill the need in that way. And we have a number of more or less incidental non-Smithsonian sources of funds--some of which are Federal and some of which are private. Of course, as a fourth mechanism we have the career advancement program, which permits us to assign qualified people who have not completed advanced degrees to graduate training.

Annually we conduct within the Smithsonian an education inventory asking each staff member to estimate the amount of time that he would like to spend with students and the number of students that he would like to have under his guidance. This is to try to determine the educational capacity of the Institution. It turns out that our staff members would like to have about 250 graduate students, so that we are under capacity by approximately 80 percent based on the fact that we have about 53 students on board.

In closing I just want to say that Dr. Hartmann listed a number of ways in which Federal facilities have been used. We have at least one variation of this which is somewhat different from those that he mentioned. This involves the fact that we deal in collections. We do a substantial amount of lending and borrowing of collections making them available to universities and borrowing them temporarily from universities for use in our graduate work and in science. Thank you.

DR. HARTMANN: Thank you very much.

Now we shall hear from Dr. Richard Robins, who is Professor of Marine Science, Institute of Marine Science, University of Miami. Dr. Robins obtained his B.A. and Ph.D. degrees from Cornell University and has had postdoctoral study at Stanford University. He has been at Miami since 1956 and has been very active in a large number of professional societies which add up to 15 in all. The remainder of the vita has been omitted so I can't tell you how many publications there are. Dr. Robins will tell us about his experiences principally in oceanography and in the training of graduate students.

DR. C. RICHARD ROBINS (University of Miami): Thank you, Dr. Hartmann.

Many of the remarks that I originally intended to make were made by Dr. Long this morning and by preceding speakers this afternoon. Their comments are of broad application and it seems silly to waste the little time available repeating them. I shall not do so.

The basic problem that has not been stated and that really underlies all of the problems that we discuss, is that we have too few scientists in the United States today, and that we are training new ones at a rate that falls further and further behind the needs. We need more scientists for research and industry, in Federal laboratories and other Governmental agencies, in education itself, and for consultation and advice. I am sure that if we went around this room and noted the schedules of everyone here for the last two weeks, we would see that we are all being spread much too thin and our research and teaching careers are the poorer for it. Moreover, many of those who are trained in science enter services and agencies and institutions that traditionally do not participate in the training of scientists. More and more of a burden thus falls on those who have gone into education. Of the last ten Ph.D. students that I have turned out only two have joined academic ranks. The others are in

industry or in Federal employ, this despite the tremendous increase in the rolls of students in colleges today and the projection of further and larger increases.

Science has been sold to the public; we don't have to interest young people in it. The big bottleneck that we really face is in graduate training. The problem, then, is not whether we should cooperate, or have cooperation, or continue cooperation between the Federal laboratories and the universities, but how we can expand and make more effective this cooperation. Cooperation we must have.

Cooperation has long existed in some fields, but in some disciplines like oceanography we face new problems. Both the universities and Federal laboratories are meeting new challenges every day and the answers to some of them are not readily apparent. At Miami we realized some time ago that the University could not continue to expand its Marine facility indefinitely. We were creating too much of a monolithic structure and what we needed was a community of laboratories. The metropolitan Dade area and the city of Miami, recognizing the importance of marine research and of the existing role of the University of Miami, very kindly cooperated in this and set aside the Island of Virginia Key for marine sciences. We were able to attract to this area the Tropical Atlantic Biological Laboratory of the Bureau of Commercial Fisheries. We have been able to attract to Virginia Key the ESSA Laboratory which is yet to be constructed. We hope to attract to Virginia Key an institution like Woods Hole's Marine Biological Laboratory to bring people in basic sciences to work on tropical marine animals. So we will have a community approach to marine sciences, a community of laboratories--each of which will have its role.

Qualified persons in these other institutions, specifically those qualified persons who are actually interested in and engaged in cooperative programs, are added to our professorial ranks. In response to Dr. Pound's question, we do give professorial rank. We call them Adjunct Professors, Adjunct Associate Professors or Adjunct Assistant Professors. They have every privilege of the faculty of the University of Miami except that of tenure and that of voting on certain issues that concern tenure.

I disagree with some of the remarks that Dr. Long made this morning with regard to graduate students in a Federal laboratory, but I do note that what he said applied mainly to situations where the Federal laboratory was far removed from the university campus. These do not apply, in my view, to a community laboratory approach. Last year at the University of Miami we had some four hundred applications in the field of marine biology, and this does not include marine engineering, marine physical sciences, and marine geology. Of these four hundred applicants perhaps fifty had no business applying to any graduate school, but about three hundred or three hundred and fifty were bona fide graduate students that most universities would be happy to have. Of them we were able to accept twelve. This is the weak link in the whole educational cycle, at least in a new interdisciplinary field like marine science. We must do something

to expand the capacity for the training of Ph.D. students. The critical problems are not in the course work, for one can lecture just as effectively, at this level, to larger classes. Most of the courses are fairly small anyway. But by cooperation with Federal laboratories some students when they complete their course work are able to move out and go into thesis research with qualified adjunct professors and our total enrollment can be expanded. Among the many things that new students need is a place to hang their hat and call their own because we don't have the space to provide for such an increased enrollment. Therefore, the Federal laboratory must be prepared to provide some sort of student laboratory space for such students even while they are mainly engaged in course work. They need financial assistance throughout their graduate program and supervision of thesis research, the last perhaps being the most easily solved of the problems.

Federal laboratories also can provide, and do provide, at our Institution, special training in advanced courses. We have a framework within our University system that allows for special courses to be taught without going through the complicated procedure of introducing new courses, some of which are very specialized and not likely to be repeated, into the catalog. These courses are approved by the teaching division of the Institute of Marine Sciences and can be taught at any time that there is need for them.

The Federal laboratory benefits from high quality technical assistance that it gets in the form of graduate students. These graduate students usually put in much more time than is required. The Federal laboratories at Miami do keep their doors open on a twenty-four hour basis so we don't have that problem which was mentioned by other speakers. Students that are so trained may become especially aware of the needs of these agencies, and I think they are more inclined to seek employment with one. We also feel that, having Federal laboratories in such a situation, the problem that came up repeatedly in this morning's discussion, the problem of taking Federal laboratory personnel back to school to keep them up to date does not exist because such persons are constantly exposed not only to the University's staff but to many visiting senior professors and they can have contact with many graduate students and keep up to date with latest techniques.

There are problems. The problems that we have met are largely ones of uncertainty. If a commitment is made with a Federal laboratory to take on a student, we feel that, provided the student is able to keep up his course work and do good work, he should be with that institution for his life as a graduate student. Unfortunately what has happened is that, in some cases, a graduate student has been accepted, only to have the director of the laboratory decide the next year to put that assistantship somewhere else. The University then is caught with a couple of graduate students for whom it has no support. These difficulties must be overcome.

There are minor difficulties in inequities of pay and the like. There are minor difficulties in red tape procedures involving editorial policies with regard to dissertations when the student is caught between policies of two large institutions.

We need to have more flexibility in both systems. It isn't the system really that is wrong; it's the people who run it. The university professors are innovative, they are imaginative, they do come up with new ideas, and they are also very frustrated. With deference to my colleagues here on the panel, within the university system I have repeatedly found that most of the difficulties stem not from the high administrative officials, but with the deans and the department chairmen who will not change from rigorously set procedures.

I want to mention one other area I'm not so much involved in myself, but I think one that we should direct our attention to and which has not been mentioned. Both Federal laboratories and the Federal Government as a unit and the universities have some obligations that really are not part of either agency per se, but are part of the public good. For example, one of our big problems at Miami today is the development of a meaningful cooperative program with Latin America. These countries need technical assistance. They need to have persons with technical training, training received not in degree programs but in graduate level and special courses. So we hope for cooperation between the Fish and Wildlife Service and the University of Miami in inaugurating a new certificate program that will bring people from these countries to be trained for a year in special and applied procedures that they can take back to their countries. In this case, the State Department becomes a Federal agency with which we hope to be much concerned.

I think such a program also applies to the non-degree students from Federal laboratories. There are many people in Federal laboratories who don't want, or who are not qualified for an advanced degree program, but who would like to go to a university and update their techniques and procedures, and get a little more insight into the problems with which they deal every day. I think some sort of certificate program would increase the base of our knowledge and of our numbers of people involved in science without overburdening our degree programs. The certificate program we have great hope for in the future.

Thank you.

DR. HARTMANN: Now we go over to the so-called hard sciences, the natural sciences. We're going to hear from the academic representative first. Dr. Hoelscher is Professor of Chemical Engineering and also Dean of Engineering at the University of Pittsburgh. He assumed this post in 1965 after 13 years with Johns Hopkins University in Baltimore, Maryland. He received his Bachelor of Science in Engineering from Princeton University and his Ph.D. in chemical engineering from Washington University in St. Louis. He specialized within chemical engineering in problems related

to the design of chemical reactors and in transport processes. He published more than 70 papers in these and related fields, and more recently, has become interested in educational methods and university organization structures and management. Other technical interests include the processes of economic and technical development of the countries of Southeast Asia and Latin America. We may find that some of the advantages which are being extended to residents of Latin America can also be extended, for example, to individuals in Federal laboratories who are not interested in graduate training, but this is really excluded from the topic of this seminar. At any rate, Dean Hoelscher has had considerable interest in education abroad. He served two terms in India; the first for UNESCO and the second as Senior Fulbright Lecturer at the University of Madras. He is now involved in an AID sponsored project in Chile and shares responsibility with others at the University of Pittsburgh for projects in Ecuador and Colombia. So, Dean Hoelscher what do you think about graduate training of Federal employees or vice versa?

DR. HAROLD E. HOELSCHER (University of Pittsburgh): It is a pleasure to appear on this program devoted to discussions of the role of the Federal laboratories in science and engineering education. This is an important subject in our world today--a world dominated by technology in which the problems of education for effective participation in the development of new technology, as well as for the more effective use of those technologies available to us, must be a prime consideration for all.

I will direct my remarks primarily toward two observations. Firstly, those of us involved in educational planning must take into consideration the changing character of our Nation's research and development activities. Secondly, we must be aware of and prepared to respond to the changing character of university involvement in the technological base of our society.

In planning for the future of technical educational programs, a number of facts must be considered: For example, the very complicated and the recently alarming facts of decreased Federal funding of university research and development; the increasing complexity of research in physics, chemistry, the health sciences, and the engineering sciences, as well as the increasing number of new multidisciplinary challenges. The latter are exemplified by the urban problems of our Nation, the environmental problems, the problems and opportunities of the space frontier, and the problems and opportunities in international engineering development and the social and economic development of the emerging countries via development of their own technological bases.

In addition, we must be aware that the interfaces among the traditional technical fields of science, engineering, the social sciences, economics, history, and humanities, are as important in the solution of problems within the real world as are the individual disciplines themselves. These interfaces provide us with new challenges for which we are only partially prepared.

Finally, we must constantly be aware of the enormous need for scientists and engineers, particularly for new kinds of engineers who are equipped to cope with the complex problems of the real world about us. The demand seems to be increasing more rapidly than the supply. More alarming, the number of young people in secondary schools showing interest or even potential interest in technical careers is apparently decreasing.

In considering these problems, we must remember the history of the university in this country. The university is not a new device; its world history dates back at least five thousand years. For all but the last bit of that history, the university has traditionally been concerned with just three things: The acquisition of knowledge, the transmission of knowledge, and the storage of knowledge. The Land Grant Act of the last century added a fourth: Responsibility for the use of knowledge. This opened a Pandora's box of problems. It opened the need for schools of engineering, for professional schools of all kinds, in order that the product of science, knowledge and understanding of the structures and dynamics of the world within which we live may be brought to bear upon the problems of our society.

This presented a new kind of responsibility with long and troublesome reactions. Professional schools on the campuses of our universities only recently became respected academic siblings. More important, we have just recently come to understand that those in the professional schools must be prepared to interact with those in the classical academic areas, in political science, economics, and humanities. This is essential if their efforts to solve the problems of our world, to improve the structures, the social and economic conditions within which all live and work, are to attain ultimate success.

With all this as background, I will turn to the meaning of those two key words with which we are concerned today, namely, "research" and "development." If we consider science to be that activity of man concerned with the search for knowledge, and engineering to be that activity concerned with the use of knowledge for the solution of problems in the real world, then research is that process whereby knowledge and understanding are used for the creation of something new in or for the real world. Research is thus not the primary business of engineers. Rather, development is the primary concern of engineers and engineering, whether it be in an industry of one of the emerging countries or of the United States.

Obviously, research has become expensive. Development is not only expensive but an effort requiring an aggregation of many creative minds and supporting personnel focused on a problem which always has many, many facets.

There was a time when one engineer could supervise a major project and keep the entire problem reasonably well in mind. This was the case at the time of the pyramids, the engineering feats of the Roman Empire,

and even somewhat more recently. But this is no longer true. Today it is nearly impossible for any single engineer to do more than coordinate the many activities involved in any significant development process.

In a world where the cost of research increases by orders of magnitude and development efforts become so monumentally complex, it seems necessary that universities must undertake to reexamine their goals in these two activities. Universities find it difficult to compete with the major research and development centers of government and industry in either effort. Traditionally, the Ph.D. candidate does research to "make a contribution" in his dissertation or thesis, and his examination has usually turned to the significance of that contribution. I suggest that the significance of the contribution is often marginal, if not nonexistent, and that we cloud issues in our pretenses. I suggest that we must begin to recognize that the research requirement and the research dissertation are pedagogical devices. This is a part of the education of a graduate student. We must begin to recognize the process values of research.

If this is true, the situation with respect to development as part of the education of an engineer is even more a problem for the university. To meet our responsibilities in the education and training of graduate engineers in development activities, we must seek allies in those establishments with this capability. To do this, we will require a new kind of program. I would thus like to tell you briefly of a program which we are considering at the University of Pittsburgh's School of Engineering. I will refer to this as an internship-based doctoral program. The program might work as follows.

A student having completed the bachelor's degree in engineering or a student in the first year of graduate work might apply for admission to this program. If accepted, he would be expected to complete two full years of intensive course work. In the second term of the second year he would be given three one-month research assignments under three different members of the faculty, only two of which may be in his own department. The purpose of these will be to give him some exposure to and training in the methodologies of research, that is, the methods available for extracting information from physical systems.

If the student successfully completes this two-year program, he may then be admitted to the internship. During the first two years the student would need to be fully supported, since it would not be possible for him to serve as a teaching assistant, a laboratory assistant, or paper grader, as is presently standard in graduate study.

The internship program for each student would be arranged during his second preparatory year on the university campus. This would involve a member of our faculty with whom the student wishes to work, an employee of a Federal laboratory or an industrial research and development organization who is the counterpart of our faculty member, and a problem. One

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of the basic principles from which this plan stems is that there are many people in the laboratories of Government and industry who would be welcome additions to our faculty and whom we would be delighted to have as regular, full-time colleagues. Such a person would be identified as the host mentor for the student and would work with the member of our faculty in the development of the problem and in the guidance of the student's effort. We could easily offer the host mentor an adjunct appointment on our faculty.

During the period of the internship, the student would work with the host mentor in the Government or industrial laboratory as an employee of that organization on the problem previously identified and structured by the host mentor and the faculty mentor working together. The identification of this problem is, of course, a key part of this program. This should be a problem which is part of the ongoing work of that laboratory or industry, one to which the student can be assigned as a regular employee with responsibility for some piece of the total effort. Identification of such problems will require considerable faculty effort. Thus far we have identified potential host mentors in a number of Government laboratories and in several industries, all of whom have expressed an interest in this program and a willingness to serve in this capacity. Similarly, we have identified approximately two dozen problems in three departmental areas of the School of Engineering which could serve as the basis for the start of this program.

The triangular relationship among the faculty mentor, the host mentor, and the student would then be the operating unit for the internship program. After a period not less than one year and not more than two years on the internship problem, the faculty and host mentors would be asked to evaluate the performance of the student. If these two certify that the student has demonstrated the highest possible levels of creative ability in his work on this real-world problem and that he has made a significant contribution to the total effort toward a solution to this problem, the student would then be released from his internship to return to campus.

The student would be required to remain on campus for a period of not less than one term and would write, participate in seminars, and confer with members of the faculty about his problem and his work experiences. At the end of that term he would be given an oral examination and, if he passes, would be recommended to the Board of Trustees to receive the Doctor of Engineering degree.

There are obviously a large number of problems involved in making this program a reality. One which could be most difficult is the need for frequent communication among the student, the faculty mentor, and the host mentor during the internship. This would require funds to permit frequent travel of the student to the campus and the faculty mentor to the internship site. Equally difficult would be the identifying and structuring of the problem assigned to the student. This, again, would require considerable conversation between the mentors.

Strangely, the identification of potential mentors and the identification of potential problem areas has not presented us with serious difficulties. Considerable interest has been expressed by those in the Federal and industrial laboratories whom we have approached with this idea, and we anticipate no difficulty in securing their professional involvement. Some preliminary discussions with our own students have indicated a very high potential interest in this plan.

We think that this might be a worthwhile, new kind of doctoral program for our School of Engineering. We have no illusions that it will represent the program for a majority of our students. Rather, it is likely that we will limit this to approximately forty students at steady state, that is, approximately ten percent of our graduate-student group.

In conclusion, I think that graduate engineering education should be for research and for development and also for participation in the exciting problems of our day. To do this, some of our students must be exposed to the problems of the real world. To do this, we must find new ways to interact with the Federal laboratories and with the industrial laboratories of our Nation. Thank you.

DR. HARTMANN: Thank you very much Dean Hoelscher for a very interesting suggestion. I hope we'll hear some more about that in the discussion.

Now pushing on to the last member of the panel, we'll hear from Dr. James L. Youngblood, who was born and educated in Texas. All of Dr. Youngblood's degrees come from William M. Rice University. He worked as Research Metallurgist for DuPont from 1962 to 1966. Since 1966 he's been with the Manned Spacecraft Center at Houston, Texas, where he's Assistant for Academic Relations. He is responsible there for providing an effective interface between the Manned Spacecraft Center's scientific and engineering programs and the college and university faculty research and curricula.

DR. JAMES L. YOUNGBLOOD (Manned Spacecraft Center): Thank you Greg.

NASA has a variety of programs with graduate students, but I'm not going to list these.[1] I would prefer to go into another area which is of particular interest to me.

We at the Manned Spacecraft Center in contrast to the Smithsonian and some of these other organizations don't have a long history of participation with graduate students. In fact, we don't have a long history at all. I have been discussing graduate programs with a number of universities which involve bringing their students to the Manned Spacecraft Center and there have been a number of questions. Therefore I would like to address myself now to what I feel is the core of these questions.

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1 For a more detailed description of "Graduate Training at NASA Facilities" see Appendix A.

I was very pleased to hear Hal Hoelscher point out that the main business of engineering is not research. As I see it there are two different basic types of graduate programs. One type is the research program; the other type is an application or practice oriented program such as the M.D. degree and Hal Hoelscher's Doctor of Engineering proposal. Both of these are legitimate graduate programs and are to some extent quite different. I'd like to go through these differences and indicate the ramifications of these differences.

I'm going to talk about the applications phase of these programs and the research in the research program is the applications phase. The internship in Dean Hoelscher's program is the application phase for the Doctor of Engineering program. Medical students spend two years of class work and then two years rotating through the hospitals. The objective of the research-oriented applications phase is to allow the student to demonstrate his ability to conduct independent research. In contrast, the objective of the applications phase in a practice-oriented graduate program is to provide the student with an opportunity to function as a professional under the supervision of more qualified and experienced professionals. As I see it, it's a transition phase between the classroom and the laboratory. I'm using laboratory in a fairly broad sense here. The laboratory may be a group of lawyers for example.

Now, for the student in the research type program, the advice and counseling primarily should be by someone who is experienced in research. This usually, although not always, implies that the man has a Ph.D. degree. It also usually implies that the man belongs to the university. Thus, in a program which brings a student to the Manned Spacecraft Center to conduct research, we would expect that the primary responsibility for advice and counseling would be borne by the university. Secondary responsibility should be carried by someone carefully selected at the Manned Spacecraft Center, the host laboratory.

On the other hand the fact that a person comes to the Manned Spacecraft Center or any other host laboratory to obtain practical experience functioning as a professional indicates that the professionals in the host laboratory have a level or a type of experience not available at the university. This means that in general the primary responsibility for advice and counseling in a practice-oriented program should usually be borne by the host laboratory with the university looking over its shoulder.

As far as freedom and responsibility are concerned, the research student, trying to demonstrate his ability to conduct independent research, should be provided the freedom to call his own shots. This means that duties as assigned are completely inappropriate. He should be working on his project and the advice that is given should be general. It should be his own work. On the other hand, if a man is working shoulder to shoulder with other professionals in a practice-oriented program, then the objective is to do the same type of work that the other

professionals do. In many cases this may amount to "duties as assigned." We need to make sure that the duties which are assigned are professional level duties and that they are carefully planned to give the student the types of experience that he needs in this transition phase.

As far as facilities and support services are concerned, Dean Pound has already mentioned that in the research area the host laboratory has to have a continuing interest in the research that the student is doing. Otherwise you run the risk of not being able to get technician support, time on the computer, and so on. As far as the practice-oriented degree programs are concerned, I see no problem there. All that you have to recognize is that the host laboratory be able to use the services of a relatively inexperienced professional.

In the case of evaluation, for a research program this is usually based upon a developed dissertation. The evaluation is primarily academic. In the case of a practice-oriented program, the evaluation is going to be somewhat different. For one thing, the written activities that the student goes through in his program are not necessarily going to be in the form of a typical dissertation. They are likely not to be publishable. In a development project the primary documentation may be a piece of hardware. One should expect him to produce a critique of his experiences, but the rating will have to be much broader than just this critique. In the medical field there are very few written documents which the student can claim as a piece of his graduate work. Furthermore there are other factors which are just as important in a practice-oriented degree as the academic--such things as initiative, team participation and interpersonal competence. In these areas the host laboratory advisor should be better able to evaluate the student because of his professional experience than the faculty advisor whose skill is primarily academic.

Finally, it is important in setting up programs such as this that the student, the university and the faculty advisor, and the host laboratory and each supervisor in the host laboratory understand his particular role and responsibilities. Dr. Long mentioned this morning that the universities do poorly in applied research, and I think we can say that the universities do poorly in practice-oriented training. Dr. Kidd mentioned that development-oriented labs do not have close ties with the universities. I think these comments tend to go together. The universities are not oriented toward development. They have little to offer the laboratories and their programs are oriented more towards research. I feel that much can be done. Just as Dr. Hartmann mentioned that the medical schools have hospitals, I think the engineering schools, the legal schools and the management schools should look to Federal laboratories as a comparable situation to the hospitals for the medical schools. Thank you.

DR. HARTMANN: We have had a very patient audience of articulate people here who I am sure would like to say a lot and we've cut them down to

only about twelve minutes worth. So I would like to throw the floor open to questions.

DR. L. C. VAN ATTA (Electronics Research Center, NASA): I have heard a number of questions and problems mentioned, but there is one that I did not hear mentioned here today. That is the problem of patent policies interfering with relations between Government and universities. Is there anything that the panel could say on that subject?

DR. HARTMANN: Since we don't really have any industrialists present here, would anyone on the panel like to volunteer?

DR. ROBINS: This is an important problem that you've touched upon. It's one of the new areas that we are much concerned with in marine science because so much of the gear that is being developed is patentable. About the only thing that I can say is that this whole subject is now under very careful study and reevaluation in order to formulate a clear policy. But it has not yet been completed.

DR. HOELSCHER: We have of course run into this question. We ran into it very quickly when we began talking about this internship based program with people in industry. We have not heard anything major about it from the Federal laboratories we've talked with. I assume that this is because any patents would be in the public domain anyhow. However with people in industry the question comes up immediately. It normally takes somewhere between half an hour and an hour of conversation to realize that one can work one's way around this problem very easily. Of the three industries that we went to directly with the request that we set up this program, two have now agreed and the third says that it will. We started off with a no, we cannot do it for that reason, but it worked out very nicely along the line.

There have been a variety of answers. One of them was that we would have to delay; that everything would belong to the industry for as long as it is necessary for them to clear through their legal department. So that the industry would, of course, have the patent rights and we would as the university involved be expected to, and are quite willing to, recognize the proprietary character--but not forever. That is, we have to ask that in some time, six months or something, the student be free to talk about the work that he did, or some evaluation of the work that he did, or some phase of the work that he did.

DR. HARTMANN: Do we have another comment on the patent matter?

DR. POUND: I'm not sure that I can answer this for the University of Wisconsin totally, but I think it is the policy of the University of Wisconsin that patentable materials and information belong to the person discovering the information. They therefore become personal problems between him and any legal agency that he would be involved with.

DR. HARTMANN: That might not be the policy of the industry which is cooperating with your student. So I guess there's a problem all right. Are there any other questions?

DR. LAWRENCE J. EDWARDS (AF Rocket Propulsion Laboratory): I am somewhat disturbed when I recognize that there is an intermediate between the university on the one hand and a federally operated or owned laboratory on the other hand. We have in the middle a university which is federally owned; there are quite a large number of examples of Government-owned universities. I would like to invite consideration of some of the problems which tend to either disappear or become minimized by both the university and the laboratory being federally owned. We have in the Air Force the Academy at Colorado Springs. Also at Colorado Springs at the same location is the Seiler Laboratory. A very good relationship with good coordination and cooperation is evident between the two organizations. At Wright Field there is the Air Force Institute of Technology. Also there are at least five laboratories located there.

The Rocket Laboratory is located about twenty-five hundred miles from Wright Field, posing a potential deterrence to maintaining a well-coordinated working relationship between our Laboratory and AFIT. But in spite of these difficulties, in the last year we have gotten temporarily two of the AFIT professors from the engineering department, and also two graduate students, captains in the Air Force, who will complete their doctoral research in our facilities. I believe it would be interesting, in considering university-laboratory relationships, to examine the unique situation of the federally-owned university and laboratory. We ought to be able to learn something very useful from such an examination.

DR. HARTMANN: I don't know if that question was addressed to anybody. I'll just comment in passing that probably these graduate students were under orders of some sort, which also makes a rather unique situation.

DR. EDWARDS: No, quite the reverse. The student seeks an appropriate Federal laboratory in which to conduct his doctoral research. There are five Air Force laboratories on the same property at Wright Field with the University. Without considerable effort from another laboratory, the easy choice would be a local laboratory. Being 2500 miles away from the school, we must establish a good mutual confidence in technical and management abilities since the academic control is retained by the school.

DR. HARTMANN: Thank you. Are there any other questions?

DR. JOSEPH L. McCARTHY (University of Washington): I want to make a brief comment and maybe ask a question about the doctor of engineering degree. My view is that there is a real place for this, and we should get about developing this in an appropriate manner. But one of the really basic questions is the matter of proprietary interests, and I'm not talking about patent rights. I'm talking about freedom for discussion. I would like to ask Dr. Hoelscher if he would want to talk just a little bit more

about this. Perhaps the other gentlemen here would like to say something about this too. At least when a student goes into an industrial laboratory in a sense of the internship program that I believe you mentioned, I should think almost always there would be a question of a sort of proprietary interest in his activity and restrictions on his freedom to discuss them. It seems to me that this is a very basic question or problem. I don't think it is a problem in the Federal laboratories, except for military security. But perhaps one of the gentlemen can speak about this.

DR. HOELSCHER: I fully agree it is a major question. It is the first thing that came up in our discussions with industry in each case where we went to the industry to talk about this problem. As you say, it is not a problem in discussions with the Federal laboratories. All I can tell you is that after much discussion it was found, within the three cases that we're moving ahead with, that we could work our way around them. The industry has to agree that the intern, if we may call him that, is not going to be placed on problems which are, over a very long time, likely to be and to remain sensitive to that company. So there's some selection of problem type on the part of the industry. At the same time we have to give a bit and recognize that things which are patentable belong to the man and the industry. It might very well be that the industry will come to us and say: "Please delay discussion or publication of this for some period of time." We've agreed that six months is not an unlikely or an unreasonable period. It is a very big problem, but I think the game is well worth the candle. I think that the end result is well worth working at this kind of thing.

DR. McCARTHY: Just an additional sentence or two. I really don't exactly understand what you said as a response to what seems to me to be the primary question. The question really is: In the course of the work, and be it developmental work as well, how do you maintain freedom for discussion of that work as it goes on, so that other people can scrutinize it and it doesn't turn out to be an ex post facto question? How do you do that? I don't see it yet.

DR. HOELSCHER: Yes I did misunderstand. You're talking about the work as it is in progress.

It is quite obvious that this is a different thing entirely from the kind of university laboratory oriented research that goes on normally for the Ph.D. Here the man is immersed in the company, largely as an employee of the company. And he behaves like an employee of the company. His supervisor is a person whom we know and who has a very close relationship with some member of our faculty. And in fact will have a joint adjunct appointment on our faculty.

We will not have this man in his industrial job butt against the other graduate students in the school on a day-to-day basis, nor against other faculty in the school on a day-to-day basis. The visitations back and forth will be much less frequent, and I agree I wish it were otherwise.

We won't have the kind of day-to-day evaluation, the day-to-day contact, the day-to-day conversation between this student and other graduate students and other faculty that we enjoy and that is very important in the Ph.D. program. Does that answer your question?

DR. McCARTHY: Well, I respect whatever you wish to do. That is Pittsburgh's question. But I do think that from the point of view of long term academic policy, this is a thing that should not be given away. I'm talking about the day-to-day review and scrutiny of a graduate student, whether he is in a practitioner's program or a research program.

DR. HOELSCHER: I don't think we are giving it away. I think what we are doing is shifting the responsibility for it from the member of our faculty to the adjunct professor who is a permanent or full-time employee of the company.

DR. HARTMANN: I don't know if anyone would like to defend the Federal laboratory as a place where interdisciplinary contacts are made on a daily basis with the opportunity to discuss and review one's work with all levels of people?

DR. HOELSCHER: If so, I would hope that they would equally well defend the R&D laboratories of the major industries of our country who are doing the same.

DR. HARTMANN: I'm not excluding them. We were just talking about Federal facilities. Is there another question?

ENZI DeRENZIS (Atomic Energy Commission): Dean Pound mentioned the acquisition of a lecturer appointment for the adjacent laboratory at the university, and Dr. Wallen mentioned joint faculty appointments. My question is: When a laboratory scientist is functioning as a lecturer at the university, does the university pay him for that service?

DR. POUND: Again, I'm not sure that I have total information, but I believe they do not. They have not historically done this.

DR. WALLEN: In our case, it works both ways. Sometimes the university pays, sometimes the institution pays.

DR. ROBINS: In our case, the Federal laboratory assumes responsibility for the person's salary, just as we assume responsibility for our professor's salary when he goes over and lectures to the Federal laboratory.

DR. HARTMANN: So the answer is "It varies." I will stop the questions now and let you look forward to the coffee break. I thank the members of the panel for their interesting presentations.

PART II: TRAINING IN FEDERALLY RELATED CONTRACT LABORATORIES

DR. IRVING: The first part of this afternoon's discussion concerned training in Federal laboratories. The panel that is on the stage now is going to consider training in federally related contract laboratories.

To moderate this panel we have Dr. Willard F. Libby who is a Coloradan and holds undergraduate and graduate degrees in chemistry from the University of California. Dr. Libby is internationally recognized for his research in physical, inorganic, nuclear and radio chemistry; and equally well noted as a university and research administrator. He has a long list of honors, capped as most of you know when he was named Nobel Laureate in Chemistry in 1960. He has been Professor of Chemistry at the University of California at Los Angeles since 1959 and has been Director of the Institute of Geophysics and Planetary Physics since 1962. Dr. Libby, the panel is yours.

DR. WILLARD F. LIBBY: The plan for using the Federal laboratories as part of graduate training has been well described in the previous session, so I shouldn't speak about that aspect of our subject. I would like to say however that I have personally found this plan very, very helpful. I have three graduate students finishing this year. Two had their thesis papers published with a co-author from the Standard Oil Laboratory in Linden, New Jersey, and the third one has a co-author from the University of Colorado High Altitude Observatory, the Department of Astrophysics. A postdoc finishing this year worked two of the last twelve months at the National Center for Atmospheric Research in Boulder with one of Dr. Roberts' colleagues. Students now in the works include one whose thesis paper will bear three names; his, mine and our outside collaborator. So I thoroughly recommend it. It is not only in engineering that it will work; it works in pure science--at least insofar as chemistry is pure.

What I see as the main advantage of the national laboratories, and by these I mean Brookhaven, Argonne, Los Alamos, Oak Ridge, the Jet Propulsion Laboratory, the Stanford Linear Accelerator, the Lunar Receiving Institute, the National Center for Atmospheric Research, Scripps, Woods Hole and so on, is something that wasn't mentioned at all in the earlier session. I found the earlier session very valuable, but nobody mentioned one of the great values and purposes of these labs. And I'm sure that what I'm about to say applies almost as well to the laboratories that were discussed earlier. This is the fact that much experimental equipment these days is too expensive for the universities. The country, even as rich as this country is, cannot afford to equip every campus with all of the tools for giving graduate education. We all can recite a long list. We think of the high energy accelerators for the study of nuclear physics. We have at Brookhaven, at Berkeley, at the Lawrence Radiation Laboratory, at Argonne, at the Stanford Linear Accelerator, and soon at the Weston Laboratory, a whole host of facilities

which cost tens of millions of dollars at the very minimum to build and which have budgets that rival the total budgets of a first rate university. We can't afford more than a minimum number of such giant machines, and yet there is no other way to study nuclear physics. So we simply have to have national laboratories for this reason if for no other. I would add the facilities furnished at the Jet Propulsion Laboratory, for example, and the Manned Space Flight Center, in the form of space probes and satellites. These are all things which are beyond the capabilities of individual universities and which we can enjoy by sharing them through a national laboratory. So I think one of the great functions of these federally related contract laboratories is to make available to the graduate students and professors the opportunity to work with these fantastically expensive machines. Who knows what lies in the future, but already we know that there's a whole series of subjects you cannot teach unless you have these facilities.

I omitted to mention the research reactors. Research reactors are too big for most schools. There are only two reactors in the whole state of Colorado. Only one at the moment, as I understand, is running. That's in a Federal laboratory in Denver. We're planning and hoping that the State University at Fort Collins will get one. Nuclear engineering is a very important part of engineering these days. With atomic power becoming one of the truly great businesses of the world, we really must teach it. Yet these reactors are so expensive that for just the expenses of running some of these great machines, the housekeeping gets to be a major consideration.

So if I can take my student to some place and tie up with Dr. X there and we make an arrangement, it's a relief to me and it's an opportunity for him. He gets a better education all the way around. If we are going to run say giant ears for listening to radio waves from outer space, which was the problem that I collaborated with Dr. Warwick of the University of Colorado on, we have no business, a chemist, you know, in that. Yet we had some chemical reason for listening. And it was possible by virtue of Dr. Warwick's great experience for a student to actually work in the chemical application of radio astronomy. So one of the main things about the national laboratories, as I see it, is to make it possible for us to have these facilities.

I was a member of the Atomic Energy Commission when we really launched the high energy physics program in a large way. And one of the things we worried most about was: "Is it practical to share a 30 bev accelerator two hours away on Long Island? Is it really possible to share that giant facility? You know the professors aren't all going to move to Long Island and bring all their students with them." There was quite a long time before we could see our way through this, but I think there is something of a moral in the way we found. The way was the following. There was a discovery made at about this time which was known as the bubble chamber. This liquid bubble chamber made it possible to photograph in intimate detail the ultra high energy collisions which the high energy

physicists are most interested in studying. This made it possible, by using good photography and good lighting to photograph these events, to make available the photographs and therefore to solve the logistic problem of transporting the professor and his graduate students to Brookhaven. This isn't to say that all of the discoveries of nuclear physics have been made with bubble chamber film. But I do say the majority of them in the last several years have been made in this way. A lucky break that it was possible. Programming a machine to store up and take these pictures makes it possible to produce so many pictures and so many different experiments that it would take all the graduate students in physics in the whole world just to look at them with the attention they deserve. And now with the proliferation of machines, the SLAC coming on line, and with Weston over the horizon, it is quite clear that this marvelous technique will continue to serve us well in graduate education.

Call it the Users Group Procedure. When a machine is first planned, this is the way it goes nowadays, as I understand it. When a machine is first planned they start organizing the Users Groups and they get in on the specifications. One of the things we learned in building accelerators was that we never give enough experimental room and facilities. We always had to go back and practically double the initial capital investment in putting in experimental facilities. But the Users Groups now get in extremely early and they work with the machine operators, and the machine operators learn from them what kind of things they need and what experiments of interest there are to be done. They meet and periodically lay out what film they're going to take. I am familiar with two Users Groups, one at UCLA and one at the University of Colorado. I understand that these are pretty typical of all the Users Groups. They have several, maybe a dozen or so graduate students associated with one or more staff members. This is the Users Group. The AEC finances them for their work associated with the high energy physics program. And they feel they are an integral part of the activities of the whole laboratory. One given group can belong to several different laboratories. The one at the University of Colorado belongs to Brookhaven, Argonne, and Stanford--maybe others but at least those three. And they're getting film from all these different places. Now it isn't to say that the students don't go visit some times and it isn't to say that a professor doesn't spend considerable time on the road visiting these laboratories, but it is a viable system which brings to the campus the benefits of these great machines.

A similar application, I think, is the device NASA has invented in the senior investigator based in a university. A senior investigator in a university takes on some aspect of a satellite or space probe and develops the instrument and technique working together with a NASA scientist. We have had quite a lot at UCLA to do with the Jet Propulsion Laboratory which sends the space probes such as the Mariners and Surveyors. They will have an experiment, say, to measure the magnetic field and our university professor will help develop the magnetometer,

and then perhaps half a dozen or more graduate students will work on various aspects of this. It proves to be a device to bring to the campus some of the benefits of this extremely expensive experiment. Another example in the space field is the vast amount of data available from earlier probes and satellites. We have now in the World Data Bank piling up enormous amounts of information unlooked at. I would venture to suggest, maybe somebody from NASA will challenge this, that over half of the data taken from satellites and space probes have never been looked at by anybody. Any challenge?

UNIDENTIFIED SPEAKER: Including the principal investigator?

DR. LIBBY: Including the principal investigator.

UNIDENTIFIED SPEAKER: And we give them two years to look at it and if they don't we make it available to anybody?

DR. LIBBY: Yes. Now there's the point. We have an enormous backlog of stuff that's piled away there for somebody to study in the future. And I think we can see how solutions will come to this apparently insolvable problem.

I think we can see that the furnishing of these special facilities is a function of the national labs which is absolutely unique. I'm all for the expansion of the campus that was outlined in the first part of the program. I think that's great and the giving of the students broader experience. I think that's just fine. But there is this special function of these laboratories which we must always bear in mind. I am particularly impressed with the newer laboratories that are being built now and how it is kept in mind that they must have these relationships with the university and they must be fruitful and profitable and meaningful to both parties, not just to the university, but also to the agency. In fact I'm a very firm believer in the theory that every agency, particularly the mission-oriented agencies, should have close relationships with the universities. As a member of the AEC I did absolutely everything I could to promote that program and I think it has been one of the strengths of the AEC. I only say about NASA, I wish you had done more. What you've done is fine. Ten times more would have been better. And we must constantly keep this in mind.

I note with some interest how the National Science Foundation is being turned into a mission-oriented agency whether it likes it or not. It may end up that all we'll have are mission-oriented agencies. I wouldn't go so far as to say we shouldn't have a pure National Science Foundation, but I do say that NASA, AEC, ESSA, all of the mission-oriented DOD agencies, should be allowed to develop this partnership with the

universities. As we build these labs which are for some specific purpose--for instance oceanology that's just coming over the horizon--we should plan in each instance to maximize the opportunities for graduate education. It isn't possible in this modern day and age to train a scientist in all fields on the university campus. In some fields it's still possible to work entirely in the laboratory on the campus, but in other fields it isn't. So we need the national laboratories, the federally related contract laboratories, for this purpose if for no other.

Now I'll call on our first panelist this afternoon, Dr. Walter Orr Roberts. Dr. Roberts is a much honored and respected scientist. It is difficult in a short time to do him justice. He is presently the President of the American Association for the Advancement of Science, and President and Chief Executive Officer of the University Corporation for Atmospheric Research. He is founder of the High Altitude Observatory and founder and first Director of the National Center for Atmospheric Research. Father and builder and inventor and protector of the most beautiful Federal building in this country, that of NCAR at Boulder. It's a real pleasure to ask Dr. Roberts to speak to us.

DR. WALTER O. ROBERTS (University Corporation for Atmospheric Research): Thank you very much, Bill. It's a pleasure to be here and to talk for a few minutes about the University Corporation for Atmospheric Research--and about the National Center for Atmospheric Research (NCAR), the laboratory that the University Corporation for Atmospheric Research operates.

Our field of interest is atmospheric research, and it embraces in principle a wide range of things: meteorology, aeronomy, solar terrestrial relationships, the solar atmosphere and planetary atmospheres. Of course, in practice at NCAR, we have chosen to emphasize only a few selected areas within the broad range of atmospheric science. It would be impossible with finite resources of people and dollars to do otherwise. Atmospheric science is by its very nature a complex, interdisciplinary affair. It involves not only astronomy and meteorology and physical oceanography, but also makes heavy demands on chemistry, physics and mathematics, and even at times requires us to concern ourselves with sections of law and economics. It cuts across the interests of a great many Federal agencies; for example, the Department of Commerce, with its major responsibility for weather forecasting concentrated in ESSA; the Department of Transportation, with its responsibilities in air operations just to mention one area of its interest in atmospheric science; the Department of the Interior, with its water resources and weather modification interests; and the Department of Agriculture, with interests in hail and in climate. There is also the Department of Defense, with its so many obvious interests in military aspects of the atmospheric sciences; Health, Education and Welfare and its concern with air pollution; NASA, with its obvious interests; and the NSF, which has had historical specific responsibilities in the field of weather modification, and which now has been given broader responsibilities in applied research.

I certainly agree about the necessity for each of these agencies to have strong Federal laboratories and for them to maximize their participation in the process of graduate and undergraduate education. Certainly in our field this is very much the case. In atmospheric sciences, moreover, every single scientific advance--I suppose this is true in every field, but it seems even more evident to us in atmospheric sciences--every scientific advance cries out for application (and very often is affected by great pressures for premature application). The National Center for Atmospheric Research came into being in this environment. I'm not sure, to use Don Hornig's words this morning, whether NCAR is an "almost-Federal" laboratory, or whether it's an "almost-university" laboratory. Technically it's a nongovernmental organization under the control of a private corporation, the members of which are twenty-seven universities spread all over the United States. The National Center for Atmospheric Research is also in a close and intimate sponsor relationship: it is sponsored by a Federal agency, the National Science Foundation, which provides most of the support to the laboratory under Federal contract. NCAR represents one of the great variety of forms that characterizes the support of research and related engineering in this country; a variety that demonstrates this nation's unique and flexible approach to problems.

NCAR has broad aims in basic sciences. Our purposes are principally these: First, to do basic research on the broad, complex, major problems of the atmosphere, some of them global in nature and almost all of them requiring long-term efforts and major commitments of engineering, logistic and scientific talents. It's obvious that to make progress in this field we need close coordination and cooperation with Federal agencies. We also need to set firm priorities so that our energies are not dissipated in too many directions.

NCAR's second purpose is to provide facilities that are too complex to manage and operate, or too costly for a single university department of atmospheric science to build or acquire. Again, the need is obvious for close relations and close coordination with Federal agencies, and for establishing priorities as to what to build and what to operate.

The third major goal is to provide a meeting place for the scientific community, principally the university scientific community, to plan major cooperative programs.

I had almost thought that I was going to talk today about one of these--a national hail field experiment--instead of more generally about the Laboratory, because this program is a good example of difficult planning, interagency rivalries, conflicting university interests--in short, a beautiful example of the variety of problems that we face in atmospheric science when we launch a large, complex effort. But I decided not to--nor to talk about the various experiments that will be parts of the Global Atmospheric Research Program of the 1970's. Each of these is an example of the kind of atmospheric science program that can be carried out by no one university, not even by a small group of

universities, but which instead requires the coordinated efforts of Federal agencies, of the universities, and of the National Center for Atmospheric Research.

I think also as a national laboratory NCAR has an intangible responsibility to stand as a visible symbol of the collective commitment of the universities of America to a major national goal. NCAR is different from many of the FCRC's in that it is university-controlled. It is under the control of twenty-seven university members, each of which names representatives to the corporate group that governs the Laboratory. The Laboratory is becoming increasingly problem-oriented while university efforts, I believe, are generally discipline-oriented. There are some interesting aspects of this that deserve discussion. NCAR is committed to university interests, and it carries out this commitment through cooperation. I might say this isn't so easy. Someone this morning alluded to the difficulty of boundary between Federal laboratories and universities. There must be bona fide cooperation in attacking important problems, and not cooperation simply for the sake of showing cooperation.

The relations between NCAR and the university community also involve an element of competition--competition for outstanding scientific talent, and competition to bring about a sound approach to research problems. I might say that it's been an inspiration to me that a laboratory like ours, competing for some of the same talent that is so scarce and so necessary in the universities, has received the complete support and endorsement of the member universities in urging us to go out and compete as hard as we can for the available talent. The universities believe that this kind of competition for manpower and even for resources will ultimately upgrade the quality and the scope of the work in the universities as well. I might say, however, that it's necessary for us to be restrained in this mode of competition. We cannot, for example, compete by going out and buying scientists away from the universities on the basis of salary.

Let me now list some of the many specific ties that can exist, and in our case do exist, between universities and a national laboratory. If there is any time in the questions later, I'll be glad to enlarge on any of them.

We have a program of affiliated professorships, where members of the NCAR staff may associate themselves with a university department and participate in university affairs. We have an extensive postdoctoral program. We have advanced study seminars that involve Federal laboratory people and industry people, as well as our own and university people. We have summer training programs for graduate students in the use of aviation and computer facilities. We have facility advisory panels, with Federal representation as well as university representation. We have quite a number of joint research projects, some small, others more extensive. One very small joint venture, for example, involved a single

graduate student who was interested in an idea of Bill Libby's about the circulation of the atmosphere of Venus. We have in our laboratory the computer, the software, and the numerical model, and we had the interest to help Dr. Fabian do an experiment that would have been very difficult for him to do without the existence of a laboratory like ours, with its capability and its interest. We also have big cooperative programs, like a program in cloud dynamics jointly with the University of Nevada--big programs that require years of cooperation and facilities like the De Havilland Buffalo turboprop airplane used in that program. We have programs of leaves and visits. We have NCAR fellowship recipients who have summer jobs at NCAR, after which they are supported in a year's graduate study at the institution of their choice. We have the possibility of Ph.D. thesis supervision at NCAR, and already have had something like twenty-five cooperative doctorates awarded. We have frequent and detailed consultations between NCAR members and members of the university community. So I feel that our pattern is a successful and an exciting one, and I'm pleased to have had a chance to talk about it for a few minutes today.

DR. LIBBY: Our next panelist is Dr. Paul Gilles of the University of Kansas. Dr. Gilles did his graduate work at the University of California in Berkeley and his undergraduate work at the University of Kansas. He returned to the University after finishing his doctorate work and has remained there since, rising rapidly in rank, maintaining relations with the national laboratories and with industry. He'll tell us today about some of these relations.

DR. PAUL W. GILLES (University of Kansas): Thank you Bill.

My purpose is to present a description of successful cooperation between the University of Kansas and Argonne National Laboratory in high temperature chemistry research. This cooperation has extended over a period of fourteen years. Instead of using the word interaction as Dr. Long did this morning, I use the word cooperation. The other person involved in most of these endeavors is Bob Thorn of Argonne National Laboratory and he is sitting down here in the second row.[1]

Now, that we should cooperate was natural. Bob's interests were in high temperature chemistry, my interests were in high temperature chemistry. Bob's work was supported by the Atomic Energy Commission through its Division of Research. We might entitle this talk, instead of cooperation between two agencies, "It Works," for indeed the procedures and the cooperation have worked.

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1 Appendix B is a Joint Report by Dr. Gilles and Dr. Thorn entitled "Cooperation Between Midwestern Universities and Argonne National Laboratories" submitted December 13, 1967, to Argonne Universities Association.

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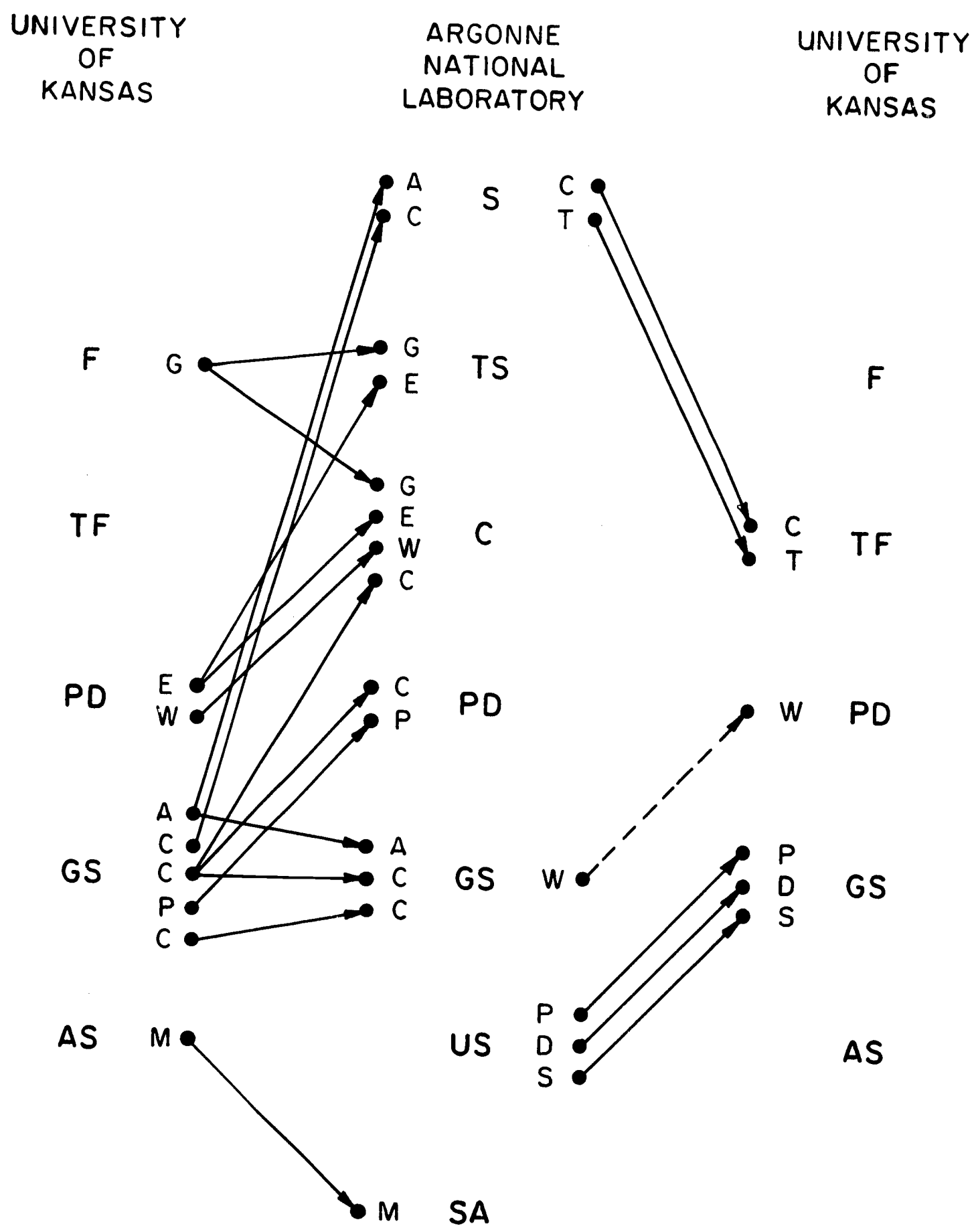
Figure 1 shows in the two columns on the left and on the right the various positions in the University of Kansas that we choose to discuss. In the middle column are various positions existing at Argonne National Laboratory. The symbois in the outer columns stand for Faculty, Temporary Faculty, Postdoctoral, Graduate Student, and Assistant. Those in the middle correspond to Staff Member, Temporary Staff, Consultant, Postdoctoral, Graduate Student, Undergraduate Student, and Staff Assistant. The directions of the arrows indicate the directions that people have gone. The first one is the one that begins in the upper left, Faculty with a G. That corresponds to me. In 1954 I spent a summer at Argonne. On the right at the upper left are two diagonal arrows down toward the right; one labeled C the other labeled T. The first one stands for Bill Chupka, a physicist at Argonne who was a Visiting Professor at the University of Kansas a few years ago; the other one stands for Bob Thorn who was a Visiting Professor at the University of Kansas last year. The other arrows also correspond to people. Most of what I shall say pertains to the graduate students near the lower left. These are individuals who were graduate students at the University of Kansas and who completed their graduate work at Argonne.

Let me point out one of the most significant features shown in Figure 1. The arrows go both ways. People have gone from the University to Argonne and from Argonne to the University. Graduate students at the University have gone to Argonne as graduate students. Other graduate students have gone from the University to permanent positions at Argonne; others have gone to other institutions yet have maintained contacts with Argonne. Argonne has encouraged graduate students who were participating at Argonne in undergraduate programs from their own undergraduate colleges to continue graduate work at the University. And the dash line on the right indicates that Phil Wahlbeck, who was a graduate student at the University of Illinois, had his postdoctoral position at the University of Kansas suggested to him by our Argonne friends.

I'd like to suggest to you some specific accomplishments that we have made under this arrangement. Individuals have been trained; scientists have been attracted to the field of high temperature chemistry; we have numerous joint publications; we have jointly sponsored meetings; and we have participated in the calibration of optical pyrometers and in some other scientific projects.

May I summarize for you what I think are the essential ingredients for success in the kind of program that we have had. First, the students have been excellent students. Second, the attitude that we have taken is the following: "I do not send students to Argonne. I take them." The significance of this remark is that our relationship has been a three-way relationship. Bob and I and the student have worked jointly. We three have jointly decided on the problem. Bob and I have been codirectors of equal status as far as the student is concerned. I visited the laboratory every three months or so to get a view of what was going on. The student reported to me every two weeks or so. Bob served on the student's

FIGURE 1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advisory committee at the University and also on his thesis committee. In addition to our mutual interest and our joint participation, we were benefited by very favorable administrative arrangements, and we had good personal relationships among us all.

As we look toward the future, we recognize other possibilities. The relationships between a university and a national laboratory should not be a one-way street. Figure 1 indicates that we have been successful to a great extent in providing a two-way street for our cooperative endeavors. We have tried to think of the University and Argonne in as reciprocal a way as possible, and when we try to put reciprocity into our notion, we come up with some new ideas. Some of these are shown in Table 1.

TABLE I

POSSIBILITIES FOR NEW COOPERATIVE PROGRAMS BETWEEN UNIVERSITIES AND NATIONAL LABORATORIES

Codirection, Graduate Student at University

Codirection, Postdoctoral at Laboratory

Codirection, Postdoctoral at University

Internal Codirection, Postdoctoral at Laboratory

Experimental Courses at Laboratory

Refresher Courses at University

Short Appointments at University

Short Appointments at Laboratory

Traveling Professorships at University

Professorships at Laboratory

Exchange of Administrators

Continuing Education

Joint Committees

Joint Monographs

Joint Seminars

These are some of the programs that we have in mind for the future. We think of two people--one at a university and one at a national laboratory--participating in a codirector arrangement with a graduate student at the University. In addition, codirection of postdoctoral work at a laboratory can occur, and we think it can occur effectively. It is desirable for a postdoctoral to have a relationship with a university.

Codirection of a postdoctoral could occur at the University. In order to stimulate interdivisional activities at a national laboratory, codirection of postdoctoral at a laboratory could occur with the two directors being in different internal divisions of the laboratory. Moreover, experimental courses could occur at the laboratory and refresher courses could occur at the University.

Short appointments can exist at the University. Short appointments can exist at the laboratory. Traveling professorships for Argonne personnel could occur such that the individual would travel around to various universities. Professorships for university individuals could be held at the laboratories. Possibilities for joint monographs and joint seminars are obvious thoughts. We have even been so bold as to suggest that the institutions might exchange administrators for limited periods of time. Joint committees can be effective and we recognize the possibility of continuing educational programs.

We look forward to continued cooperation between the University of Kansas and other midwestern universities and Argonne National Laboratory. We look forward eagerly to working with Dr. Miller, Dr. Roberson, Dr. Poor, and Dr. Pierce, as we have worked previously with Dr. Boyce, Dr. Simpson, and Dr. Manning. Our hope is that the arrangements will be sufficiently fluid so to allow the insight and the ambition and creativity of scientists to flourish.

DR. LIBBY: We have as our third panelist the Provost of the University of Arizona. I knew Bowen Dees when he was here in the National Science Foundation. He has had a long experience of administration in the Government. He has now rejoined academia. I'm sure that he will have some interesting things to say to us, having seen both sides of this coin very closely. Dr. Dees.

DR. BOWEN C. DEES (University of Arizona): Somebody said this morning that universities couldn't be innovative. Dr. Gilles' remark about letting administrators flow back and forth strikes me as being the innovation of the day. The innovation inherent in the topic of this session is another one; Federally Related Contract Laboratories are frequently referred to (as Walter Roberts pointed out) as FCRC's--which, for some of you, will mean Federal Contract Research Centers or national laboratories. Let me say that it seems to me one of the things that we need to worry about in connection with this kind of a discussion is not this question of terminology or even precise definition, but the question of what kinds of organizations, over time, we are going to see develop in this whole domain.

One of the things I want to mention is the importance of thinking both in terms of the immediate future and the fairly long-range future. We are not simply talking about how things might be done in 1970. We

should be talking also about the year 2000. If we do think in these terms, it's quite clear that we are going to see new laboratories come on the scene. Surely, over time, we are going to find that there will be new laboratories needed--and they will be created. In part, my plea would be that--as we see these new needs coming on, as we begin to plan for meeting these needs--there should be the same kind of thought given to the ways in which these units can fit well into the university, Federal, or federally related pattern that is being given to such studies as the one that Walt Roberts referred to a few moments ago as "a project for the late 1970's." It is clear, for example, that if we are to see a policy develop that will maximize the connection, in a useful and profitable way, between the universities of this country and the various kinds of federally related or federally supported laboratories, that we're going to have to do it a bit differently from the way it has been done in the past.

When I came to Washington some seventeen years or so ago the word "planning" was essentially a naughty word. Nowadays, it is perfectly clear that, more and more, the ideas that emerge from such terms as planning, programming, systems analysis, etc. are inherent in the thinking of national leaders--and that there will be planning on a basis other than simply reacting to the needs one sees developing at a given moment. Part of what this means is that there will be need to think further about some of the kinds of organizational interactions that we've heard about today and that have worked very well in a broader context.

This session is supposed to be focusing its attention on the federally related laboratories, but many of the problems such entities face are precisely the same as those which confront Federal laboratories themselves. A good many of the "rules of the road" are actually more restrictive in some of the national laboratories than they are in the Federal setting, at least in terms of the particular rules as they are interpreted by some of the governing bodies of the federally funded (but nominally independent) organizations. Their rules can be changed more easily, but nonetheless there are now quite a few "strings" tying the hands of the personnel in some of these organizations.

I'm reasonably sure that we are going to have a larger range of interests represented in the federally related laboratories in the years ahead. Chuck Kidd mentioned this morning the fact that we are going to be moving more and more in the direction of the social sciences, in the direction of multidisciplinary activities which will involve the social and the natural sciences, and in particular we're going to be moving in the direction of laboratories that can help us get a handhold on some of the major societal problems that we face. The universities are and must continue to be vitally interested in all of these problems and the ways in which they can best interact with the federally-supported centers in terms of using their facilities as training grounds for graduate students or their faculty members.

I want to mention one particular area in this domain, mainly because I would not wish it to go unmentioned and thus far it has not been. I note from the list of participants that we have with us two representatives from the regional educational laboratories that have been established under the auspices of the U.S. Office of Education. These research and development centers in education, I submit, represent one of the kinds of federally supported laboratories that we are going to have to find new and vital ways of relating to our campus interests.

Much is made in a lot of the literature in this general area about the greater efficiency that can result if one finds ways of using national laboratories (or Federal laboratories) in ways such as those we've heard described today. Since one can define the word efficiency in this context pretty much as one likes, it is clear that you can use it in a way that is unexceptional. However, I think that many people in speaking of efficiency in this connection make a mistake which can be a serious and important one. That is, they are simply looking at a cost accounting kind of efficiency without thinking in terms of questions (which are far more significant) of long-range, really fundamental, efficiency of education and the educational process. We should not just be interested in trying to find ways of saving money through the use of these laboratories. Rather, we should be trying to find ways of making the best educational use that we possibly can of the total national resource.

Finally, harking back to one of the points that was mentioned earlier today regarding continuing education, I submit that graduate training at the laboratories we're discussing can be provided by the universities for some of the staff members of the laboratories. Many of the units that ought to be thought of as falling within this very broad spectrum of national laboratories are finding difficulty in getting the kind of relationship with a university that they would like. I know explicitly of one case (not a laboratory in the strict sense of the word but a military installation which employs a large number of technically trained people) where they are having very serious difficulty making arrangements for the kinds of advanced training for some of their people that they would like. Here I am saying to my colleagues in the academic group that I think we have some things to do on our side in finding better ways of writing our rules that will enable us to be of greater service to the staff members of Federal installations, federally-supported laboratories, or other comparable organizations.

Thank you, Mr. Chairman.

DR. LIBBY: Our last panelist is Dr. Christian Anderson. Dr. Anderson has for a number of years been the Assistant Director of the Brookhaven National Laboratory in charge of scientific personnel and university relations. Dr. Anderson.

DR. R. CHRISTIAN ANDERSON (Brookhaven National Laboratory): Dr. Libby. Gentlemen. I am pleased to present to you the pathetic remnants of what four hours ago was a reasonable contribution to this meeting. I am caught on both sides by having listened to Frank Long this morning who is the interim President of the Associated Universities, Inc., which runs Brookhaven for the AEC, and caught on the other end by the fact that on the program tomorrow, Jack Miller of Columbia will talk about Brookhaven National Laboratory. But beyond that it seems clear with the lateness of the hour that I'd better talk about something completely different.

I'm going to speak for the graduate students who are conspicuous by their absence. Now I may not be qualified to do so because I am clearly over thirty and I have been told by many of my very young friends that I'm also too old for a beard. I think it's quite true that our Federal focus is on a grand scale and we are usually involved in making profitable the obvious wealth of facilities we have in the United States. But we should not be talking about the training of graduate students. They are not merchandise, even if marketable. And we must be careful to avoid using graduate students either to ornament a laboratory or perhaps to stimulate an aging staff or to buttress up the reputation of a university professor. If our students go to the barricade, perhaps I'm going to be tempted to go with them. We are looking down one end of a very long pipe, and, as members of administrations with such concerns, we tend to forget in graduate education that we are dealing with young people between six-teen and twenty-six whose own requirements, whose own views, whose own expectations, must somehow be satisfied.

I will necessarily, of course, have to talk for a minute about Brookhaven to introduce what to me will be the one small point of my talk. I think we have to look at the connections that graduate students have with institutions other than the schools in which they are enrolled and will speak to this point specifically in terms of Brookhaven. That Laboratory, as you are all well aware, was created by professors whose sympathies lay with the academic mode of science. We've had descriptions by Dr. Roberts of his institution which precisely describe the creation of Brookhaven, what its purposes were and are, and the means by which we have made these things come to some fruition. It's staffed just as a university is and we offer a wide variety of appointments to visiting scientists, to students, both graduate and undergraduate, and to many postdoctoral research associates. To give you an idea of how large this interaction is, at the moment Brookhaven's own scientific staff numbers 450 odd; while, at the same time, over 1200 appointments are out to individuals, both faculty members and students from other institutions who, however, are not in residence at every moment--this would be a formidable undertaking. But they do come to the Laboratory, either to pick up the bubble chamber film that Bill Libby mentioned, or to come during the summer, intermittently or during other school recesses. They come because some critical part of their own work, or some interest generated on their part, could only be satisfied by being at Brookhaven.

We are often asked to tot up the manhours of interaction as if the measure of a man's time was a measure of his interest and the results of his investigations. The interaction is intense; it is productive. But I can speak very little more about this at the moment.

It has been true at Brookhaven that the number of resident graduate students has been small. We've spent much of the day pointing out the reasons for this. On the other hand, the number of students that come to Brookhaven to do work for their theses, who come with members of users groups is very large. It runs in the hundreds.

With this experience stretching over some twenty odd years, there are certain things we think are important and might be useful to note. We take it, or I take it--I'm a little old fashioned--that there is some merit to the nineteenth century idea of a university as expressed by Sir Eric Ashby in a recent article in Minerva, to wit, that it is pre-eminently a community of scholars. We have found today that perhaps the university is not what we thought it to be. The students are certainly suspicious of that. A laboratory such as Brookhaven, has to be in some direct and concerned way related to that concept of the university.

The laboratory has to be large enough and good enough to have a culture of its own. This is a famous phrase of Bill Baker at Bell, and it says everything that need be said about the issue. Because if that condition exists, then the condition exists whereby students can benefit from being in such an organization.

The exchange of students and faculty must be smooth. There must be an impedance match between the quality of the university faculty and the atmosphere to be enjoyed in the universities, and that of the laboratory staff and its culture.

This does not say that formal contractual relationships between the university and laboratories should exist. I rather believe this latter is, in many cases, a serious mistake, as it leads to a sterile confrontation between administrators and their lawyers. I take it to be of deep importance that Brookhaven has dealt and, hopefully, will continue to deal with individuals and not with their institutions.

For us to have such a large amount of interaction with the academic community, we have had to make large adjustments in our own policies. Our policies and procedures must give way before the needs of the visiting faculty and students. Since these needs and expectations vary widely the laboratory must have the flexibility to accommodate to them. Simple things become important.

Students do not want to apply or be treated as if an applicant. I think it imperative that they be appointed as a member of the new community.

Students need students. It takes an extraordinary student to leave the campus to work at a laboratory isolated from campus activities--a point that was alluded to several times today. It is only in our summer student program that we've had any success with a program involving students. This is simply because there were a large enough number of them, usually over a hundred, for them to create their own environment. Their own interactions were surely as important as anything the staff could contribute.

Then, as has also been said, students need services which are available without regard to the work day of the laboratory itself. For example, libraries must be open at all hours.

So much for these necessary details. Some of them are noteworthy if only to give the temper and style of the laboratory itself. Attention to these details will, however, do nothing to increase the actual interaction of resident and visitor. It will only allow it to prosper if it occurs.

Now I come to my single point. Looking at the matter from the graduate students' point of view and not our own parochial points of view, we must see to it, if we are to open our laboratories, that the graduate students we accept can enjoy decent, intellectually disciplined, life-giving apprenticeships. It doesn't make any difference where this occurs. There are failures and omissions on this in the universities as well as in the laboratories themselves.

Actually, a much larger issue is at stake. Administrative devices are internally directed. Our whole view in this meeting reflects our preoccupation with what to do with things as they are. The larger society will remain patient with us for only so long. We must attract and educate the very best young people, or we sow the seeds of our own destruction. If we are seriously interested in graduate education we must accommodate to the deepest expectations of our young people. If we can provide decent, to repeat, intellectually disciplined, life-giving apprenticeships, each in our own way, we can take up Bacon's dream that science can be put to the relief of man's estate. Society will come to expect this of its investment in science.

DR. LIBBY: It seems to me that we have found in our collective considerations this afternoon that the national laboratories have contributed substantially to the richness of the offerings made in our graduate schools. We found that all this can be increased and perfected by careful planning and fitting to the new needs as our technology unfolds. We could do worse than follow past practices. Nothing is ever perfect, however, and we should encourage the laboratories to make every effort to remain flexible to respond to these new needs. I'm not suggesting that Argonne go into the space business, but I am suggesting that Argonne be interested in the space business. And I'm not picking on Argonne. Now I'd like to ask for some questions if there be any.

DR. ROBINS: This is more in the nature of a comment and comes out of Dr. Libby's remarks and the remarks that others made. I think one recommendation that might come from this meeting is that wherever possible when new laboratories are planned priorities should be given to the establishment of these laboratories in a university community, because obviously there is much to be gained by proximity. Of course for some special facilities this proximity isn't possible, but I think this is one recommendation that could come out of it.

DR. LIBBY: Are you favoring the kind of thing that went on in the Weston Laboratory? The location of the Weston Laboratory?

DR. ROBINS: I was favoring our own situation where we developed sort of a community of laboratories that can meet and join toward a common large problem.

DR. LIBBY: I think it's a good point you raise. In Southern California we figure short as compared with other areas. We have the Jet Propulsion Laboratory and that's it. We think with one tenth of the people in the country that maybe we ought to have more. But it isn't making all that much difference. Travel is so easy. However, I do think you're right that one ought to locate with something like the care that was used in the Weston. Although it was a kind of three-ring circus done with the most democratic rules and practices imaginable.

DR. ROBERTS: May I comment on that? I'm glad that Professor Robins reminded me of a point I forgot to comment on during my talk. Just a week ago today, I was down at his campus at the University of Miami. In the meteorology building, on the top couple of floors of that building, you see the National Hurricane Research Center of ESSA. The people working there are analyzing their weather maps and preparing their predictions of where particular tropical storms will develop, and so on; and this is right in the middle of the University campus. The graduate students are all around: they come in and use that weather research and synoptic mapping facility, and learn from the ESSA people at work. I am certain that this experience makes a major impact on young people and gives them a sense of the excitement and importance of this field of work. And it affects the undergraduates as well as the graduates.

DR. LIBBY: It would be good if we could do that, but these laboratories take a lot of real estate and most campuses aren't that big.

DR. ROBERTS: Well, I think Miami was very wise to provide a building for a Federal laboratory right in the middle of the campus, with the students, professors, and Federal employees right in the same building.

DR. LIBBY: Very good.

DR. JOHN C. JOHNSON (Ordnance Research Laboratory, Penn State): I'd like to say a few more words on the same subject and give a demonstration. Among other things I might mention, before I forget it, that it makes it easier for the Students for a Democratic Society to find you if you're right in the middle of the campus. (laughter) I happen to be from the Ordnance Research Laboratory at Penn State and we have visitors from the national magazine of the Students for a Democratic Society yesterday and right now in our Lab I think.

Anyway, to demonstrate the point of what it can do for you to be in the center of campus with regard to students, I'm sort of amazed as I hear us discussing programs with two, three, or four students per year. At last count taken recently in our Laboratory we had a hundred and seventy-five students who are receiving financial support from us. About a hundred twenty-nine of these were graduate students. Of these something like thirty-five had supported theses. I attribute this high number to two things. It is not only the facilities, but also the programs. So one must consider not only federally owned facilities but also the programs which go along with it, in determining whether it is suitable to be located on campus. I think this clearly demonstrates that with the right program on campus, we will not be talking about three or four students, we will be talking about hundreds of students. I might mention our total full time academic staff is, including joint appointments, less than a hundred and eighty. This means that we have almost as many students as we have regular full time academic staff members in our research laboratory. Thank you.

DR. LIBBY: Thank you, Dr. Johnson.

Some of the facilities which I mentioned are too dangerous to be put in a populous area. One of the facilities which is most useful is a high flux nuclear reactor, so it isn't always possible. But it certainly is desirable whenever it can be done to place them close to the campus. The Jet Propulsion Laboratory you see is quite close to Cal Tech and benefits from that. We are hopeful of having some kind of facility some day with these high flux reactors in it, but we would never have any hope of being able to put it in downtown Los Angeles. The AEC wouldn't allow it. Also other special facilities can be nuisances, like wind tunnels. The needs vary a lot and some of them fit campuses and some of them don't.

DR. ELLIOT S. PIERCE (AEC): First I'd like to enthuse a moment about this panel. I think it is a superb panel, and second I'd like to point out maybe a bit of disagreement between this panel and the one that preceded it. Dr. Anderson's observation pointed to the needs of the

graduate students, I think he's pointed to one of the major contributions that a national laboratory can make in the present climate. It is to offer things which will meet the needs of graduate students as they see them, as well as the Nation sees them, in ways that maybe are not being met on the traditional campuses. The disagreement that I see, and I hope I don't misquote Dr. Robins who made an observation I thought I heard at the beginning of his remarks, is the implication that we don't need to sell the public. That the students are already enthusiastic. I don't think they are. I see this as a disagreement and I would like to hear a little exchange on it if there is any further to be made.

DR. LIBBY: Well, we may not have to sell the public, but we sure have to sell some Congressmen.

DR. ROBINS: I didn't mean we shouldn't sell the public. I thought that I said that we didn't have to sell the young people on science as a career. That is, we are already receiving more qualified applications than we can possibly take. Although we have a hundred and fifteen graduate students at our Institute in Oceanography, we could take four hundred really well qualified people if we had the space. We actually have created our problem for ourselves because we have encouraged these people to go into oceanography. We have told them, and rightly so, that there is a challenge here. Then when they go through and complete their undergraduate training, there is no place for them to go because we don't have the space.

DR. LIBBY: Any other questions, comments?

DR. MILTON BURTON (Univ. of Notre Dame): How many of the people here are having this experience of having more people apply for graduate school than you can possibly need or use? I see about five or six.

And how many have the opposite experience? (Quite a few hands raised.) This is the usual thing.

I think that we are confronted with the fact right now that we have to do something in the way of an educational program. We are having a falling away of interest in science and this is generally not appreciated. You have a special situation at Miami because you have a very special laboratory, with a very special problem. But this is not the usual situation. We have to do a job of educating the public because we have to educate the Congress, and unless we educate the public we can't educate the Congress. Many of us are neglecting this responsibility. It is a public relations responsibility that each one of us is called upon to do something about.

I could talk about other features of this thing except there is one point that I want to make, and that is one cannot say in principle where laboratories should be. If you say special laboratories should be in far out places and general laboratories should be close in to the universities, that's not right. After all, the laboratory at Miami is a very special laboratory. This is not the usual kind of thing. I think the rule that one should follow in regard to laboratories that come on the campus is that they are stimulated largely by the interests of the faculty who are there. If they are willing to fight for a particular kind of laboratory and build it up, build up a staff, then the time comes to organize a laboratory. But if you are going to impose a laboratory on them, it's not going to be a very successful effort.

DR. ANDERSON: May I speak to the first of these points again. My remarks are iconoclastic to be sure, but I am dreadfully concerned about the quality of the young people that are going into science and I am equally concerned about our myopic view of what we think they see in science. They see in science these days large, cold laboratories devoted to public programs with which they disagree. And while we may find qualified students applying, are we finding the better students applying?

DR. LIBBY: Are there more questions?

DR. JOSEPH L. McCARTHY (University of Washington): To really move forward the participation of graduate students in the federally related contract laboratories the professor is the element or the primary person, it seems to me, that really needs to be sold. I was very interested in Dr. Gilles' comments about this excellent participation, but I would be happy to hear whatever comments the gentlemen might want to make, any of them, on what might be done on an immediate basis to stimulate collaboration. How do you get the individuals to shake hands in a cooperative sense? How do you begin?

DR. LIBBY: Would you like to begin an answer to that?

DR. GILLES: Most contact among scientists occurs at meetings. So the people in the national laboratories ought to be encouraged to go to the meetings, as should the professors be encouraged to go to the meetings. Second, probably the laboratories ought to sponsor reasonably small symposia where the very topic of interaction could be explored with university professors and with the national laboratory personnel. The interaction has got to be on a low level in the organization. The administrators cannot cause the interaction to occur. They can help create the atmosphere. They can cause the meeting to be accomplished. But the interaction must occur at the working level. As Ross Martin and John Roberson will recognize in a recent set of meetings in which they

and I participated along with Russ Poor, I claimed that I was the only non-administrator participating in the meeting. I think we must have more interaction directly at the working level.

ALBERT J. FLEIG (Goddard Space Flight Center): We've had a discussion on some of these points previously. I tend to feel that, as previous speakers have commented, the universities very strongly resist change, and that perhaps the problem isn't to find a way to get the students to take what the universities want to teach or necessarily to work on the problems that the laboratories want solved, but to work together with the students to identify important things to teach and important problems to solve in which you can get the best qualified students to go with you. This may relate to why some of the schools have tremendous numbers of applicants and others perhaps would like to have even more qualified applicants. Perhaps it's what you want them to study. And perhaps it's what we want them to work on for that matter, and we're both neglecting the fact that the students may have some of their own opinions as to what is important that don't concur with ours.

DR. ANDERSON: I assure you they do.

DR. ROBERTS: May I comment on that? I agree with that comment, and I feel also that the reason for the great interest in oceanography, atmospheric science, astrophysics and a few other areas at the present time is partly that young people see in them something that is ultimately going to be useful to society. Young people today are concerned with problems of conservation of our resources, and with doing things that are of value and benefit to us, things that are not likely so readily to be directly applicable to military activity. I really suspect that the students now coming into some of these cross-disciplinary fields that appear to have great social benefit are very good students, comparable to the very excellent students that used to dominate physics a few years back.

DR. LIBBY: I think this will be our last question.

DR. HILTON A. SMITH (University of Tennessee): I'd like to comment on a possible way to get interaction between the universities and the laboratories and make it meaningful to the students. I speak out of the experience of our own University and the Oak Ridge Installations, particularly the Oak Ridge National Laboratory. As long as everything was done on an overtime basis with our people acting as consultants when the opportunity came or the Oak Ridge National Laboratory and other Oak Ridge installation personnel coming to teach for the University on an overtime basis, we never had what I would call true success. But about six years ago an idea came from the University and the Oak Ridge National Laboratory

together, and with the support of the Ford Foundation we employed a number of people from the Oak Ridge National Laboratory on a part-time basis. These people had reduced loads at the Laboratory and did not work for us on an overtime basis. Their salaries were reduced by twenty percent there and we paid them for their services at the University. They came into our Department of Physics, our Department of Chemistry, our Engineering Departments, our Biological Science Departments, and our Mathematics Department. They became full-fledged permanent, though part-time, faculty members. Each one of them, although employed at the twenty percent level, became a full voting member of each faculty. There is nothing that has happened to us which has brought together so closely a Federal laboratory and a university. Furthermore it has excited the students. These people have been in contact with our graduate and undergraduate students and many of our graduate students have gone to the laboratories to do their work under the direction of both our own regular professors and these special part-time professors. Research of students at Knoxville has also been directed by these part-time professors. The main point that I'm trying to make is that unless you have true interaction between the faculty and the scientists or engineers at the laboratory, you can't hope to transmit to the students the true interaction which one must have between the universities and the Federal laboratory.

DR. LIBBY: I think we will adjourn the meeting and handle any further questions individually.

DR. IRVING: Thank you Dr. Libby and Ladies and Gentlemen.

Wednesday, October 30 A.M.

FORMAL EDUCATION AND TRAINING PROGRAMS FOR LABORATORY PROFESSIONAL STAFF

DR. IRVING: With Dr. Millman's permission we are going to start so that we keep reasonably on schedule in the long program today. This morning session concerns formal education and training for laboratory professional staff.

Dr. Sidney Millman holds an undergraduate degree from the City College of New York, and a Ph.D. from Columbia. He has taught at both of these institutions and also at Queens College in New York. His research specialties include nuclear magnetic moments and traveling wave amplifiers. From 1942 to 1945 while he was at Columbia, Dr. Millman participated in the research and development of magnetrons for the Office of Scientific Research and Development. He joined the Bell Telephone Laboratories in 1945, where he is now Executive Director of Research, Physics and University Relations. Dr. Millman, the floor is yours.

DR. SIDNEY MILLMAN (Bell Telephone Laboratories): Thank you, Dr. Irving.

This morning's session will be, as Dr. Irving mentioned, concerned with education and training programs for laboratory professional staff. I hope that many if not all of the speakers will make some reference to, and preferably hit hard, the problem of continuing education. At least I intend to do that as far as Bell Laboratories is concerned. Following the pattern of yesterday's sessions the chairman will start with a little talk of his own. But before I start, I would like to mention a slight departure in procedure from the sessions we had yesterday. I would like to open up individual talks for discussion immediately after each speaker gets through. This may be of necessity quite brief, perhaps no more than two or three questions that are urgently on your minds and that you would like to have the speaker clarify. When all the speakers are through we can join in some more general discussions.

My talk is about Continuing Education at Bell Telephone Laboratories.

CONTINUING EDUCATION AT BELL TELEPHONE LABORATORIES

It is a real privilege to be invited to participate in this symposium which really is devoted principally to the Government laboratories. Bell Telephone Laboratories is primarily a research and

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development organization for the Bell System. We are also involved in work for the military in technical areas where we have some special competence, such as communications and missile guidance, and have many interests and problems similar to those encountered in government laboratories.

Industry shares with you the problem of keeping its technical people intellectually vigorous. This problem has occupied the attention of a number of our people for a long time, and in the last three years it has gotten even more intensive attention. Recently I participated in a conference of about fifty people from our various locations who are concerned with education. The chief theme of the conference was "What can we do to boost materially the level of effort involved in continuing education?". I'll have more to say about this theme shortly, but before I do that, I would like to sketch for you the present state of our educational effort for our technical people and then touch on some plans for expanding our continuing education program.

A few statistics will help you get a little better acquainted with Bell Laboratories. Our total population is about 15,800. We are concerned here with our program for our technical people. In that category we have first and foremost some 5,400 scientists and engineers called Members of Technical Staff (MTS). Then we have in the support type of personnel about 1,100 in a professional category called Associate Members of Technical Staff (AMTS) and about 2,600 of the technician-type personnel called Technical Aides or Senior Technical Aides.

Our people are distributed over a substantial geographical area of the United States with a concentration in the east as shown in Table 1. This dispersion adds a degree of inhomogeneity to our educational problems.

TABLE 1

BELL TELEPHONE LABORATORIES LOCATIONS

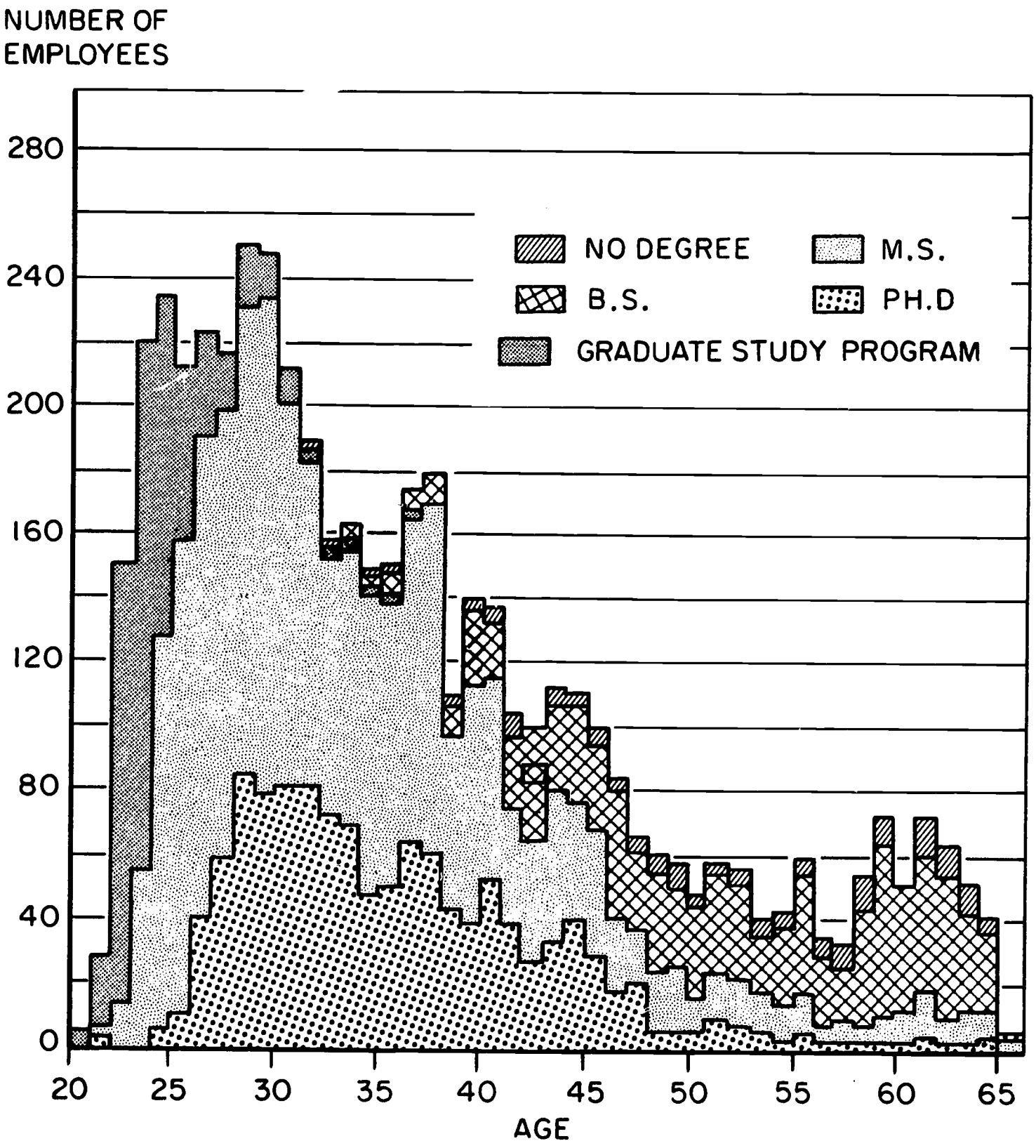
Murray Hill, New Jersey
Holmdel, New Jersey
Whippany, New Jersey
Chester, New Jersey
Allentown, Pennsylvania
Reading, Pennsylvania
North Andover, Massachusetts
Winston-Salem, North Carolina
Columbus, Ohio
Indianapolis, Indiana
Naperville, Illinois
White Sands, New Mexico
Kwajalein, Marshall Islands

About 12,000 of our 15,800 people are located in the three principal locations in New Jersey: Murray Hill, Holmdel, and Whippany. Most of the remaining Bell Laboratories branches are located at or near Western Electric manufacturing plants. Allentown, Columbus and Indianapolis are typical examples.

The composition of our Members of Technical Staff by highest degree attained and age is shown in Figure 1.

FIGURE 1

MEMBERS OF TECHNICAL STAFF



You will note that whereas only a small percentage of the older people have an advanced degree, all of the younger members have at least a master's degree. Our current hiring, which is about 600 MTS annually, is running at about 40% Ph.D's and 60% in the bachelor-master's category. For new hires at the bachelor's level we have a Graduate Study Program (GSP) which requires them to obtain the master's degree for continued employment. This degree can be obtained with our support in a variety of disciplines including electrical engineering, mechanical engineering, engineering mechanics, mathematics, device physics, materials and computer technology. The master's degree is obtained in one of two ways. Our local university part-time program involves a work-study program for two years to obtain the master's degree at a university located near their work location. This program operates at some seventeen universities. Our one-year-on-campus program involves full-time study for one year. It is carried on in eighteen universities.

About 10% of our people at the master's level are selected for financial support to obtain the doctoral degree. A few of these are selected to continue their studies directly to the doctor's degree on a full-time basis immediately upon the completion of the master's degree. The majority are selected after taking some advanced graduate courses for a year or two at a nearby university. For this part-time study program, we provide time off and tuition reimbursement.

I would like now to turn to that portion of our educational program that bears more directly on the problem of continuing education. I shall first mention the involvement of a number of our people in teaching at colleges and universities. In a very broad sense, this is for them the best form of continuing education. Some seventy people are involved principally at universities located near their places of work. They teach one or two courses, usually in the evening. About twenty people are involved in "assigned teaching". By this we mean that the teaching is considered essentially a part of or an extension of their normal technical activities. The participant may be at a university for a period ranging from a month or two to a semester or even a full year, with our financial support ranging from part salary to full salary. The range of this activity is illustrated by the next table, which lists universities where our people are currently doing assigned teaching.

TABLE 2

ASSIGNED TEACHING

University of Rome	MIT
Stanford University	Columbia University
Lehigh University	National Physics Lab., England
U. of Cal., Berkeley	University of Paris
U. of Cal., Los Angeles	Oxford
Princeton University	

Finally we have a number of people holding joint appointments with a university and Bell Telephone Laboratories. This is an extension of the idea of assigned teaching, the joint appointment generally being for a longer and less defined period. Scientists participating are listed in Table 3.

TABLE 3

JOINT APPOINTMENTS

1968

Name	Institution
Anderson, P. W.	Cambridge University
Bartlett, N.	Princeton University
Geballe, T. H.	Stanford University
Matthias, B. T.	Univ. of Cal., La Jolla
Miller, T. A.	Princeton University
Shannon, C. E.	MIT
Shockley, W.	Stanford University
Tukey, J. W.	Princeton University
Wasserman, E.	Rutgers University

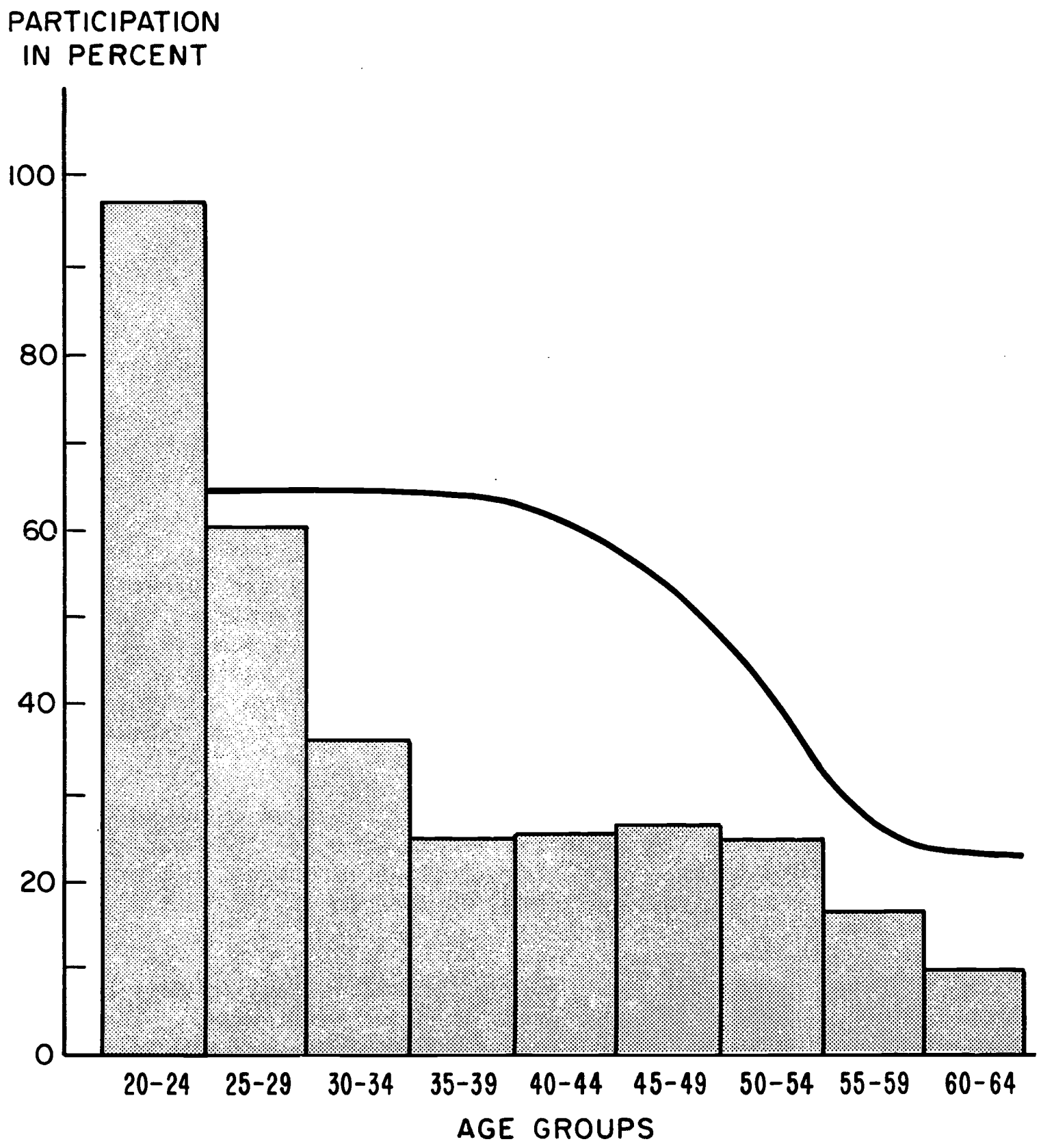
About 8% of our professional staff, MTS and AMTS, are currently involved in taking courses at nearby colleges and universities under our Tuition Refund Plan (TRP). Employees are allowed up to one day of working time per week for such activities. The participation of our people in this plan at the various locations is dependent upon the graduate educational opportunities available. Participation ranges from 3% at some locations to as high as 10% at others.

In addition to these programs in local colleges and universities, we have had for many years an extensive in-house program of "out-of-hours" (OOH) courses. These courses range from foreign languages, mathematics and programming, to rather sophisticated courses in physics and advanced engineering topics.

The total participation in some form of study by our Members of Technical Staff in all of these programs is shown in Figure 2. The vertical bars indicate the percentage participation by age groups. The participation is particularly high in the lowest age bracket because of the extensive involvement of our bachelor level people in our Graduate Study Program.

FIGURE 2

MTS ENROLLMENT IN OOH, TRP OR GSP BY AGE GROUPS



This participation in some form of continuing education varies considerably among our various locations. The curve shows the unusually high participation at our Merrimack Valley laboratory located in North Andover, Massachusetts, where the development of transmission systems is carried on. Supervision there has nurtured an extensive in-hours course program because of the particular technical and education needs of that laboratory. The participation of their technical people in the program is considerably greater than at any other location and indicates that a high degree of participation can be obtained by providing appropriate opportunities and encouragement. We are now striving to establish a favorable climate for continuing education throughout Bell Laboratories as was done at this particular laboratory. In other words, we have an existing proof of what can be done and we are not talking about visionary ideas of the armchair variety.

I am reminded of a quotation by Dean Everitt which appeared in a recent report of a University of Illinois faculty committee: "Engineering is not merely a learned profession - it is a learning profession, a calling whose practitioners must first become and then remain students throughout their active careers." I think we can all subscribe to this definition. The problem is one of implementation.

What are we now planning for increased participation in continuing education by our professional staff? We will, of course, continue our Graduate Study Program, Doctoral Support Program and Graduate Tuition Refund Program.

Beyond this, we are developing a series of in-hours courses which will constitute the core of an expanded continuing education program. These courses will be of three types. The first will be in-depth courses for 'specialists' who move into a new field or, for one reason or another, find themselves not in the forefront of the new science and technology. Such courses will probably extend over two to three years. A second type will be broad general interest courses in various subjects at the Bell Laboratories for those who need to interface with rather than specialize in a field. They do not necessarily need that knowledge in depth, but would profit by some literacy or acquaintance with fields of knowledge that impinge on what they are doing. As an example, suppose that somebody who works in transmission wants to know a little more about the devices he uses in his systems. He would take a somewhat different kind of course from what the Device Development Engineer needs, possibly lasting only two semesters instead of four to six. The third type of course is a preparatory course intended principally for the middle-aged members of our technical staff, let us say ages forty to fifty, who have been away from school for a long time, who not infrequently find it difficult to handle new and tough courses in direct competition with younger people who may be more up to date technically. Naturally they feel a little reluctant to join an advanced class with bright young graduates only four or five years out of school; they feel that they cannot keep pace. The real problem is that they are just a

bit rusty. With a few prerequisite or "ramp" courses they can be soon brought up to a level where they can participate effectively along with their younger colleagues.

Finally, a very important part of the program is to create an atmosphere for continuing education so that it becomes "fashionable." Supervision must provide tangible evidence that it subscribes to Dean Everitt's philosophy by providing constructive encouragement rather than cynical tolerance.

It is my hope that the educational experience and projected plans for continuing education at Bell Telephone Laboratories will be of relevance to the educational problems facing some of the Government laboratories.

Before I call on the next speaker, I would like to open my talk to some questions.

DR. JAMES L. YOUNGBLOOD (Manned Spacecraft Center): Do you have any indication that the turnover rate is higher with the people wanting to get their degrees? In other words do people come to Bell, manage to get degrees and leave?

DR. MILLMAN: There is very little sign of this. We are very pleased with the fact that turnover from those people is not, as far as I remember, materially different from the regular Ph.D.'s we hire. As a matter of fact, although this is a somewhat different subject, our turnover for Ph.D.'s is considerably greater because we not only get Ph.D. people on a regular basis but employ about 25% on a postdoctoral or Limited Term basis. Those postdocs are taken on for two years and only about 20 to 25% acquire regular status. As a result the overall Ph.D. turnover is actually greater.

DR. CRAIG M. CRENSHAW (Army Materiel Command): We have a problem in that working for the Government we have to exercise some control over the expenditures. Is there any control of any sort placed on an individual who goes away to campus or is there a moral obligation that he stays with you, or don't you care once he completes these courses?

DR. MILLMAN: I would say that there is a moral intent for the employee when he completes the courses that he continue to be a member of the Bell Telephone Laboratories. In the last analysis the test is the turnover. As we just remarked the turnover is not particularly bad. In fact we are very pleased with this.

DR. CRENSHAW: What are you speaking of? One percent? Five percent?

DR. MILLMAN: I don't have any numbers with me, but five percent is not a bad approximation to the rate at which Members of Technical Staff resign annually. This figure is substantially the same for our people completing the Graduate Study Program as for our regular Ph.D's (excluding the Limited Term appointees).

UNIDENTIFIED SPEAKER: On these in-hours courses, are these to be structured by Bell Laboratories? Are you actually preparing the curricula?

DR. MILLMAN: We are talking about in-hours courses that have so far been mostly in the forefront of our technology. We would find it very difficult to get people on the outside that would be in a position to teach these subjects, except perhaps for the introductory part of the courses. For example, if you need electromagnetic theory in order to get on with transmission design and this is your first course, then you might find that you can get some professor to come and teach that. Anytime we can avail ourselves of that opportunity, we will be very happy to do it. We don't regard using our own instructors as a less expensive way of doing it.

UNIDENTIFIED SPEAKER: I was more concerned with these refresher courses, for the middle-aged.

DR. MILLMAN: Let's put it this way. The emphasis I want to put on these courses is in-hours and not in-house, although it may turn out that much of the teaching will be in-house as well as in-hours. But the in-hours is the emphasis. I think we'd better stop now and allow discussion time for the other speakers.

The next two speakers are going to discuss their involvement in educational programs with the University of Alabama. The first is Dr. John Hallowes. He is a Ph.D. in nuclear physics with some EE background. He is Director of the Physical Sciences Laboratory of the Army Missile Command at Huntsville, Alabama. It will be interesting to know what his experiences are.

HUNTSVILLE ALABAMA LABORATORIES

Two agencies (Redstone Arsenal and the Marshall Space Flight Center) cooperate to develop educational facilities

DR. JOHN P. HALLOWES (Redstone Arsenal): Thank you, Dr. Millman.

As you heard, this will be a two part presentation. I represent the Army Missile Command. I will be followed by my colleague from Marshall Space Flight Center, Dr. Russell Shelton.

Yesterday, the purposes of training and the goals of training were very extensively discussed, and many examples of Federal laboratory-university relationships were presented to you. Today, I would like to discuss the specifics of the graduate-level program that has developed over a seventeen year period at a large, multi-agency, Federal installation. To give you some appreciation of what I mean by large, the personnel strength at our installation is approximately 16 to 17 thousand civil service employees plus approximately 13,000 or so people in the contractor community in Huntsville.

The major agencies at Huntsville are the Marshall Space Flight Center, which is a part of NASA, and the Army Missile Command which is a component of the Army Materiel Command. I would also like to mention that prior to the arrival of the Arsenal, the two most distinctive characteristics about Huntsville were that it grew more cotton than any other county in Alabama and it was the watercress capital of the world. All of which is completely irrelevant to a discussion of a major graduate program in science and engineering for our staffs in the Huntsville agencies.

The mission activities of the present agencies in Huntsville, the Army Missile Command and the Marshall Space Flight Center, essentially began at Redstone Arsenal in about 1951. Since that time there have been approximately three formative periods of development of graduate-level education, or I should say travail, perhaps, at this installation. In 1951, the Army element at the Arsenal found itself anxious to establish graduate-level educational opportunities, but the nearest universities having graduate schools were located some one hundred to a hundred and fifty miles away. Our training regulations at that time prevented us from entering into an affiliation with any of these universities for giving instruction in Huntsville. So our management at that time decided to do the next best thing; this was to hire a University of Alabama professor full-time to supervise the so-called Redstone Graduate Institute which gave out-of-hours courses to the young and growing staff of the agency at that time. The instructors for these courses were agency staff members who had advanced degrees. This arrangement persisted until about 1956. In a retrospective appraisal, there was little motivation for students to participate in this program because of the non-credit courses offered.

In 1956, our second stage of development began. At this time the University of Alabama decided to begin offering formal courses for graduate credit in Huntsville. We entered into a contract with the University of Alabama at Tuscaloosa to teach twelve hours in Huntsville in several disciplines. The remainder of the master's program had to be completed in residence at Tuscaloosa. Local instructors for this program were again drawn from the staff of the agency in Huntsville, who

had to meet the University of Alabama faculty standards. Fortunately, these instructional resources were augmented in about 1960 with the creation of the Marshall Space Flight Center, so ultimately we did have a substantial number of instructors available. It was still disagreeable, of course, to send people to Tuscaloosa for the campus residence.

Overall guidance to the graduate level program then, and now, was provided by a committee: the Joint Army Missile Command-Marshall Space Flight Center Graduate Study Committee. Fortunately, this is one committee that worked. It was composed of individuals from Marshall and the Army with advanced degrees who gave advice and counsel to the management and to the training offices of each agency, and who actually helped in structuring the course offerings. This committee, as I said, has been a continuing one since 1956 and the chair rotates each year between the agencies. This group has not only been active in graduate education, but has also been instrumental in establishing the Redstone Scientific Information Center and the University of Alabama Research Institute, about more of which Dr. Shelton will have something to say. During this part Huntsville-part Tuscaloosa master's degree program, about thirty people acquired a master's degree.

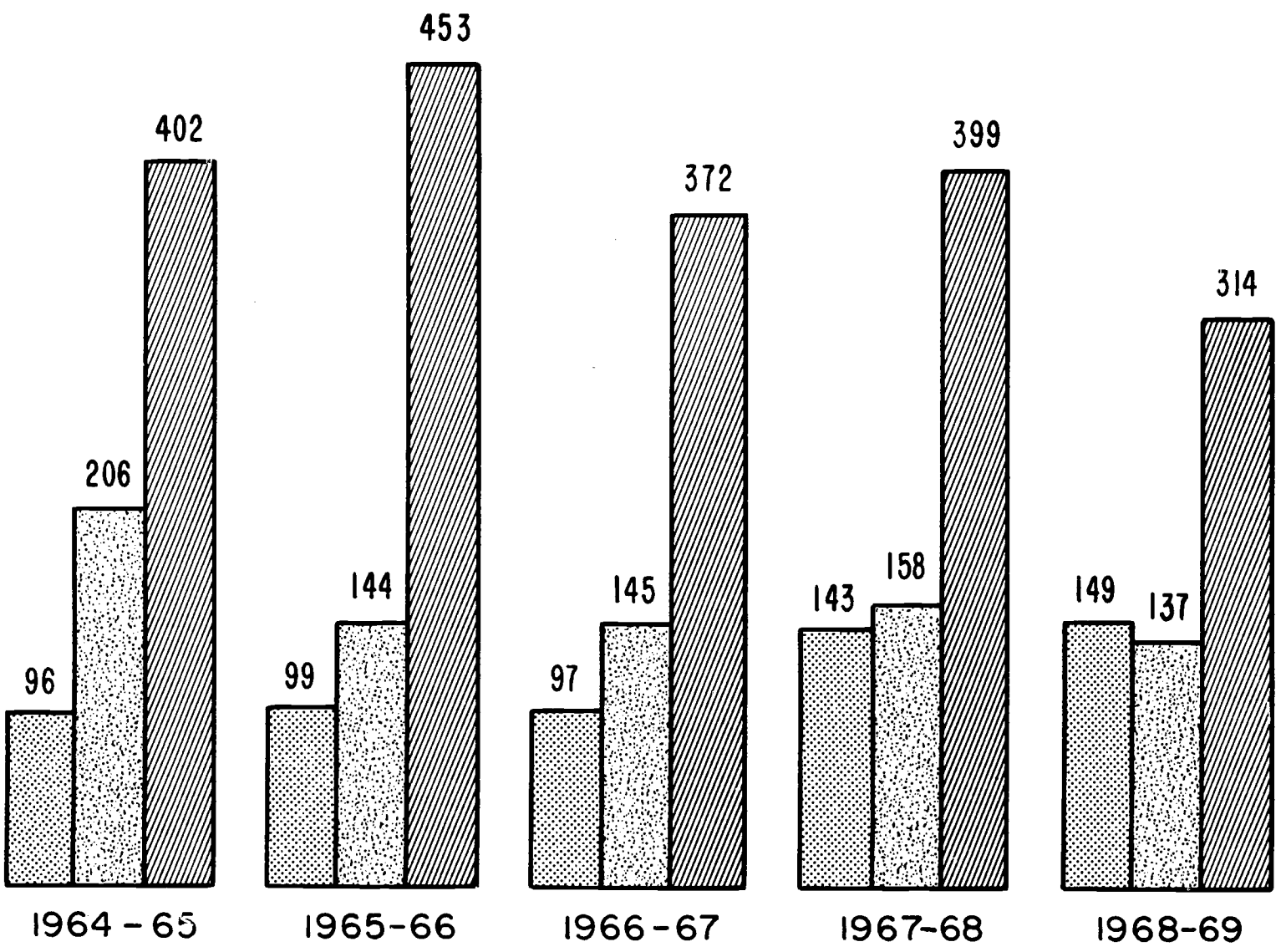
In 1963, we entered into our last period of development of graduate-level education in Huntsville; this began with the major decision of the University of Alabama to create a new organization, the University of Alabama in Huntsville, and to acquire a permanent, full-time staff to instruct in the sciences and engineering, principally. This new institution now offers a residence master's degree program at Huntsville. Each of the Federal agencies has supported the residence master's degree program wholeheartedly by an increased financial support that it necessitated. The University of Alabama in Huntsville started out with a full-time staff in 1963 with about 14 people. In science and engineering, they now have 51 full-time staff members of whom about 43 have a doctor's degree. These full-time staff members spend one-half of their time in teaching and one-half of their time in research. Most of their teaching is at the graduate level. The current residence master's programs that are available at Huntsville are depicted in Table 1.

About 40 to 45 graduate courses in each of the disciplines in the residence program are given each quarter in Huntsville, with the exception of summer months, of course, when we have a substantial reduction.

Figure 1 shows the graduate student enrollment since the inception of the residence program in Huntsville. You can see that we have a substantial number of people participating in the program from the contractor/industrial group in Huntsville. We welcome this because it reduces our training costs substantially. You can correlate the height of the bars with various changes in missions, completion of projects, and so on. You can see that the Army students have increased somewhat and Marshall has stayed constant. The contractor group has dropped off, as some parts of the Apollo program were completed. The possible input patronage to this graduate program can be quantitatively stated: there are

FIGURE I

GRADUATE ENROLLMENT AT UNIVERSITY OF ALABAMA
IN HUNTSVILLE



approximately 7,200 scientists and engineers in the Huntsville area. This is broken down into about 1,100 people in the Army and about 2,600 people in the Marshall Space Flight Center who might be considered candidates for advanced degrees. The remainder come from the contractor element in Huntsville.

TABLE 1

RESIDENCE MASTER'S DEGREE PROGRAMS
AT UNIVERSITY OF ALABAMA IN HUNTSVILLE

MATHEMATICS

PHYSICS

ELECTRICAL ENGINEERING

MECHANICAL ENGINEERING

ENGINEERING MECHANICS

INDUSTRIAL ENGINEERING

AEROSPACE ENGINEERING

MASTER'S DEGREE PROGRAMS
NECESSITATING ONE SEMESTER RESIDENCE
AT UNIVERSITY OF ALABAMA IN TUSCALOOSA

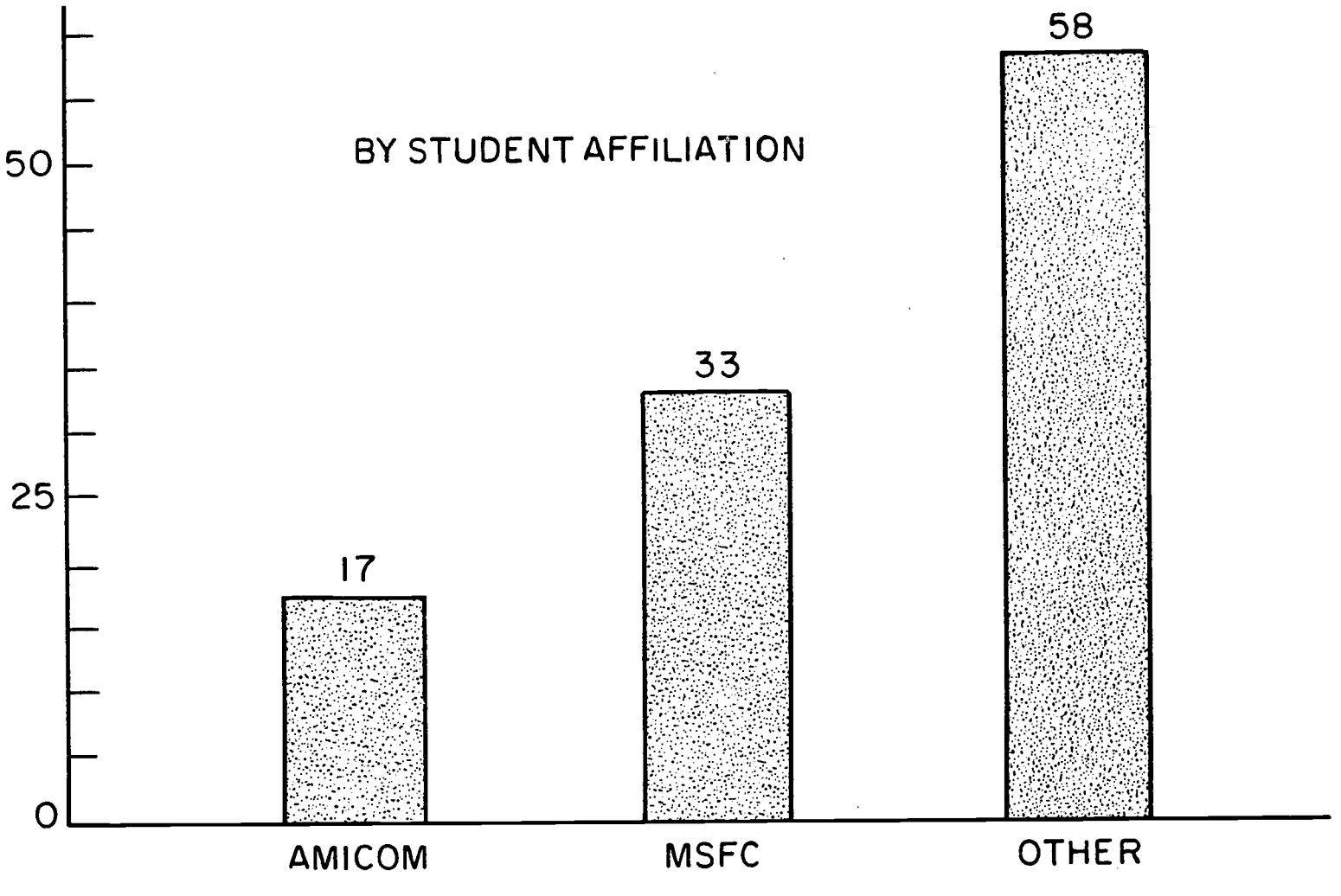
CHEMISTRY

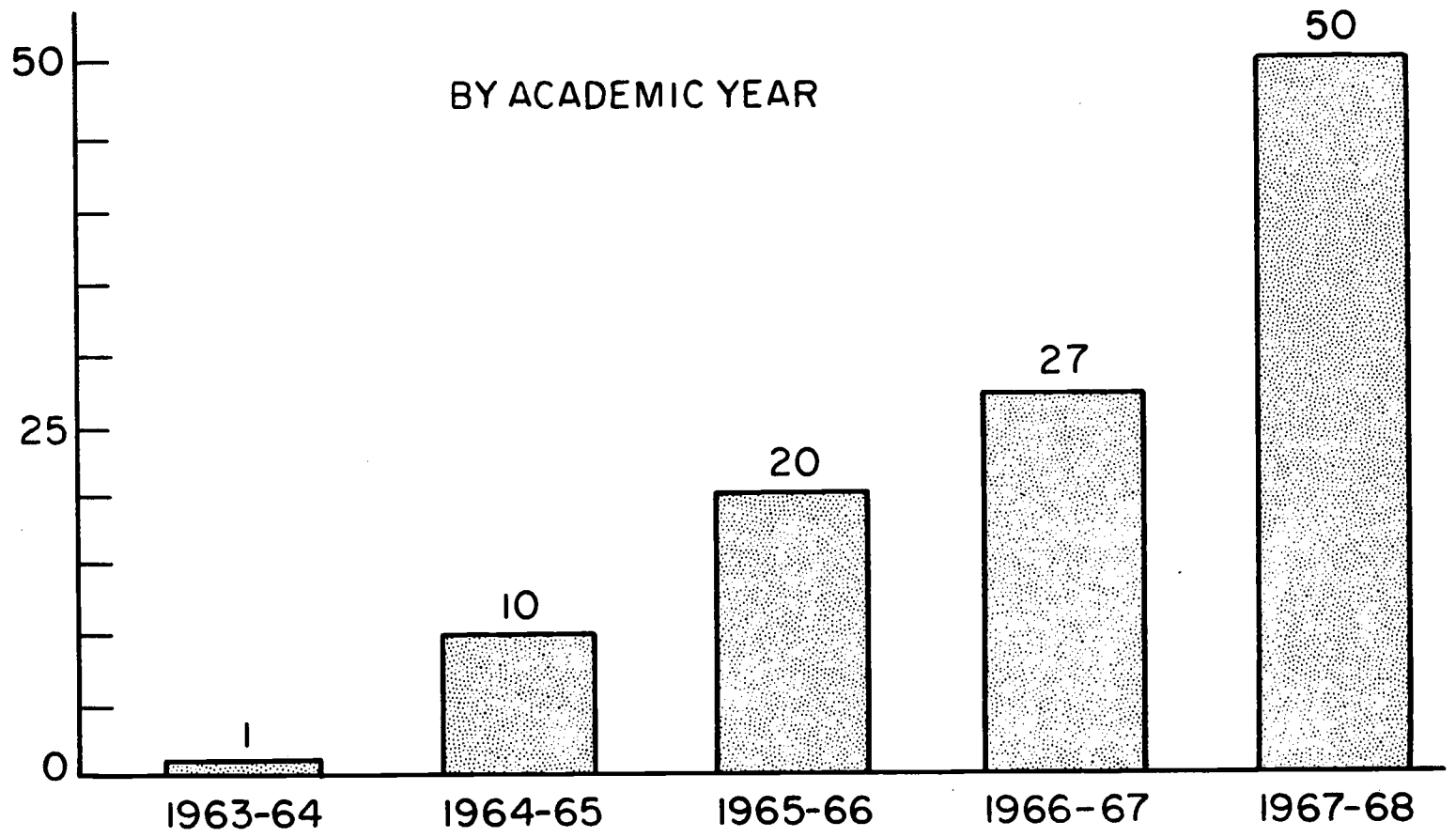
PUBLIC ADMINISTRATION

Figure 2 shows the actual through-put: the number of master's degrees that have been awarded since 1963 from the residence master's degree program in Huntsville. For example, to indicate the size of the program, in the present semester, the Marshall Space Flight Center has about 70 employees who are part-time students, while the Army has about 75, for a total of 145. We have about ten people from the Army who are doing master's thesis research in our laboratories, and Marshall has five people working in their laboratories. With the advent of the residence master's degree program in Huntsville, there seems to be an inclination of more people to go to school full-time, that is to say, they are in the category of long term training. I think this is natural because of

FIGURE 2

NUMBER OF MASTER'S DEGREES AWARDED AT UNIVERSITY OF ALABAMA IN HUNTSVILLE





the availability of full-time course offerings; and people have a tendency to wish to complete their master's degree expeditiously. Additionally, certain changes in emphasis in the missions at Huntsville have made it necessary for people to be reeducated and to prepare for new assignments. To illustrate training consequences of this transitional situation, the Missile Command has about 38 people in full-time graduate study at the present time and the Marshall Space Flight Center has 40. I think in the future we can expect to see an even larger proportion of people going to school full-time as opposed to part-time. Currently, the part-time courses are given in the late afternoon and at night, and we give free release time to people who have late afternoon classes.

We are interested also, of course, in getting a residence PhD program at the University of Alabama in Huntsville. Currently, we have people from Huntsville in a PhD program, but they must have one year residence at the Tuscaloosa campus in order to become a candidate for the doctorate. All work taken at Huntsville is credited toward the doctorate and the thesis may be done in Huntsville under the nominal supervision of a Huntsville thesis supervisor. Currently, we have a total of 31 PhD students from Marshall Space Flight Center and the Army Missile Command who are doing thesis research for the PhD degree at the University of Alabama. The President of the University of Alabama convened an ad hoc group to study the question of establishing a resident PhD program at Huntsville; the group recommended against beginning the resident PhD program at this time. They suggested that initiation be deferred to some later date when the UAH acquired additional strength in faculty, physical facilities and libraries. We are confident of acquiring a residence PhD program in Huntsville when these requirements are met. However, lack of a residence PhD program has not deterred each agency from producing PhD's. There have been 38 PhD's produced in Huntsville agencies by utilization of the University of Alabama and other schools in the country. Approximately 17 or 18 originated from the University of Alabama.

There have been other opportunities for training at Huntsville. For example, the Army Missile Command has a postdoctoral program of sorts. We have had one person who has gone to the Oak Ridge National Laboratory for a year. We have had one person to go to Harvard to study optimal control for a year. Also, there are substantial opportunities for training in short courses in Huntsville for the members of the staff not interested in degree programs. In 1964, the University of Alabama in Huntsville embarked upon a baccalaureate program at Huntsville, and they currently enroll 900 full-time students and about 1,300 part-time students. This June of this year they had their first graduating class. I mention this because of its relevance to the graduate program.

In summary, I believe the agencies in Huntsville have had reasonable success in meeting their goal of providing quality, graduate-level educational opportunities for their staffs. I think this can be attributed to the constant and abiding judgment of management, even through numerous organizational changes, that it was mandatory that the

installation have a graduate-level program in Huntsville to sustain our scientific and technological enterprise. Secondly, management at Redstone has been very bold and aggressive in interpretation of the Government training regulations and I think we have benefited consistently by it. The agencies have displayed unanimity in their purposes and goals in their relations with the University of Alabama. And, of course, another essential fact that cannot be overlooked is the fine cooperation we've had from the University of Alabama. Thank you.

DR. MILLMAN: We might take time for one or two questions.

DR. RUDOLF HERMANN (University of Alabama): I would like to fill in with one figure on what Dr. Hallowes said. The total number of the full-time professorial staff of the University is 107. It is distributed about 32 in mathematics, physics, chemistry and biology; 25 in engineering--all of them have Ph.D.'s by the way; and 50 in the general studies which is English, history, and psychology. The undergraduate college which Dr. Hallowes mentioned at the end totals up to 107.

DR. MILLMAN: I think we might go on to the next speaker, Dr. Russell Shelton. Dr. Shelton taught physics at a number of institutions, including the University of Tennessee where he got his Ph.D. Until a week ago he was Chief of the Nuclear and Plasma Physics Division of the Marshall Space Flight Center. He is now Technical Director of the Limited War Laboratory at Aberdeen Proving Ground.

DR. RUSSELL D. SHELTON (Marshall Space Flight Center): I'm going to talk about the Research Institute of the University of Alabama and the gentleman who just stood up and gave you the figures on the professorial staff is Dr. Rudolf Hermann, the Director of the Research Institute. I'm going to present the Government side of the story and if he feels too much outraged by some of the evaluations which I give, I hope that he will stand up again and express his opinions.

Dr. Hallowes has outlined several aspects of the development of the University of Alabama in Huntsville (UAH). The evolution from a series of extension courses to a university operation granting undergraduate and graduate degrees in several areas has naturally required the assembly of a number of basic ingredients such as students, professors, libraries, classrooms, and research facilities. To the young constituents of the large technical complexes of Army and NASA in Huntsville, the important thing was an opportunity for further education. To the older members of the community, there was a need for a local college education for their children. To the businessmen of the Huntsville area, there was a need for a diversification of industry which would reduce the total reliance on the "big government" operation and promote greater stability in the

local industry. To the holders of advanced degrees in physical sciences, there was a need for expression in teaching and research in a creditable academic environment.

The Research Institute of the University of Alabama was intended to contribute something to each of these elements. Most important, it was to provide research opportunity for professors in science and engineering and to provide thesis opportunity for graduate students. Table 1 lists some of its unique contributions to the educational process. Our methods of evaluating the contributions of the Research Institute are summarized in the Table 2.

TABLE 1

CONTRIBUTIONS FROM THE UAH RESEARCH INSTITUTE

Research in aerospace physical sciences and engineering

Research opportunity for professors

Thesis opportunity for graduate students

Classroom space for the graduate program

Office space for some professors

Support for special programs

TABLE 2

METHODS OF EVALUATING THE UNIVERSITY OF ALABAMA, HUNTSVILLE

Graduate Study Steering Committee

Report and publications

* * *

University of Alabama critique of UAH

* * *

Part-time professors

Part-time students

Thesis projects

Project work

351-958 O-69—8

In the beginning the financial condition of the University of Alabama in Huntsville was not adequate for support of a professor in research in the normal academic environment of departmental budgets. It was felt that the Research Institute, by acquiring business of a nature suitable for meaningful professional research by professors, could provide the research opportunity necessary for a progressive academic environment. This part of the Research Institute has succeeded admirably. Of the 21 research projects now at the Research Institute, 20 are managed by professors who work in their fields, typically with one or more graduate students for each professor. Figure 1 shows the composition of the Research Institute staff. Table 3 shows the place of the Research Institute in the life of the full-time graduate professor.

TABLE 3

THE TYPICAL FULL TIME GRADUATE PROFESSOR
IN PHYSICAL SCIENCE AT UAH

Teaches with pay from the AMC-NASA graduate study contract

Researches with pay from the Research Institute

Directs theses at the UAH and at Government installations

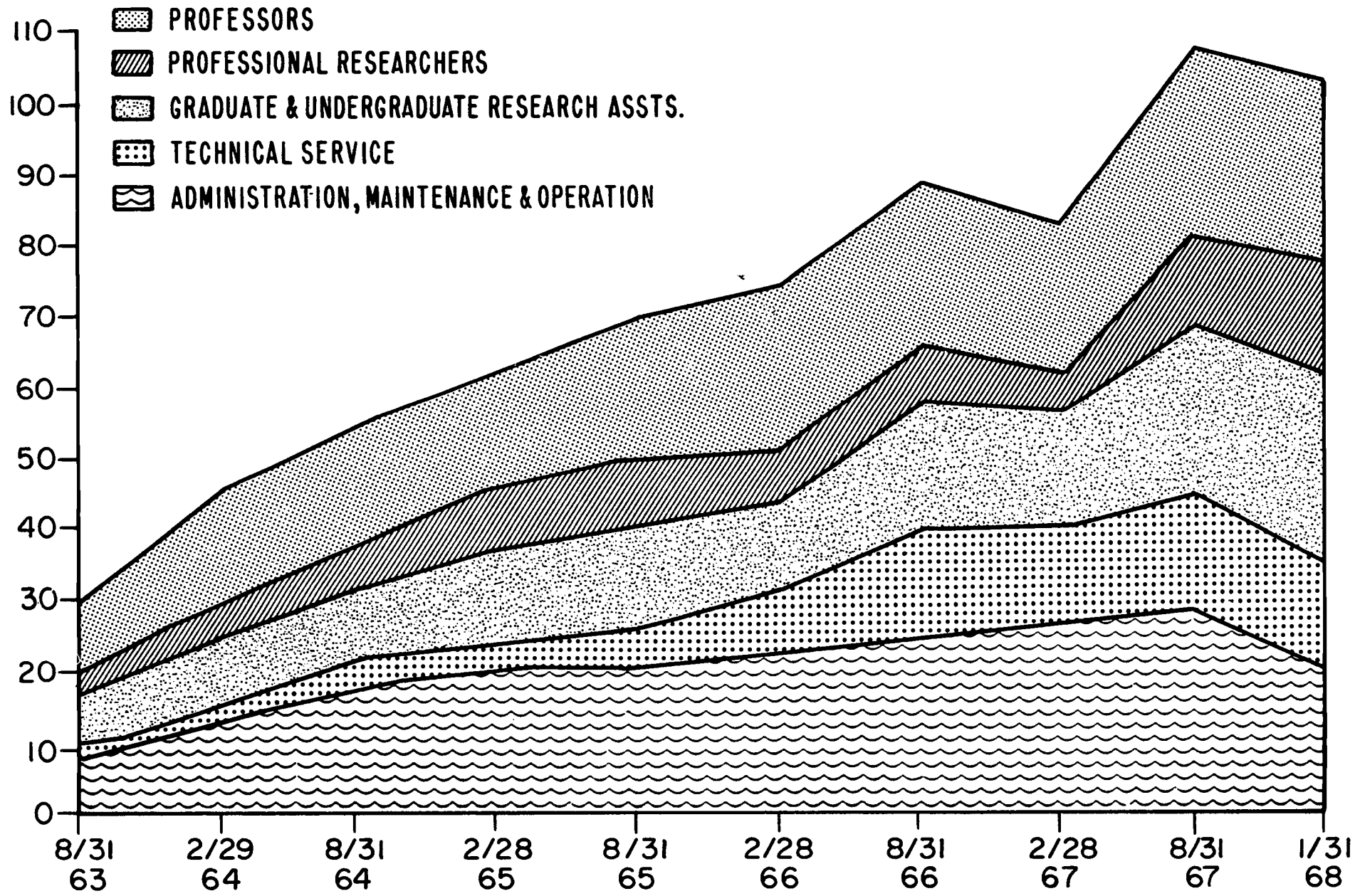
The Research Institute has made it possible for surplus equipment at Army and NASA laboratories to be acquired by the University through a facilities contract.

The Research Institute, through the efforts of its director Dr. Rudolf Hermann, obtained the installation of a Univac 1107 (later an 1108) computer system. In return for housing the computer facility, the Research Institute received 50 to 80 hours of computer time per month and was able to add a terminal to the main campus at Tuscaloosa so that it also could benefit from the computer. This computer facility was used to handle overloads from the Army and NASA installations.

We have watched with interest the evolutions of a number of research institutes around the country. Some have become "research mills" with no academic connections. Some have been rejected entirely by the mother university. Some have been absorbed entirely by the university management structure. We in Huntsville feel reasonably sure that, out of sheer necessity, the Research Institute will remain academic for the simple reason that it is the only research opportunity available to the professorial staff. There are pressures, naturally, to increase departmental management of the research opportunity and to incorporate it into the usual academic structure. There are those who feel that the Research Institute ought to represent a more coherent organization with emphasis

FIGURE I

RESEARCH INSTITUTE PERSONNEL
(INCLUDING PART TIME)



on major projects of interest to the Army and NASA, but it is unlikely that this will happen as long as the UARI is the sole research opportunity foı professors and as long as professors with individual interests require research opportunities previously agreed upon before they come to Huntsville.

It is difficult to assess the value of the Research Institute in bringing new industry to Huntsville. It can be said that a lot of new industry has arrived, and that this industry has been very interested in the University operation, in some cases because it represented competition and in other cases because it represented a necessary educational and cultural environment. The Industrial Park across from the Research Institute is certainly impressive, and is still growing.

Financial support for the Research Institute is mostly from Army and NASA, as shown in Figure 2. Unfortunately, the picture for this year does not look as good, especially for the interdisciplinary grant from NASA Headquarters. It should be pointed out that the hiring of professors, who fit into the instructional program and who have a strong desire to continue work in a special area where they are competent, is greatly aided by the availability of flexible money, such as the NASA grants, the availability of which is typically such as shown in Figure 3 for the case of the Research Institute. The step funding arrangement does much to encourage sound long-range planning and reduces the fear of sudden poverty.

As an aside, I would like to mention the Redstone Scientific Information Center, supported jointly by the Army and NASA, and its importance to our university relations. Table 4 shows some of its contributions, which have been more fully explained by Dr. Hallowes and me in the April 13-14, 1964, Proceedings of the Second Symposium of the Federal Council for Science and Technology.

TABLE 4

SOME CONTRIBUTIONS OF THE REDSTONE SCIENTIFIC INFORMATION CENTER TO UNIVERSITY RELATIONS

Inter-library loan arrangements

Support of local graduate program

Surplus books

Cooperative studies on automation with University of Alabama

Support of university consultants and contractors

FIGURE 2

SOURCE OF CONTRACTS AND GRANTS
INCLUDING NSG-381
(AS OF JULY 1, 1967)

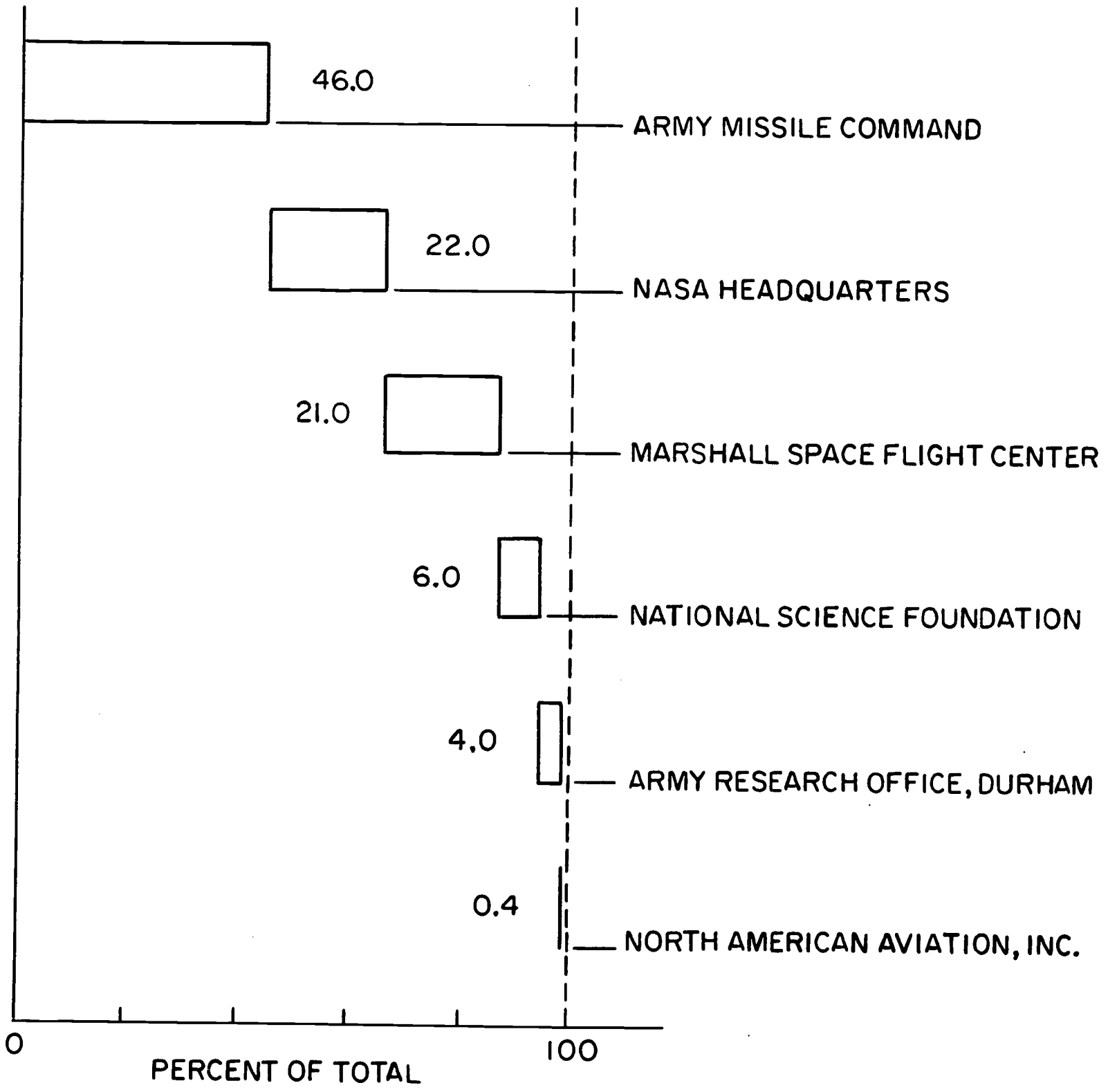
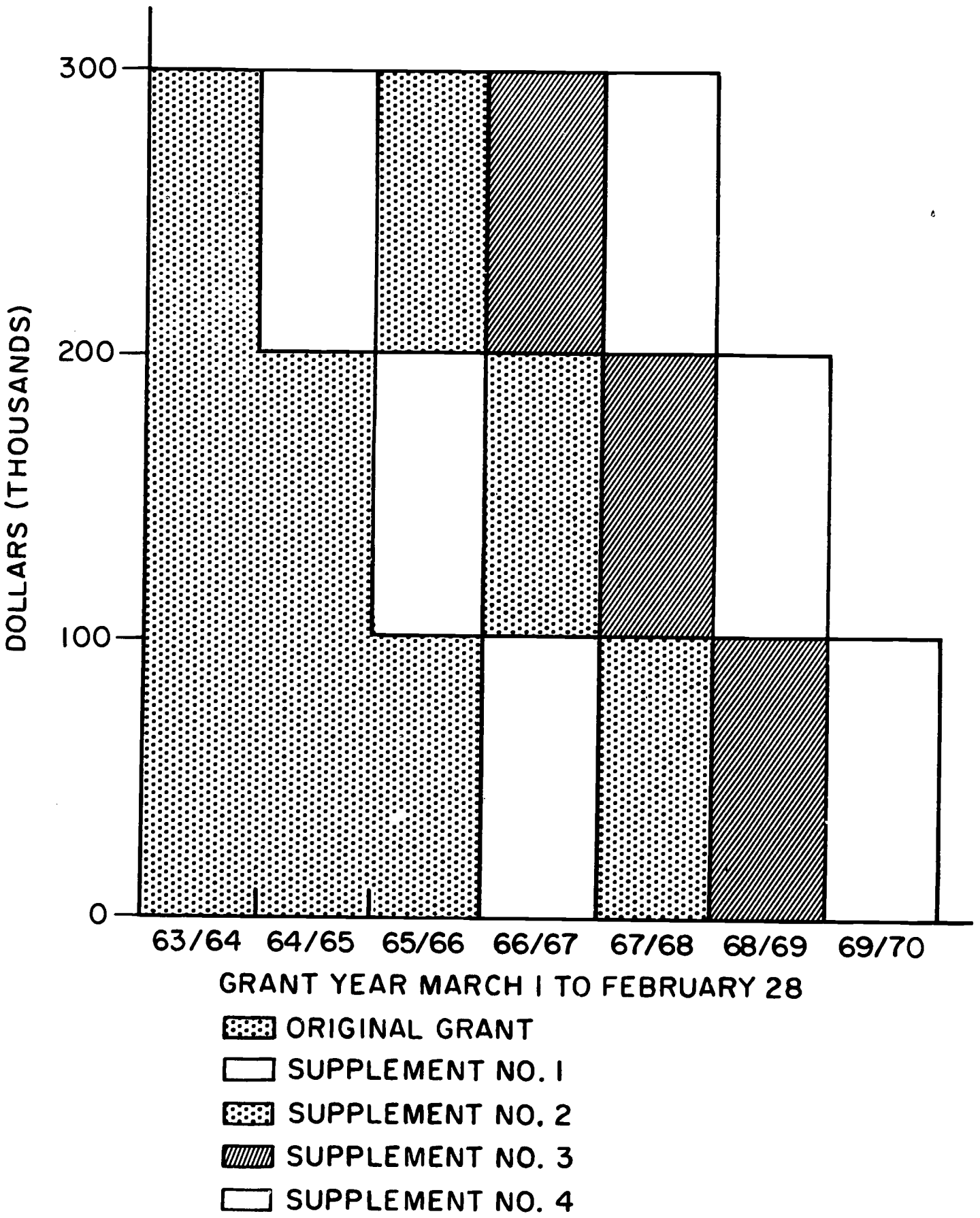


FIGURE 3

NASA GRANT NSG – 381 IN SUPPORT OF RESEARCH IN THE AEROSPACE PHYSICAL SCIENCES

UNIVERSITY OF ALABAMA RESEARCH INSTITUTE



At the request of Dr. Wernher von Braun, both the House and Senate of Alabama passed legislation to provide the Research Institute with $3,000,000 for land, buildings, and equipment. The voters of Alabama gave a 3-to-1 approval for a bond issue to raise the money. The Research Institute provides the computer support and experimental facilities for faculty and students at the University. It is at present supported almost entirely by Federal money. It is subject to the tensions caused by its creation as a research entity and its utility as a means of supporting academic departments in mathematics, science and engineering. Its purpose and performance are understood and appreciated, its origins and developments have been influenced heavily by needs of the Army and NASA for improved education and research in Huntsville, and yet it is at present an academic anomaly to many university administrators in the sense that it serves academic purposes outside the usual academic organizational structure.

To those of us in Government service who have seen the development of the UAH and the great improvement of the opportunity for education and research which it has provided, the Research Institute has been a great success, and we expect its contributions to continue and grow in the evolution of the University.

DR. MILLMAN: Is there a question or two?

DR. GRAYDON BURNETT (U.S. Bureau of Reclamation): For those students who spend full time on campus pursuing their master's or perhaps their Ph.D. degree, do they remain on the Government payroll during this period?

DR. HALLOWES: Yes, they surely do. They're quite highly paid, most of them probably at the average level of GS-12 or GS-13.

DR. BURNETT: I'm wondering a little about whether this would be in conformance with the Training Act, which I believe specifies that you don't send students for the primary purpose of obtaining a degree, an advanced degree, at Government expense.

DR. HALLOWES: I absolutely refuse to argue that with you. (Laughter)

DR. HERMANN: I would like to add one figure which I believe both speakers very modestly did not say. We are most happy to have approximately 90 Adjunct Professors, or part time instructors they're called, from both agencies participating regularly in course work and not all at the same time, roughly 30 per quarter. This comes on top of the 107 full

time professors who are University of Alabama employees. They are extremely valuable in enriching the program.

DR. MILLMAN: A very useful comment.

Now I'd like to turn to our next speaker, Dr. Brage Golding. Dr. Golding received a Ph.D. in chemical engineering at Purdue and was the head of the School of Chemical Engineering at the same institution. He has unique experience in being certainly the first President in this audience of a newly created institution, in the university right near the Wright Patterson Air Force Base. We are looking forward to getting his experience of the interaction of these two institutions. Dr. Golding.

WRIGHT-PATTERSON AIR FORCE BASE AND WRIGHT STATE UNIVERSITY

Example of multi-laboratory efforts to cooperate
with universities and also to establish a local university

DR. BRAGE GOLDING (Wright State University): Thank you, Dr. Millman. Ladies and Gentlemen.

The conversation has been so serious so far this morning that I merely want to remark that every time I have a chance to address an audience in an auditorium I'm reminded of its definition by a famous etymologist--the first part of the word coming from the Latin "audire", to hear, and the second part coming from the Spanish "toros". I'll try to be a little more serious from now on. It's a good definition to remember, though.

I want to talk about what I believe to be a unique situation out in Dayton, Ohio--a city of about a quarter of a million. The Greater Dayton population is close to eight hundred thousand and is the fourth most populous area in Ohio. A large Air Force installation just outside of Dayton is the Wright-Patterson Air Force Base which has some twenty-eight to twenty-nine thousand employees, among whom there are roughly, a thousand Ph.D.'s doing research on high-level work for the Air Force. The relationship between Wright-Patterson Air Force Base and Wright State University which I represent I think is unique in the history of higher education because the whole thing actually started before the inception of either institution. Very briefly let me review it for you.

In 1924, the Dayton community, with considerable foresight, donated over 4,500 acres of land to start an Air Force facility now known as Wright-Patterson Air Force Base. Twenty-four years later, in this same Dayton community, through its Miami Valley Conservancy District, an additional tract of land was relinquished at a small cost to the Federal Government with the intent that it be used for educational purposes.

Dedication of land in the Dayton area to the Air Force and to education took another turn when the United States Air Force returned to the State of Ohio 190 acres of land, about one-third of Wright State's present 618 acre campus, to assist the citizens of the Greater Dayton community and the State of Ohio in satisfying the pressing need in the fourth largest metropolitan area of Ohio for educational programs at the university level, with state assistance, and located within commuting distance of most students it would serve. Among the dividends anticipated by the Air Force from the establishment of a new university located nearby were:

> One, it would aid in the retention of scientific personnel--particularly junior personnel anxious to further their education at the graduate level.
>
> Second, it would be of assistance in attracting senior scientific personnel because of the potential opportunity for teaching and associating with a university.
>
> Third, it would provide opportunities for contributions to the research laboratories through part-time studies by the faculty and graduate students of the university.
>
> Fourth, it would provide Wright-Patterson Air Force Base employees and their children with educational opportunities within easy reach.
>
> And fifth, it would provide an additional source of college graduates for potential employment at Wright-Patterson Air Force Base.

It is of interest to note that the Ohio Board of Regents (which was responsible for establishing Wright State University) said this about the technical programs to be established at the Wright State University:

> "The science and engineering program as planned for Wright State University...is intended to be different from the engineering program offered at eleven other private and public institutions in Ohio. This program...would match professional and research resources unique to the Dayton area. The fields of specialization as developed are in biological engineering, materials-science engineering. While additional science and engineering fields may be developed at a later date in the light of demonstrated need, it is expected that initial efforts will be concentrated upon these three science and engineering specializations in order to make them of outstanding quality."

So it can be seen that for the past forty-four years, since 1924, by cessions of land and by recognition by the Board of Regents of the special position of Wright State University vis-a-vis Wright-Patterson Air Force Base, the basis for the University-Federal Laboratory relationship was being established.

In our case, history--good as it was--was lent a helping hand by public policy. At the time the General Assembly of the State of Ohio was establishing the Wright State campus--under the auspices of Miami and Ohio State Universities, the President of the United States was sending to the heads of departments and agencies his well-known memorandum: "Strengthening Academic Capability for Science Throughout the Nation." In this memorandum, the President said, in part:

> "The strength of the research and development programs of the major agencies, and hence their ability to meet national needs, depends heavily upon the total strength of our university system. Research supported to further agency missions should be administered not only with a view to producing specific results, but also with a view to strengthening academic institutions and increasing the number of institutions capable of performing research of high quality."

He cited specific functions of NSF and HEW as examples of this policy and then went on to generalize:

> "All Federal agencies with substantial research and development programs have an interest and need to develop academic capabilities for research and scientific education as a part of their research missions."

* * * * * * * * * *

> "To the fullest extent compatible with their primary interests in specific fields of science, their basic statutes, and their needs for research results in high quality, all Federal agencies should act so as to:.....Provide research funds to academic institutions under conditions affording them the opportunity to improve and extend their programs for research and science education and to develop the potentialities for high quality research of groups and individuals, including capable younger faculty members; and contribute to the improvement of potentially strong universities..."

To complete the story of the establishment of the actual operating relationship between Wright State University and Wright-Patterson AFB, Wright State did achieve independent university status on October 1, 1967, and this fall began its first full academic year as a member of the State of Ohio university system, with an independent Board of Trustees, administration, faculty, and accreditation, and almost 8,000 students. At Wright State University there are some two dozen major disciplines, some 96 different programs, and we already have graduate programs running concurrently with development of undergraduate programs in education, business, chemistry, biology and mathematics.

The importance of planning the enterprise is nothing new, but as we all are aware, since operations research began during World War II and was followed by subsequent research, it has taken on a new significance. Systems analysis is important to any university but particularly to a

new one. We at Wright State are especially concerned because we realize that only through planning can we hope to meet the impatient community demands and the demands of an ambitious faculty to achieve in a decade or less what some institutions of higher learning required a century or more to accomplish.

It is because of the signal importance of planning to the Wright State enterprise that this Symposium is from our vantage point most timely. We are right now in the process of developing a compatible and mutually beneficial relationship with the Federal laboratories (and other installations at Wright-Patterson--the Air University and the Air Force Institute of Technology in particular--) as well as with the broader Dayton community. We are delineating goals; we are making plans; and we are witnessing some tangible dividends with even more promising prospects for the future. We need to plan, and for successful planning, we need data. We are therefore delighted to learn what we can from you and pass on what we have discovered and done.

Given the location of Wright-Patterson and Wright State University, and the policies guiding our relationship, let us look at the principal factors tending to make the relationship successful and fruitful and then at the factors which could render it unsuccessful and barren.

Contributing to its success are proximity and easy communication--people become acquainted professionally and socially. Wright-Patterson employees and their dependents (many spouses as well as children) attend Wright State University. Some 15 percent of the students at Wright State University are either Air Force personnel or dependents of Air Force personnel.

Although the relationship is not exactly symmetrical (Wright-Patterson is roughly fifty times as large as Wright State University at this time in size, personnel, and budget), we each have resources needed by the other in the areas of: (1) technical competence, faculty, consultants, teams to work on government contracts (2) facilities, and (3) as already mentioned, because of proximity, students for us and education for Wright-Patterson people.

On the other side, we have different institutional purposes and different approaches in research--mission-oriented vs. discovery-oriented. Very often this conflict is more theoretical than real; e.g., the effort to engineer a method or system to accomplish a specific end may be as productive for engineering education as it is of a design for action.

There is general suspicion of and antipathy toward the military and the war effort, by some of the younger faculty members particularly. The war in the Far East has perturbed a lot of young faculty members as well as older ones. Classified research has perturbed a number of them and we will probably face the problem that many other institutions have

faced as to how deep and how abiding this tie between Wright-Patterson and Wright State University is going to be.

Given the factors of proximity and complementary needs and resources on the one hand, standing against divergent institutional purposes and suspicion of the military on the other, what has been our experience? There is no question that it has been and continues to be highly satisfactory and reflective of the desirable circumstances of proximity and the fulfilling of mutual needs, while the potential for discord and barrenness remain largely matters of discussion and speculation. Let me now itemize for you the specific areas in which the University-Federal Laboratories interaction has been extremely fruitful already--and this is only a beginning:

Technically trained faculty in the sciences (chemists, mathematicians, physicists, engineers, and psychologists) have been and are being utilized as consultants by Wright-Patterson Air Force Base laboratories.

Base personnel have provided invaluable assistance in the development of our programs in the science and engineering areas. The Air Force Institute of Technology has supplied a number of faculty in areas initially understaffed by Wright State University faculty to assist the University in providing strong academic programs for our students.

The laboratory facilities of Aerospace Research Laboratories and others at Wright-Patterson Air Force Base have been made available to our faculty while our own in-house facilities are being developed. In our Department of Chemistry, for example, this cooperation has enabled the University to attract and retain highly qualified young faculty members. In addition, this interplay has a directional influence on research interest areas of certain of the faculty. For example, we now have research going on in holography, photochemistry, high temperature polymer behavior--to name a few areas of joint interest to both our faculty and scientists at Base laboratories.

The common University and Wright-Patterson AFB interest in various physics areas (for example, plasma physics) has led to the exploration of a possible Wright State University jointly cooperative faculty, base personnel, and facilities effort between the two organizations.

The Wright-Patterson AFB Materials Laboratory has made facilities available for assistance in graduate research studies. While our facilities are excellent, certain equipment items are not yet available to us because of only four short years of operation. In numerous instances we have relied upon the facilities of the Wright-Patterson AFB to augment our capabilities.

We are presently engaged in research involving both physics faculty and students using the Base accelerator facility coupled with our University facilities.

We cannot overlook the normal research and development contract programs in support of individual faculty members at Wright State University which have provided funds for the maintenance of our already developed research groups.

Several of our Departments at Wright State University are presently looking toward specific individuals at Wright-Patterson AFB as Adjunct Professors to bolster research capabilities within our rapidly growing departments. One such department, chemistry, has not only proposed interfacing with key Base personnel but also with key industrial concerns in the area via the use of adjunct staff to augment their specialty area capabilities with outstanding scientists.

Joint symposia and conference sponsorship between Wright State University and Wright-Patterson Air Force Base to bring noted scientists to both the campus and the Base has had a mutually stimulating effect upon the research atmospheres of both organizations.

Educational possibilities for Wright-Patterson Base personnel and their dependents at all levels from non-degree employees to Ph.D. level scientists is perhaps our major contributing effort at the present time, with approximately 15 percent of all Wright State University students having some association with Wright-Patterson Air Force Base (military, civilian, or dependents thereof).

These interchanges have had an influence on both faculty and students. The contact of personnel on both sides has been valuable in shaping attitudes and abilities in areas of paramount interest to a wide segment of the scientific community.

In any potential interfacing of the academic community with those of the mission-oriented Federal facility, there is required a mutual understanding and joint appreciation of those elements common to the goals of each. We are presently fostering this understanding by frequent meetings of our faculty and administrative staff with Wright-Patterson Air Force Base personnel. Hopefully, these meetings will generate even more fruitful cooperative efforts.

What does the future hold? I am sure Wright-Patterson Air Force Base and Wright State University each has a slightly different perspective. As our capabilities improve, particularly in the science and engineering areas, our ability to cooperate in the efforts of the Base can only improve. In this area, and even within present support restrictions, we can realize in some measure a truly cooperative venture between the two organizations.

However, the potential is greater than this. The setting and climate are especially suitable for joint cooperative efforts between Wright-Patterson AFB and Wright State University; however, this process can only be feasible if we can overcome the restrictive policies curtailing it. Many present policies, geared toward the "establishment",

prevent the development of new talent regardless of climate (for example, policies which militate against support of programs in which the Ph.D. degree has not yet been authorized other than on a highly specific contractual basis). These policies are present at Wright-Patterson AFB and most other Government laboratories. Our faculty often hears from a few base personnel, "We can obtain the best scientific talent regardless of location" or "We don't need to develop capabilities, we can buy them". This short-sightedness adds fuel to the faculty doubts and discourages the very attitudes needed to improve any cooperative efforts, particularly those of a growing university.

In summary, propinquity and mutual benefit provide the catalyst for the rapid interaction between Wright State University and Wright-Patterson AFB. Both institutions are working hard to increase the base of interaction.

An ancient seer summed up our situation concisely and well: "The day is short and the task is great. It is not incumbent upon thee to complete the whole work, but neither art thou free to neglect it." We do not intend to.

Thank you very much.

DR. MILLMAN: Any questions or comments?

If there are none, we will go on to the last speaker on this half of the morning's program.

Dr. Albert Hoyem is a physicist. He has taught physics and been chairman of the math-physics departments in the past. For the last twenty or so years he's been associated with the Naval Weapons Center at China Lake, California. Since 1965 he has been the Educational Director. He will describe their experience with UCLA and perhaps say something about future plans.

NAVAL WEAPONS CENTER, CHINA LAKE, CALIFORNIA

An old, well-developed program established in a geographically isolated community is faced with university withdrawal from the program

DR. ALBERT G. HOYEM (Naval Weapons Center): Thank you, Dr. Millman.

The Naval Weapons Center at China Lake, California is the former Naval Ordnance Test Station, long familiarly known as NOTS. It is located on the western edge of the Mojave Desert and occupies nearly 1200 square miles of territory. Within its boundaries are a vast array of precision-instrumented ground, track, and flight-test ranges, the

Michelson Laboratories complex for pursuit of research, development, and production, a Naval Air Facility for test and logistics support, and the Navy-owned community of China Lake with a population of about 12,000 people. For the benefit of boat and yacht owners I should point out that the lake from which China Lake takes its name is dry, though the town is not.

China Lake is approximately 150 miles northeast of Los Angeles. Its location can be further defined as 120 miles east of Bakersfield, 130 miles north of San Bernardino, 250 miles west of Las Vegas, and about 330 miles south of Reno. In between is lots of interesting country, but few towns and few people.

The total population of the area immediate to China Lake is nearly 20,000 counting those who live in the nearby towns of Ridgecrest and Inyokern.

The Center at present has 4,100 civilian employees and a Navy complement of about 700 officers and enlisted personnel. Fourteen hundred, or roughly one-third of the civilians are college or university graduates. One thousand and eighty of these are scientists or engineers. Slightly more than 200 have the Masters and about 80 the Ph.D.

When the Center was established in 1943 the nearest schools with full-fledged curricula in engineering were Cal Tech, USC, and UCLA--all more than 100 miles away. Since that time a multitude of campuses of the California state college and university system have been established, but none closer than these three. So, we continue to be both geographically and academically isolated.

To enable its employees to acquire needed training and to further their education without leaving the area, the Center in 1949 entered into a contract with UCLA for an off-campus graduate and extension program at China Lake. The program was basically a graduate program in engineering and was sponsored chiefly by the University's College of Engineering through its Engineering Extension Division. The program also provided graduate courses in mathematics and extension courses at the upper division level in all of the technical fields directly related to the Center's mission--especially in mathematics, physics, and chemistry, as well as in engineering. The number of courses offered per semester ranged from 12 to 15, and about one-third of them were at the graduate level. Classes were held outside of working hours during the late afternoon or early evening and were taught, almost without exception, by employees at the Center who had been certified by UCLA.

The program enabled China Lake employees to complete at China Lake all of the requirements for a Master of Science in Engineering, including the research and writing of the thesis. The thesis was under the direction of an on-campus graduate advisor with whom the candidate maintained close contact. A master's degree in mathematics was also obtainable in the early stages of the program, but the requirements in

mathematics were gradually tightened; first to require that one semester be spent in residence on campus, and then finally that all graduate courses be taken on campus.

The graduate program in engineering was monitored by a member of the University's engineering faculty who devoted one-fourth of his time to that assignment. This included periodic visits to China Lake to counsel students and to meet with those at the Center who administered the program. At China Lake the program was under the surveillance of the Center's Education Committee, a group of high level scientists, engineers, and administrators appointed by the Technical Director. Responsibility for the conduct of the program was shared jointly by the Employee Development Division and by the Education Director. The Education Director, attached to the Office of the Technical Director, was responsible for recruiting the required instructors, planning the curriculum and keeping it attuned to the needs of the Center and its employees, and maintaining liaison with the University. Registration of students and related administrative matters were handled by a China Lake resident who was a part-time employee of the University.

This program continued without interruption until June of this year, at which time the graduate phase was terminated by the University. We were given 18 months advance notice of this termination. The termination was in accord with a decision by the University's Graduate Council, handed down in the fall of 1966, which ordered the halt of all off-campus graduate instruction. Other off-campus graduate programs affected were one in San Diego and one in the Buena Park-Montclair district, both of which were no longer needed in view of the existence of new University of California campuses in those areas. The decision centered on concern about the quality of the off-campus work done by faculty members who moonlight and by graduate students who go to school part-time and are encumbered by job responsibilities. The main objective, we were told, was to strengthen the caliber of the on-campus program by allowing the faculty to concentrate on the resident students and on paper-producing research.

Our efforts to secure a continuation of the graduate program were in vain. Our final proposal, presented in May of this year, was a plan which would have required two quarters of on-campus residence, but which would have permitted about one-half of the coursework for a Master of Science in Engineering to be completed at China Lake. The plan received full endorsement from the University's College of Engineering, but it failed to win the Graduate Council's approval.

At the present time we are in the process of negotiating a contract with the School of Engineering at the University of Southern California for a graduate program in engineering which we hope to have underway the second semester of this year. At the outset, this program will be limited to electrical and mechanical engineering. Under this program, China Lake employees will be able to complete at China Lake 6 of the 10 courses, or 18 out of the 30 units, required for the master's. The

courses will be taught during working hours, on Government time, by Naval Weapons Center employees who will have teaching as part of their regular duty assignment. The students who are enrolled for the Master's program will be expected to take two courses at one time and will be allowed as many hours off for study as they spend in class. Two USC professors, one in electrical engineering and one in mechanical engineering, will monitor the program and will devote one-fourth of their time to that effort. As in the case of the UCLA program, the main function of the USC program will be to provide opportunity for employees to advance their training while working. Pursuit of the master's will be reserved for those who have the necessary qualifications, interest, and potential for advancement.

We have two other programs which relate to the purpose of the symposium, namely, an on-site graduate program in public administration and a program of fellowships and awards in support of full-time advanced academic study on campus. The on-site program in public administration leads to a master's degree in that field and is completely in-house. It is sponsored by the University of Southern California and is currently in its fourth year. Three courses are offered per semester and are taught by USC staff members who commute to China Lake once a week. About sixty employees are enrolled in this program at the present time.

The program of fellowships and awards was instituted in the early 1950's. To date there have been 176 participants in the program and a total of 276 separate awards. At present we have 27 employees away at school, pursuing advanced training under this program. The primary purpose of these awards from the outset has been to increase the competence of the recipient and to provide training needed by the Center. Up to the present time, 44 have acquired the Master of Science through this program and 35 the Ph.D. Six of the Ph.D.'s received the master's while studying for the doctorate.

Availability of these programs has proven to be a tremendous aid in our recruitment work. The constant inquiries we have had during the past year and a half from employees at all levels about what is being done to restore the on-site graduate program in engineering is clear proof of its need and importance.

Thank you very much.

DR. MILLMAN: Any questions? I guess we've used up all the time for questioning. Any general questions for the previous speakers? If not I'd like to turn the microphone over to Dr. Irving.

DR. IRVING: Thank you, Dr. Millman and members of your panel, for your session this morning. We will have a fifteen minute break for coffee.

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DR. MILLMAN: Our next speaker is Dr. Ralph E. Gibson who came to us originally from England with a B Sc and a doctorate from the University of Edinburgh. Dr. Gibson came to this country in 1924 as a Research Fellow at the Geophysical Laboratory at the Carnegie Institution of Washington. He joined the staff of the Applied Physics Laboratory of the Johns Hopkins University in 1946, was appointed Acting Director in 1947 and became Director in 1948. Dr. Gibson.

APPLIED PHYSICS LABORATORY, SILVER SPRING, MARYLAND

An example of education and training programs
in a contractor operated laboratory

DR. RALPH E. GIBSON (Applied Physics Laboratory): I first came in contact with the subject of your symposium somewhat over forty years ago when I took on a teaching job at George Washington and most of my class were then young men who were starting in the Government. Many of those young men are now in directing positions and so on and one of them is of cabinet rank. So I think that the perspective of forty years indicates that a great deal has been done in promoting the competence and the wisdom of our technical people in the Government.

Introduction

The Applied Physics Laboratory is a Division of the Johns Hopkins University which is operated under a single contract with the Navy through which many other Government agencies support work. Its mission may be stated in part as follows:

> "The mission of the Laboratory is to provide, within the contractual authority provided by the Navy, support of specific Navy and other Government programs through research, development, engineering, test, and evaluation in the areas of surface missile systems, space systems, astronautics, electronic warfare systems, ballistic missile systems, advanced propulsion systems and their subsidiary technologies, ordnance devices, and other areas in which the need for the Laboratory's assistance arises."

For the past few years the efforts under this mission have been devoted: (a) to the development and improvement of ship-launched missiles and systems; (b) to the testing, evaluation and analysis of the behavior under realistic conditions of tactical and strategic missile systems, including the Fleet Ballistic Missile Submarines; (c) to the development of a satellite navigation system and the development and use of satellites for scientific investigations; and (d) to research and exploratory development in fields pertaining to the foregoing applications.

To support its mission the Laboratory maintains a staff of 2500, which has remained constant in number for five years. Of these approximately 1100 are professional scientists and engineers drawn from a wide

range of scientific disciplines and all branches of engineering. The scientific disciplines represented on the staff range from pure mathematics to psychology and biology, the majority being physicists and physical chemists. Engineers - aeronautical, mechanical, electrical and electronic constitute about 75% of the staff, electrical and electronic predominating. From these branches and combinations there are developed systems engineers. Since the Laboratory's chief function is to apply advanced technology to solve operational problems arising in the Navy and other Services and in Space, its developments must result in prototype devices or systems that operate successfully in the appropriate environment - be it on board ships or in space. We must, therefore, maintain a corps of practical engineers and skilled technicians who can engineer and build these prototypes.

You see that in the Laboratory itself, we have a Federal Laboratory/ University interface so that we see the topics engaging this symposium from both sides.

Informal Education Activities

Although this session is primarily concerned with formal educational programs, I must take a moment or two to mention some of our informal activities. The object of all educational exercises of an organization is the growth of the entire staff in wisdom and professional stature. A climate conducive to this growth is essential and the promotion of informal education by reading, group discussions, attendance at scientific meetings and discussions with authorities in other fields is an essential factor in creating this climate. To this end the Laboratory maintains a library which not only contains a good collection of books and periodicals but also keeps the interest of the staff in its contents by monthly informative bulletins. Programmed learning books are available in the Library. They are primarily of interest to the supporting staff. Weekly colloquia are held at which authorities discuss recent advances in their fields. Informal study groups are encouraged and the policy for attendance at scientific meetings is as liberal as possible.

Formal Training and Education Programs

Let me first discuss our training programs i.e., programs designed to increase the competence of members of the staff in areas directly pertinent to our work.

Associate Staff Training Program

This is in its eleventh year and has proved to be of great value. It is designed primarily for recent college graduates who have joined the staff to give them a full time systematic course of instruction in the technologies associated with the Laboratory's technical work before they are assigned to permanent jobs. The program assumes that the students have a good knowledge of the various disciplines required for a bachelor's degree in science or engineering and, therefore, presents

courses given by senior members of the staff in areas of technology such as guidance and control of missiles, propulsion, orbital mechanics and analysis, satellite technology, computers and computer language, signals and data processing. Students are required to pass examinations in these courses. In addition, there are individual lectures to orient the students in the operations of the Laboratory and to acquaint them with novel projects of special interest.

After completing a systematic course of lectures lasting five months, each student is assigned to a project in one of the technical groups and at its completion submits a report on the project which is evaluated for technical quality and clarity of presentation. The total associate staff training program occupies a man's full time for seven and one-half months. Over the years 317 persons have passed through this course; 191 are still at the Laboratory.

Systems Engineering Training Program

This program is intended to extend the competence of men who have just been, or are about to be, promoted from the associate to the senior staff and who are assigned to it by their technical supervisors. It consists of an intensive series of lectures and workshops. The purpose of the program is to train men who are sufficiently well versed in the component technologies that they are able to exercise judgment and give direction to more highly specialized members of a team which is working on the synthesis and analysis of complex systems or subsystems involving a number of different engineering and scientific disciplines. This program is just getting underway.

Continuing Education Program

The Part-Time Study Program

The program supports members of the staff in attending local accredited four-year colleges or universities from the junior level up to obtain degrees. It resembles the part time study programs sponsored by the government laboratories in many respects but differs from some . It allows for reimbursement of tuition to those who successfully pass courses given in the evening and allows six hours leave per week or a maximum of 156 days in a calendar year to those taking courses in the day time. This program has been going on for upwards of twenty years. During the past six (6) years eight (8) people have received Ph.D degrees, 93 masters degrees and 50 bachelors.[1]

The JHU Evening College Center at APL

This center was established in 1964 as a result of negotiations between the Evening College at Johns Hopkins University, Baltimore, and the Applied Physics Laboratory. The Center offers, at the Howard County

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1 For greater detail on the APL Part-time Study Program see Appendix C

Laboratory, curricula of courses leading to master's degrees, with majors in various specified fields. Those covered at present are electrical engineering, numerical science, applied physics and space technology. The courses leading to the various master's degrees are open to all who fulfil the entrance requirements set by the University. In order to help students who lack some of the prerequisites, courses to fill these needs are offered in addition to those required for the master's degree. The Center has proved to be very popular, not only with the Laboratory staff, but with scientists and engineers from a number of industrial and governmental organizations in the neighborhood, i.e., within a radius of 20 miles from the Laboratory.

The growth of the Evening College Center at APL may be learned from Chart 1.

CHART 1

ENROLLMENT AT THE JHU EVENING CENTER AT THE APPLIED PHYSICS LABORATORY

	1965	1966	1967	1968
NUMBER OF M.S. CURRICULA OFFERED	1	2	4	4
NUMBER OF COURSES OFFERED	11	16	19	22
TOTAL NUMBER OF INDIVIDUALS ENROLLED	193	331	442	457
NUMBER OF CANDIDATES FOR M.S. DEGREES	56	164	265	309
NUMBER OF INDIVIDUALS FROM GOVERNMENT AGENCIES	25	67	98	140

In June 1968, 58 people attending courses at APL received M.S. degrees from The Johns Hopkins University. With one exception this year the whole faculty of the JHU Evening Center at APL is drawn from the regular APL staff. Although it is our policy to encourage teachers, not on the APL staff, to participate for the purpose of introducing new points of view, I must say that the interest of the Laboratory staff in these teaching assignments is high and the effect of teaching courses on their professional growth is quite significant as you might expect. One interesting feature is a system of collecting constructive comments from the students on the content and the presentation of the various courses offered them. At the end of each course, the students are presented with questionnaires which they may or may not answer and may or may not sign. The responses run from 60 to 80 percent. Each instructor is given the results for his particular course. In addition, so that he may see

the reactions of the entire student body, he is supplied an information sheet on which all course responses are consolidated. No instructor sees the isolated results of another instructor's course. It is interesting to note that as the years have gone by almost every instructor has improved as measured by the reactions of his students. I am convinced that this Evening College Center not only increases the professional competence of the members of the Laboratory staff who take part in it, both students and faculty alike, but it offers a chance for real service to our neighbors in industry, government, and even education.

Fellowships

The Applied Physics Laboratory supports two types of fellowships. One gives full assistance, for an academic year, to selected Laboratory staff members for the purpose of studying or teaching on the Baltimore campus of The Johns Hopkins University. The other offers the facilities and assistance of the Laboratory to selected individuals who are not Laboratory staff members but who are doctoral candidates at the University. Both programs are designed to promote interrelationships between the Applied Physics Laboratory and other divisions of The Johns Hopkins University for their mutual benefits.

Thank you very much.

DR. MILLMAN: Do we have any questions for Dr. Gibson?

DR. ZOLA BRONSON (National Science Foundation): Dr. Gibson, apropos of your comment about the importance of maintaining the organization spirit, could you elaborate a little bit? Would you please describe the overview that top management exercises over the supervisor in his relationships with the research staff to make sure that the individual is receiving proper motivation in the area of continuing education?

DR. GIBSON: Well, in the first place if I could answer that question simply I wouldn't be able to do the job. This is one of the things that's like composing music. It is just really a process, at least as I see it, of osmosis. People in the laboratory sense the objective that the people that are running it are interested in and often initiate these new education endeavors. Then it just gets down that everybody comes in. The worse thing, I think, is to feel that the people don't have responsibility for doing it. Once they get the atmosphere, the atmosphere brings the responsibility. Let them alone to carry it out; that's the way I feel about it.

DR. MILLMAN: Any other question?

DR. GIBSON: I might add one other thing. It is always useful to have a good man organize these things, because nothing can be worse than haphazardly.

DR. MILLMAN: Our next speaker is Mr. Harold Nutt. Mr. Nutt has been educated in aeronautical engineering and has thirty years experience in marine engineering. He also has had experience in personnel administration at George Washington University. For the past ten years he has been the Technical Director of the Annapolis Division of the Naval Ship Research and Development Center. He will tell us about his relations with several academic institutions in this area.

NAVAL SHIP R&D CENTER
ANNAPOLIS, MARYLAND

Efforts and problems in coupling laboratory work to universities

MR. HAROLD V. NUTT (Naval Ship Research and Development Center, Annapolis): Dr. Millman, Ladies and Gentlemen.

Dr. Gibson sort of hesitated on the question that was asked him. It reminded me of the age old argument as to the nature of management--is it a science or is it an art? Dr. Gibson indicated that there are many elements of the arts still in management. We have not yet committed this proposition of training of employees to an exact science.

The Engineering Experiment Station, succeeded by the Marine Engineering Laboratory, succeeded by the Annapolis Division of the Naval Ship Research and Development Center, is located in Annapolis, Maryland. We consider that we are a marine engineering group. We deal primarily with the propulsion of ships, with the auxiliary machinery aboard ships, with the electric power generation, the automation of the equipment on the ship, noise reduction, ships' materials, life support, and systems engineering.

Our chief claim to fame from a technical viewpoint, I suppose, is that we may have pioneered something at some time or another. An example of this came to light recently when we entertained about fifteen of the executives from the NASA organization and had lunch in the Goddard room. Five of these people were from Goddard and they wondered why we preempted them in calling the cafeteria the Goddard room. They were quite surprised when they found that we did pioneer in rocket propulsion, although this is not the type of business that we are in today.

I remember back in 1942 when Goddard came aboard and we started our first few experiments in connection with the propulsion of aircraft by

rocketry. Prior to that, dating back to about 1939, we built our first nozzle in our machine shops. Prior to that we were in the materials business to a considerable extent.

Most of you know that the Navy experiences some real problems in connection with corrosion. In fact we usually say that the Navy loses two billion dollars a year due to corrosion. We did a considerable amount of pioneering work in connection with corrosion research. Prior to that the Navy was interested very much in sound propagation in the sea. Much of the pioneering work in that area was done in our Laboratory. That, by the way, was before the formation of some of the real advanced organizations of today, such as the Naval Research Laboratory, the Naval Ordnance Laboratory and so forth.

The results of all of this work are really very highly dependent upon the performance of each technologist and the interaction between these technologists. Where do these technologists come from? Primarily they come from the universities. Therefore, the work that we perform is highly dependent on the performance of the universities. We must then, if we are to do a good job, couple with the university to the maximum practical extent. The outward manifestation of this coupling in our Laboratory we call the UNI-LAB program--university coupled with the Laboratory. The program has several facets, including cooperative student education which is an undergraduate program, a master's program, a doctoral program, a university research program, and one which is essentially the university extended to the local area. I think you've heard of several examples of that today.

The cooperative program is ten years old and over 100 students have graduated. Many of them are still with us. In round numbers we have a professional turnover of about fifteen percent per year. We try to replace one-third of this turnover from our cooperative program. We have fifteen colleges presently participating in this program with us. These are shown in Table 1.

TABLE 1

UNILAB CO-OP ASSOCIATES

American University
Antioch College
Cleveland State University
Drexel Institute of Technology
Florida Atlantic University
Georgia Institute of Technology
Howard University
Morgan State College
Northeastern University
Pratt Institute
Tennessee A&I State University
University of Cincinnati
University of Detroit
University of Michigan
Virginia Polytechnic Institute

In addition to the problem of recruiting high caliber trainees is the problem of maintaining a sufficient number of the students in college during the summer to ensure an even distribution throughout the year.

Another problem in connection with the coop program is ensuring an even flow of recruits into the program. Illustration 1 indicates the number of cooperative students that we have recruited each year for the last five years. Note that due to the paucity of the input during the years of 1963 and preceding 1963, we increased our effort and like a pendulum we over swung to the point that in 1946 we had increased the number considerably beyond what we wanted. We have managed to bring this down to what we consider a suitable amount since then. We are shooting for eight to ten percent of our total professional population as input during the year.

Another problem considers the mortality of the students entering the program. Illustration 2 is a plot of the retention figures for co-operative students and also for normal college graduates, the retention figure being the percentage of those recruited who remained with us three years after graduation. In 1965 we recruited a certain number of college graduates and about 50 percent of those college graduates are now with us in 1968, three years after they graduated in 1965. While with the co-op population, 100 percent of them still remain with us. There is a big difference between the upper and lower graphs, indicating the advantage of the co-op program in retention of graduates.

In our master's program we have twelve universities as our associates. During the last five years one-half of our bachelor's level employees have enrolled in a graduate level course. Of these, two thirds have enrolled in one or more graduate level courses, and have been accepted as master's degree candidates. In the same five years we have doubled the number of master's degrees awarded to our employees.

In addition to the more formalized programs that we've been carrying on, there is a rather large number of courses of various types that we give at the Laboratory which are presented by various educational institutions. Table 2 shows some of the organizations that have presented courses in the immediate past. Some of these courses were credit courses, others were not.

TABLE 2

UNILAB SPECIAL TRAINING ASSOCIATES

Oklahoma University	U. S. Naval Academy
MIT	Ohio State
University of Michigan	University of California
George Washington University	NYU (New York University)
Wayne State	

ILLUSTRATION 1 - CO-OPS RECRUITED COMPARED TO AVERAGE PROFESSIONALS ON BOARD

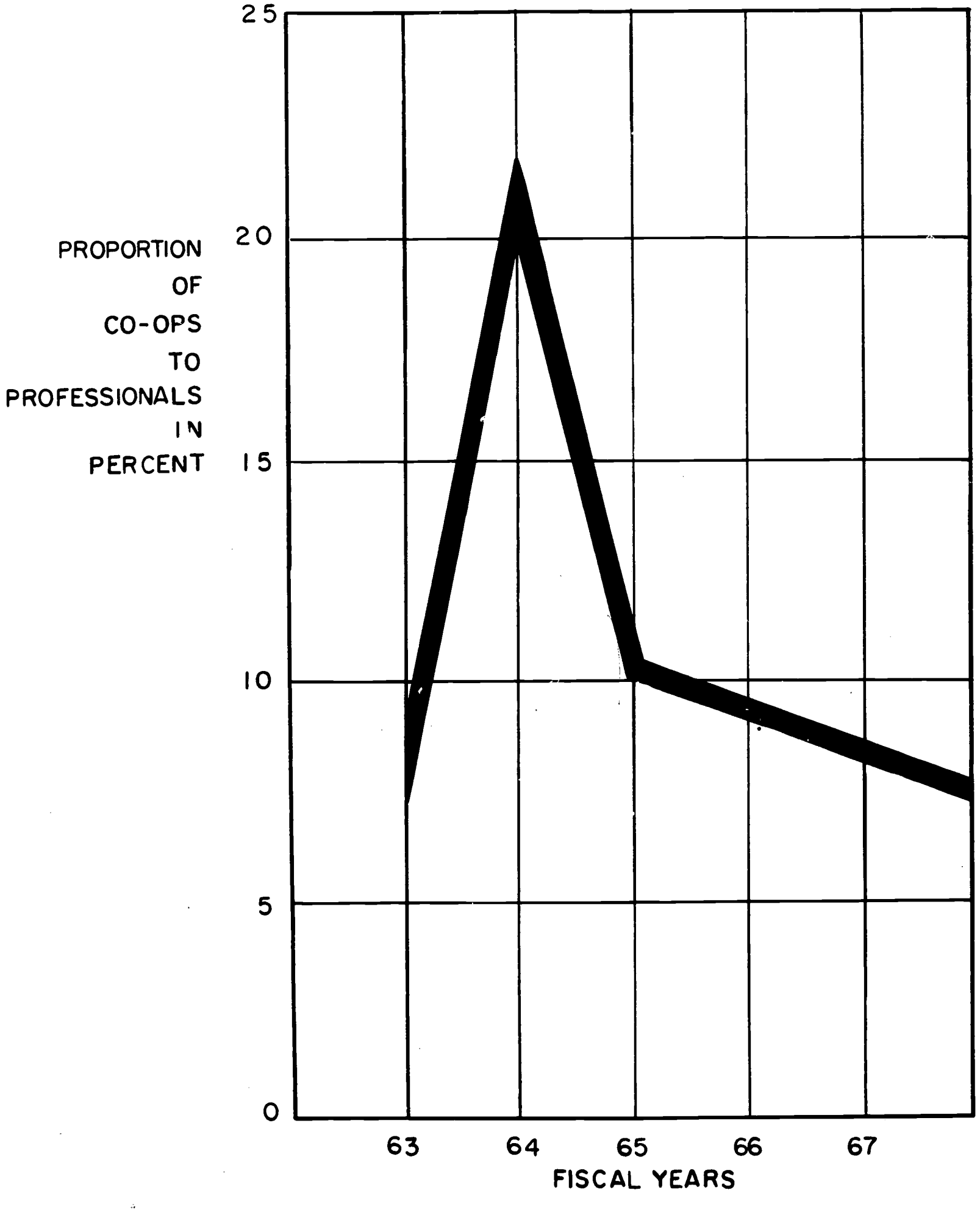

ILLUSTRATION 2– GRADUATED CO OPS REMAINING THREE OR MORE YEARS COMPARED TO THOSE GRADUATED AND COLLEGE GRADUATES (NO CO-OPS) REMAINING THREE OR MORE YEARS COMPARED TO THOSE RECRUITED

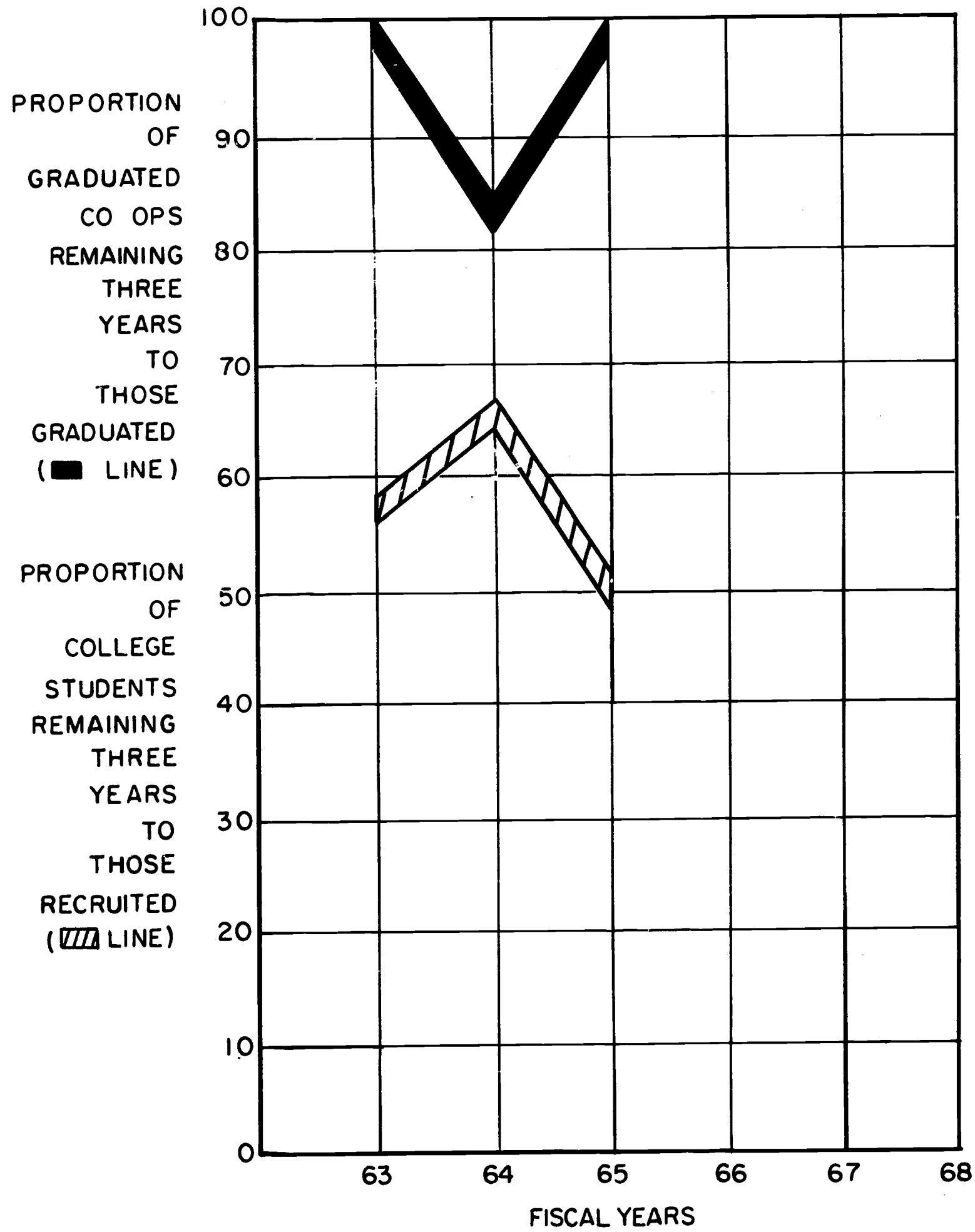

Table 3 indicates the range in subject matter and number of students per course. You'll note that we range all the way from a management seminar there in the upper left, which is a monthly program that we carry out, down to such things as technical writing, very specific technical subjects, such as gas chromatography, holography, oceanography, and so forth--a variety of things given in the laboratory during working hours.

TABLE 3

UNILAB SPECIAL TRAINING COURSES

Course	No. In Attendance	Course	No. In Attendance
Management Seminar	35	Transistors (RCA)	20
Fluidics Seminar	8	Engineering Seminar	5
Low Cycle and Thermal Fatigue	3	Modern Optics	5
Holography	4	Leadership Training	20
Oceanography *	10	Advanced Technical Writing	30
Physical Metallurgy *	16	Technical Writing	23
Dynamic Design Analysis	4	Gas Chromatography	8
Reverse Osmosis	3	Statistics	28

*Credit Courses

We are presently also developing a course in continuing education for those people that have been out of school for a period of time and perhaps lost some of the education, the knowledge that they gained in school, or the skill and proficiency in working with technical matters, perhaps because they have been promoted to more supervisory positions or they have narrowed their pursuits considerably. This course will consist of a nine month's series of weekly seminars, each seminar being six hours in length. These will be led by prominent educators. We are now not only developing the subject matter, but are locating the proper people to lead the seminars. We will start this in the beginning of the year.

In our doctoral program we are associated with a number of universities. These programs of course are highly personalized in nature and we try to support the candidates to the maximum possible extent. Presently eight percent of our professional people are enrolled in doctoral programs. This is a fairly high percentage and is the highest that we have ever had enrolled. The support that we give these people ranges from an all-expense full-salary proposition down to one where we pay tuition only. Presently a few of the doctoral research projects are being conducted in our own laboratories. The majority however are not.

Another project that I wish to tell you about is one wherein the university is extended to the locality of the students. At Annapolis, Navy employment is insufficient to make such an undertaking practical. Therefore we have formed what we call the Greater Annapolis Graduate School Committee to foster among all of the local potential graduate students in surrounding universities a unified effort to produce a mutually beneficial program at the graduate level. We have enlisted the aid of Government activities, the School Board, Chamber of Commerce, and employers of professional people. Programs are now under way in Government administration, personnel administration, and education. Some courses are also being given in science and engineering but a solid program still needs to be evolved. Several problems must be surmounted in order to have a successful graduate level scientific school in our vicinity. One problem is the size of the class. Some universities require a minimum enrollment of twenty students in a class. For a graduate level class it is my opinion that this figure should be a maximum and not a minimum.

Another problem is the transfer of credits. This practice varies with the university from no allowance at all for work done elsewhere for a master's program to an acceptance of as much as twelve credits so earned at some universities. The average is probably about six credits. In this modern day when engineers and scientists move frequently, a much greater allowance for transfer of credits seems reasonable. A friend of mine has 83 post-graduate credits obtained over a period of seven years from five universities, ranging in location from Florida to Pennsylvania. He moved five times in the seven years. None of these institutions would accept a meaningful number of transfer credits.

The final area of UNI-LAB relationships which appears to be of major importance is the joint effort in conducting research. Many Federal Government agencies place research grants in universities. These same headquarters activities underwrite complementary and sometimes even redundant research at Federal laboratories. Too little effort appears to be expended toward obtaining fruitful exchanges between these two research groups. Without spending another dollar except for effective coordination, it is my belief that the efficiency of Federal research could be greatly extended through such communication. I commend particularly the efforts of ARPA in this respect. Project Themis also has taken some helpful steps in the same direction. My chief recommendation is that the Federal laboratory be brought into the negotiations with the university

research groups at the beginning. These laboratories have much to offer in steering a research proposal into a more rewarding undertaking for all concerned.

My time is up. I do want to list some other projects we are working with in connection with university coupling matters. One is the subject of workshops. Another is the subject of visiting committees. A third is the subject of summer consultants. A fourth is the subject of personnel exchange. A fifth is the subject of adjunct professors. A sixth, the subject of visiting professors. And, finally, the subject of professors in residence at the Laboratory. I would be glad to discuss any or all of those with you in detail after the meeting. Thank you very much for your attention.

DR. MILLMAN: You're welcome to see Mr. Nutt after the meeting and discuss this more leisurely, but there's no reason why you cannot raise a question or two right now. Are there any questions?

UNIDENTIFIED SPEAKER: In connection with the Ph.D. programs, some of the universities are fairly remote from the campus. Where does this Ph.D. work take place? Annapolis or the home campus?

MR. NUTT: We have a rather liberal program at the moment, of underwriting education of an advanced scholar such that sometimes he can take full time away on quarter salary, in other cases full time away on half salary and, in what I consider a rather relatively large number of cases, full time away on full salary. Thus it is possible for the student to choose the university that he desires to attend. That's the reason for many of these at the remote locations. Perhaps it's a concept of the pasture on the other side of the fence looking greener.

DR. RICHARD B. CURTIS (Indiana University): I wish that Mr. Nutt had spent the whole time on the last few sentences. In fact I wish the whole conference had been spent on the last few sentences. It seems to me that this is the crux of the whole question. We have a problem of coupling between universities and laboratories. I think in major part it comes from many of the universities and many of the departments within these universities. The faculty members do not think there is anybody out there in the laboratories worth talking to. Because they don't think that, they aren't interested in engaging in either exchanges or in mutual research projects, etc. This is not the case with some of the AEC laboratories and a few others, but for a great number of them this is the case. We can sit here and listen to program after program after program, but if we don't get at the nub of the question, which is how do we get scientists talking to scientists and not deans talking to laboratory directors, we really are wasting our time.

DR. MILLMAN: Do you want to take that?

MR. NUTT: I would like to say that the series of colloquia, workshops, visiting professors, and so forth that I listed at the end are steps in that direction.

DR. MILLMAN: If I could make a comment, my impression of not only this morning's session but yesterday afternoon's as well is that we've been shown examples of very successful programs, and the successes are due to the fact that there have been very strong interaction between the professor and the scientist. I think it would have been wrong to overemphasize the barriers, although they were mentioned, because the programs you've witnessed here are programs of fairly successful operations. But this is not necessarily typical, as I understand it, of all Government laboratories. I think what the less successful laboratories need is a demonstration that in many instances things work and they work very well indeed. One of the things that has come through yesterday afternoon and this morning is how important and how much it adds to the success if the laboratory is very closely tied in with the university. If you can have this kind of a set up, it's ideal. Conversely, the China Lake experience showed that with UCLA far away you have problems. Nevertheless in spite of the problems, they've managed to achieve quite a bit of success.

DR. CURTIS: The problem, sir, is not that the laboratories don't have something to gain. The problem is: What does the university professor have to gain? Unless he can be convinced he has something to gain, we haven't resolved anything. I don't think anybody denies that it would be great for the laboratories to have more interaction with the universities. The question is what is the benefit on the other side and how do we tell professors this, not deans?

DR. MILLMAN: Well, the university professor has a lot to gain by having access to apparatus that he may not easily find in his own place and there have been examples shown where that is actually working. He is going to appreciate that gain more and more as time goes on, as we find further tightening of the budget and so on.

One more question?

DR. HOYEM: I'd like to comment on this. To promote good relationships with the universities at which we recruit and a good understanding of what we have in the way of talent and facilities, we annually bring to China Lake a number of professors for summer employment. The appointments range from consulting and research to direct participation in development projects. Toward the end of the UCLA Program, on which I reported, we had an exchange arrangement wherein a member of the university's

engineering faculty spent a year as professor-in-residence at China Lake, and two members of our technical staff spent part of the same year in residence at UCLA as members of the on-campus faculty. Discontinuance of the university's graduate program at China Lake prevented us from continuing this exchange which has great potential.

DR. GIBSON: Mr. Chairman may I make a remark? Because I did detect in the question that there was a sort of grass roots differential here that, if you want to put it bluntly, the universities didn't respect what Government science is doing. I think that is an overstatement by a long way. There are things going on, I can say this since I am not in the Government, going on in the laboratories from which I see representatives in this room, which excite the greatest respect anywhere you can go, not only in this country but in the world in general. I might mention NIH. If you haven't been there, what good are you in the biological field? I really feel that this is something I would like to take exception to.

DR. MILLMAN: One more question.

DR. ALEX D. ALOIA (Loyola University of Los Angeles): I'm Alex Aloia from California and was past Chairman of the College Federal Council last year at which the universities and colleges, about 140 of them, in an informal way got together with all the federal agencies. One of the things that the faculty members from the various universities asked for was a chance to go in with the various Federal agencies. So we developed for the first time, a cooperative relationship, and I think China Lake is involved too, with sabbatical and leave of absence programs in which faculty members can go into the Federal establishments, laboratories and other phases of Federal agencies so they can not only contribute, gain, grow and get this contact, but can bring back to their university things that they've received. In turn the Federal establishments are receiving so-called expert help in various disciplines. This covers most of the disciplines primarily in the sciences. What I'm saying here is there is a desire on the part of university faculty members and individuals to get into Federal agencies of all kinds, so that they can have not only this dialogue but growth and development and mutually work together. That is called the College Federal Council for Southern California. Our new Chairman this year is Don Sullivan from the Naval Station at Point Mugu and he's here at this meeting. In fact I have twenty or thirty copies of our sabbatical program that tomorrow I'm going to leave out here for people to pick up. I just thought it would contribute to this idea.

DR. MILLMAN: Thank you. Perhaps we ought to take one more question.

DR. WILLIAM J. PRICE (Air Force Office of Scientific Research): I'd like to support Dr. Curtis' major point that the question that really is critical here is how does one get this exchange on a mutual respect basis. However, I would like to relate to the other side of it. Through AFOSR, I have had occasion to talk to hundreds of university professors over the last five years and I really know that the interest and potential of university people wanting to go into laboratories is much greater than the real opportunities for them to do so. So I line up on the other side of the issue here, but agreeing that it's a very critical question.

DR. MILLMAN: If I can take the Chairman's privilege of making a final comment on this. Our effort, as I gather it, is to do whatever we can to improve cooperation between government laboratories and universities plus emphasis on continuing education so that the scientific and engineering efforts of the various laboratories are going to be improved. This is a bootstrap operation. The stronger the laboratories become, the greater work you are going to do and the more attention you are going to attract. The professors are going to come knocking on your door and say when do we come next?

We can carry on this discussion and will be glad to at the luncheon table, but I think we must go on to our final speaker for this morning's program. That is Dr. Michael Pelczar.

Dr. Pelczar was a professor of microbiology at the University of Maryland for fifteen or sixteen years and has been Vice President of Graduate Education and Research since 1966. He will tell us about his experience with various nearby Government laboratories such as the Naval Ordnance Laboratory, the Office of Naval Research and the National Bureau of Standards. Dr. Pelczar.

UNIVERSITY CONSIDERATIONS AND TRENDS

University view of laboratory programs,
major problems, current trends, and innovations

DR. MICHAEL J. PELCZAR, JR. (University of Maryland): Thank you Mr. Chairman, and members of the symposium.

The University of Maryland by virtue of geography is advantageously located for collaboration with Federal laboratories. In fact, we send to prospective graduate students a piece of literature which graphically emphasizes this point. Some 25 major academic resource facilities (Federal laboratories, universities, libraries) are within a 10-mile radius of the campus. Another half dozen facilities, for example, the AEC and the NBS are within 20 miles of the campus.

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Our associations with the Federal laboratories are many and varied, formal and informal. They range over the entire spectrum beginning with the expected person-to-person associations to a formal agreement between the top administrative officer of a Federal laboratory and the top administrative officer of the University. For purposes of this Symposium, I have selected three examples to illustrate the Federal Laboratories-University Relationships in which we participate.

1. The first of these is our participation in offering graduate courses off campus. These courses are agreed upon in advance by all parties and constitute part of a program in the physical and engineering sciences.

2. Second, are our formal agreements between the University and, for example, the National Bureau of Standards, the Naval Research Laboratory and the Environmental Science Services Administration.

3. And third, a case study of a single department and its involvement with Federal laboratories. (Unfortunately, time will not allow for the development of this case, namely the Physics Department and Federal laboratory collaboration.)

Now for some details on each of these examples. First, the Graduate Course Program off campus.

This venture includes participation by: The Washington Consortium of Universities, The University of Maryland, The National Bureau of Standards, and representatives of the industrial complex near the National Bureau of Standards.

The National Bureau of Standards, through the offices of Dr. Shirleigh Silverman, served to facilitate development of the program. I emphasize program since the offering of courses per se has been going on for a long time both at NBS and other locations. The selection of courses is made on the basis that they will provide an appropriate beginning toward a graduate degree program.

The unique aspect of this program is that the group of universities agreed in advance on the courses, who would teach them, together with the understanding they would be acceptable as graduate credits in all of the universities participating. Each student, in advance, would have to be accepted as a degree-seeking graduate student at one of the universities. The NBS provides physical facilities for teaching the courses.

It is also agreed in advance that a maximum of 12 hours course credit taken in this program is eligible toward fulfilling total degree requirements. The student, after taking these 12 credit hours, must return to the university in which he was admitted to complete his program.

The industrial group has agreed, in advance, to subsidize the program, if necessary.

This program is characterized by the following features:

1. Collaboration between universities, Federal laboratories, and industry.

2. It is designed to provide initiation of a graduate program rather than simply an aggregate of course offerings.

3. Industry has made a financial commitment to the program.

The second example of University-Federal laboratory cooperation that I wish to comment upon are formal agreements between the University of Maryland and Federal laboratories. This year, in fact just this past summer, the University entered into the following formal agreements with Federal laboratories:

1. A memorandum of understanding with the NBS for University-Government Cooperation in Advanced Research.

2. A cooperative program in advanced materials research between the Center for Materials Research program at the University of Maryland and the Institute for Materials Research at the NBS.

3. A similar arrangement in advanced materials research between the Naval Research Laboratory and the University of Maryland.

4. A memorandum of understanding between the Environmental Science Services Administration and the Graduate Meteorology Program at the University.

I wish to assure you that we regard these arrangements as simply the beginning of collaboration in specific areas. Much needs to be done before we realize the full benefit of these associations.

In July of this year (1968) we endorsed a memorandum of understanding between the National Bureau of Standards and the University of Maryland entitled University-Government Cooperation in Advanced Research. This is a general memorandum of understanding between the National Bureau of Standards and the University of Maryland concerning the increase in cooperation between the two institutions in scientific research of mutual interest. This document was drawn to provide a general agreement under which such cooperation between the University of Maryland and the National Bureau of Standards can be enhanced. When required, supplemental agreements would need to be executed to cover specific joint scientific research programs. A specific Cooperative Program for Advanced Materials Research constitutes the first such agreement.

Some of the stated objectives in the memorandum are:

1. To make greater use for graduate educational and research purposes the national investment in scientific personnel and facilities at NBS;

2. To bring University competence more strongly to bear on appropriate problems relevant to national goals;

3. To provide increased opportunity for quality graduate study and advanced education at both institutions.

4. To encourage and facilitate mechanisms for effective collaboration between the University of Maryland and the National Bureau of Standards in joint programs.

I would like to point out that the development of these memoranda of understanding evoked considerable faculty discussion. Indirectly I gather that similar discussions occurred at the NBS. Meetings and conferences on this topic at the University took place throughout most of the last academic year before there was an adequate understanding and general agreement of purposes.

Some of the concerns and apprehensions expressed by the faculty during the discussions might be summarized as follows:

1. Concern about the possibility of increasing the number of part-time graduate students in a department.

2. Danger of over-extending the department in response to requests or pressures from the Federal laboratories.

3. Sensitivity to personal relationships following requests for appointment to adjunct professorships.

4. Possibility of jeopardizing acquisition of equipment or facilities if we are associated with Federal laboratories which already have such equipment or facilities.

5. Some faculty saw no need for the formal agreements since, in their opinion, the kind of cooperation contemplated was already taking place on a unilateral arrangement, i.e., Federal laboratory scientists with university scientists.

The formal agreements, memoranda of understanding, as I have indicated, have just recently been enacted and hence, it is too early to enumerate accomplishments. However, in the area of Advanced Materials Research, I am informed that some of the developments to date include:

1. A joint seminar program between NBS, NRL, and the University of Maryland.

2. Initiation of recommendations for appointment of selected adjunct professors.

3. Preliminary discussions on a major joint research project between NRL, NBS, and University of Maryland.

One of the more immediate pay-offs of these memoranda was the fact that we were able to bring together people at all levels from both the Federal lablratories and the University for purposes of discussing the pros and cons of such collaboration. The President's Office of the University, the top administrative officials of both the National Bureau of Standards and the Naval Research Laboratory, University Vice Presidents and Deans, the working scientists at both institutions, and others took part in the deliberations. I think it is very significant that this topic evoked a spirited dialogue resulting in an interchange of ideas among faculty and administrative persons at the University. I am told that a similar experience occurred at the Bureau.

I would like to conclude my remarks with two or three general observations. One, I do not think that we are sufficiently involved with continuing post-baccalaureate education as distinguished from graduate education programs. This has been commented on by several speakers already, but I think it needs to be underscored. Too frequently, I believe, we confuse the matter of providing continuing education courses with graduate education in the sense of degree programs. This raises very serious problems, particularly in terms of the quality of graduate programs. A clear distinction must be made, and more post-baccalaureate offerings should be available for purposes of upgrading an individual in his discipline.

Secondly, it is abundantly apparent to me, at least, that in terms of graduate education we are "creeping" into a new era. As Dr. Long pointed out Tuesday morning, the conventional graduate study cluster is the professor, one or two postdoctoral students, and five or six graduate students. These are on campus, full-time, a closely knit group pursuing some common theme in research. Now we see increased possibilities for graduate student studies and research to be pursued off campus. This, quite obviously, requires very close supervision by the graduate faculty of the home university and by a person at the other agency who may hold an adjunct professorial appointment at the home university. I would raise the question as to whether we might not attempt to extrapolate what might be anticipated ten years from now and to align our graduate educational policies to respond to new development.

Thirdly, in line with the point that Dr. Curtis brought up and getting back to these administrative memoranda that we sign, these in themselves will accomplish nothing unless we can gain the enthusiasm of the faculty to partake in these collaborative efforts. This requires that we continue to explore various means of bringing together both parties so that areas of productive collaboration can be mutually identified. This is, I think, the toughest part of our job. Thank you very much.

DR. MILLMAN: Thank you. Perhaps those who want to discuss this paper further will buttonhole Dr. Pelczar and talk to him at lunch.

DR. IRVING: Thank you again, Dr. Millman, and the new members of your panel, for the second session of this morning. Thank you very much, gentlemen.

Wednesday, October 30 P.M.

JOINT RESEARCH ACTIVITIES INVOLVING UNIVERSITY AND FEDERAL PERSONNEL

DR. IRVING: Our session this afternoon concerns joint research activities involving university and Federal personnel. Our moderator, Dr. Theodore C. Byerly, is a physiologist, animal physiologist, and zoologist from Iowa with degrees from that institution. He has taught both zoology and animal physiology as well as animal husbandry in places like Michigan, Hunter College and the University of Maryland, but most of Dr. Byerly's career has been as a civil servant in the Department of Agriculture. He has specialized in his taught disciplines with emphasis on poultry. He has been a member of and has served as Chairman of the Division of Biology and Agriculture of the National Research Council. He was at one time Deputy Administrator in charge of all farm research for the Agricultural Research Service before he assumed his present position as Administrator of the Cooperative State Research Service in the Department in 1962. This Service administers the Federal research and facilities grants that go to the land-grant colleges. Dr. Byerly, will you take over?

COOPERATIVE STATE RESEARCH

DR. THEODORE C. BYERLY (Cooperative State Research Service): I have been warned by our chairman that this afternoon's session is to leave time for questions even if it costs the speakers some of their time. Let me speak a little about the land-grant colleges.

Among the unique events that took place in 1862, on the second day of May, that year, my father was born. Two months later on July second the first Morrill Act was passed establishing the land-grant college system. Reading the book, I believe that my father's birth and the Morrill Act attracted public attention of about the same order of magnitude because at that time there were certain other events competing for attention.

The Morrill Act contains these words, after providing for the land grants: "The capital of which shall remain forever undiminished, (except so far as may be provided in section fifth of this act,) and the interest of which shall be inviolably appropriated by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are

related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

Of the land-grant colleges pursuant to this Act, there is one in every State. Pursuant to the Second Morrill Act, there are sixteen which were established under the Act of 1890 as Negro land-grant colleges. In one State, Massachusetts, there is another great land-grant institution, the Massachusetts Institute of Technology. In the District of Columbia, due to special legislation of the last session, the Federal City College is to be a land-grant institution, but not associated with an experiment station as most of the others are.

In 1887 the Hatch Act, and this is not that Act which proscribes the partisan political activities of bureaucrats like me but an earlier Hatch who was then Chairman of the Agricultural Committee, provided for the establishment, as the States might designate in association with the land-grant college, of an experiment station. This was the beginning of a program which ought to provide a broader pattern for consideration of some of our current problems of association of universities and Federal laboratories than has been the case. I would like to describe very briefly some of the characteristics of this Act and of associated acts which include the McIntire-Stennis Cooperative Forestry Act, P.L. 87-788, and the Abernathy Facilities Act, P.L. 88-74. These three have in common that they provide for the appropriation to the Department of Agriculture the funds for payment to State institutions. In the Hatch Act institutions are designated by the Legislature. Under the McIntire-Stennis Act institutions are designated by a duly appointed representative of the governors of the respective States. In the Cooperative Forestry Act we have about sixty participating institutions. Under the Hatch Act we have fifty-three. In addition we have a very small project grant program under P.L.89-106 which includes project grants to 16 of the former Negro land-grant colleges established pursuant to the second Morrill Act. We have no formal relations in CSRS with the Federal City College nor with MIT.

I have emphasized the fact that these State agricultural experiment stations are State institutions; that they are associated with colleges. This implies that one of their principal characteristics is that the experiment stations are headed by a Director who is a State employee and, in all but one case, an employee of a land-grant college or university. He is not an employee of the Department of Agriculture. He is not under the administrative control of CSRS. The question of his autonomy within the university is one that varies very widely from one institution to another.

Originally, of course, these experiment stations were the principal research arms of colleges of agriculture. As the land-grant universities have become universities, not colleges, as they have added to their leading (the teaching of agriculture and mechanic arts) other objectives

which have bulked rather large quantitatively (though, of course, not qualitatively) the association of the experiment station with the university has undergone change. Of the 53 agricultural experiment stations at least 38 support research in colleges other than the college of agriculture as well as the principal portion of research within the college of agriculture.

The integration of the experiment station into the university is a process that varies from place to place. I would point out that the very term agricultural experiment station is in lower case, not in caps, so that several stations no longer have a place that, in caps, is spelled Agricultural Experiment Station. This is a sign of the times, a sign of orientation and integration. The research that they cover extends all the way from soil to sociology, including, of course, forestry.

The characteristics of the program include the geographic distribution to all of the States by formula as a principal means of allotting funds. Institutional grants are the basic form of research support. The funds cannot be transferred, for the most part, from one to another. They are, however, limited administratively to expenditure only on projects that have been approved by the Cooperative State Research Service. This is not required by law with respect to the formula funds, but by mutual agreement it is a matter of fact.

The Hatch Act provides that not more than 25 percent of increases in funds appropriated may be designated as Regional Research Funds to support cooperative research projects on problems that concern two or more States. The agencies of the Department of Agriculture and other interested agencies cooperate on these projects, using their own funds. The Regional Research Fund is allotted to projects recommended by a statutory committee of nine persons, elected to represent the Directors of the experiment stations. The projects are recommended by the Committee and approved by the Secretary of Agriculture or his designee, in this case CSRS.

A substantial portion of the formula funds under Hatch, the formula funds under McIntire-Stennis, and those for facilities grants require matching. The matching by the States, which is an essential portion of these programs, has in fact been in a ratio of more than two to one from State appropriations as compared to Federal appropriations. Of the total support to the agricultural experiment stations, the funds provided through the Cooperative State Research Service amount to only about one-fourth.

In total, funds from several sources support the research of the ten thousand scientists and research investigators in the experiment stations and cooperating forestry schools, in the amount of more than $225 million. Of the Federal funds that they receive, they are not limited to funds from the Cooperative State Research Service. They are eligible, too, for contract and grant funds from other agencies of the Department of Agriculture including the Agricultural Research Service,

the Economic Research Service and the Forest Service. They are eligible for receipt of grants from other granting agencies. Many of the ten thousand people in the experiment stations are receiving additional support on the order of $35 million collectively from such sources.

To come back to the Cooperative State Research Service itself, we are a very tiny agency. We are a granting agency. We have a staff of about 45 senior scientists thinly spread across all the scientific areas from soil to sociology. Our tasks are to administer for the Secretary of Agriculture these acts, to verify fiscal accountability and program accountability, to participate in the coordination and the planning and evaluation of research. These are our functions.

This morning there has been discussion of the two-way exchange of people. I hold firmly that with respect to senior scientists in an agency such as ours it is essential that they should be retrained from time to time. As a matter of policy and a matter of practice we have succeeded in keeping about ten percent of our professional staff out for academic year training periods. We have fallen below that in the current year. We have tried at the same time to have a like number of scientists from the cooperating institutions in our establishment. At the moment we have one man at Cornell and one woman at Michigan State. We have, in exchange, a woman from Penn State and a man from Oregon State in our staff. We feel that this is essential to keeping a staff of persons of high competence who can hold their own with their fellow scientists in the Establishment.

Now let me come down to one or two of the problems. I spoke of projects. Projects are statutory under the Regional research funds. Projects are not statutory but are a matter of practice with respect to the formula funds under Hatch, McIntire-Stennis and the associated non-Federal funds.

During the past two years we have under way in the Department of Agriculture the development of an automated system of current research information storage and retrieval which, when it is completed, hopefully will tell us who within the Federal and State establishment is doing what, where, now. Hopefully it will tell us what was achieved last year, what it cost, and, in a sentence or two, what is planned next year. I said hopefully. This small segment of research involves ten thousand scientists in the land-grant colleges and other public institutions, approximately ten thousand graduate students associated with them, and another five thousand scientists in USDA research agencies. There are more than twenty thousand work unit projects in the system.

It is beyond human comprehension to know all that is going on in twenty thousand bits. I say it is beyond human comprehension because I am human and it is beyond my comprehension. Perhaps there does exist somewhere someone who can do this. I have heard of idiots who can sit beside the railroad track and watch a hundred car freight train go by

and recite the car numbers backward after it's passed. This is a particular type of idiocy to which I do not aspire. There is the problem.

There are other problems. There is always the problem of the administrator and the problem of the scientist. The scientist who says, "Bring me the money and go away. What did I do with it? Don't ask me, I'm busy." These problems are there in our system; they're not different from yours.

With respect to fiscal accountability we have, up to now, managed to keep things fairly simple. Under the Hatch Act, for example, an experiment station has to have two accounts. One for all of the Hatch formula projects, and there may be two or three hundred, one account on a total aggregate basis. There must be another one on the aggregate of Regional research funds in which a particular station is participating. There may be from one to fifty at any one station. The very small programs of facilities grants and of special project grants are accountable on an individual project basis.

These fiscal accountability matters, as I said, we have managed to keep simple. And since, as I understand from the chairman's instructions, we were supposed to identify issues, I identify and perhaps only wonder what the course holds for the movement toward a single audit agency for recipient institutions. This is well down the road. I am very sure that our cooperators will not have so simple an audit system under the aegis of any other agency as they now have. This is subject to challenge, but I believe it to be a true statement.

Now, the question of program accountability is one that bothers me very much. I spoke of the association of funds. No matter who puts in ten dollars and who puts in one into a project jointly associated, the fiscal accountability is easier than the program accountability. The easy tendency is to say, "Look what we did. This is what we found and everybody who contributed to it gets credit for all of it." Ethically this bothers me some. Pragmatically it's no problem. Perhaps we shouldn't talk about it.

I want to come to another thing that concerns me. I listened to Dr. Long's very effective presentation yesterday, and twice I understood him to say that a university was a better place to do basic research than a place to do applied research or development. This, I'm very sure, was his honest and considered opinion and, as such, he has a perfect right to it. I do not hold that opinion.

I give you here the history of research--mission-oriented research--in the United States Department of Agriculture and its cooperating land-grant and other institutions since 1887. If we cut it in half and cut that in half and half again, the contribution in terms of human welfare that has stemmed from the technology developed through this research is one of the wonders of the world. The only assurance that can be given to you or your children or your grand-children that they will eat well

rests on this technology and its continuing development. Whether or not it could have been done better without the universities I do not know, because we didn't do it that way. We do know that the system we have has been a highly effective system.

I challenge, therefore, whether it has been established that the university is a better place to do basic research, than it is to do applied research. What we call agricultural research may, by generous terms, be said to include 35 percent or some other percent of basic research, whatever that is, but its objectives are applied and mission-oriented. It is a success story.

In the interest of further challenge and to try to provoke conversation before we're through, let us come back then to whether or not a university is a good place to do research at all which has been accepted, but perhaps is subject to challenge. A Nobel Laureate said there only have been two really fundamental advances in the sciences. The first is in the field of atomic physics leading to creation of quantum mechanics and the release of atomic energy; the second in biology in which the fusion of biochemistry, biophysics and genetics to form molecular biology has led to an understanding of basic biological phenomenon which only a generation ago seemed out of reach of science altogether. Atomic physics was created almost exclusively within the framework of traditional university institutions whereas in biology the modern developments have not come from the traditional departments of biology. They are largely the results of the efforts of chemists, physicists, and biologists who frequently work in non-biology departments and outside the universities. In Britain decisive advances associated with the names of Wilkins, Crick, Watson, and Kendrew were made in the medical research council units in London, at Kings College and at Cambridge. Both of these units financed by the Medical Research Council were placed in physics and not in biology laboratories. In France the decisive contributions associated with the names of Monod, Jacob, and Lenow came from the Pasteur Institute, an institution not controlled by a university. In the United States the Rockefeller Institute was a major contributor through the work of Avery, McCloud and McCarthy to the new developments. Enough. I'm a biologist. I think this is a very ponderable statement. Now are there questions?

I'm not going to try to provoke you to ask me questions because I am very sure that the two following speakers can use this time to very good advantage.

The next speaker has asked me to give him an introduction which he wrote on one piece of paper and I'll have to find it because I wouldn't want to do him any violence. I have his assurance that he was born, that he is the Chairman of the Joint Institute for Laboratory Astrophysics, that he is Chief of the NBS Laboratory of Astrophysics Division and that he is Professor Adjoint of Physics at the University of Colorado. Dr. Lewis Branscomb.

THE JOINT INSTITUTE FOR LABORATORY ASTROPHYSICS

A fully integrated partnership between
Government Laboratory and University

DR. LEWIS M. BRANSCOMB (JILA): Thank you, Dr. Byerly.

I have been continuously rethinking my remarks since this meeting started and I did want to introduce it with two thoughts added since I prepared my remarks. The first takes off very naturally from the remarks of Dr. Byerly. It is important to realize that in agriculture, in veterinary medicine, and in many other areas there is a long and fine history of collaborations, particularly at the land-grant colleges where Government-appointed people have been on campus doing academic and research functions together. I think it is a fact that in the areas of academia that dominate the prestige in the big institutions, which are the basic departments in the liberal arts colleges and science faculties, this healthy and close interrelationship has not existed. It is impeded by what in my private moments I sometimes consider academic arrogance. It is also impeded by the fact that Government agencies involved most strongly with physics, mathematics and chemistry tend to be agencies born out of national security requirements. They tend to be more sensitive politically about external involvements as a result of events of the 1940's and 1950's, and tend therefore to be a little more inhibited. They have more fences around them and there are more restraints of an indirect type in the free flow of people in and out the front door than you will find in agricultural laboratories. So let me not claim that JILA represents a uniquely successful example of civil service scientists working on a university campus. Agricultural people have been doing this successfully for a long time.

My second point, which needs to be made very strongly, is that the remarks I have prepared are directed to telling you how we did what we did at JILA; not how we managed to provide the incentive in the first place for having it happen. It is very certain that the predominant university attitude toward Government laboratories, at least in fields like physics and chemistry, is a somewhat internally inconsistent mixture of jealousy and disdain. Whether that disdain is justified and whether or not we all compete for the same pot of money is irrelevant. The attitudes are there and they must be faced. The lengths to which we in JILA went in order to prepare for that circumstance and to overcome it will be demonstrated in what I say. So there is at least implicit in what I say an important emphasis on the way this collaboration looks to a university faculty and to its students.

Now I should tell you first what the acronym JILA stands for. After yesterday morning's remarks, I think it ought to stand for the Joint Institute for (Frank) Long Appreciation. But it actually is a

research and postgraduate training institute on the campus of the University of Colorado and the acronym stands for Joint Institute for Laboratory Astrophysics. Jointly operated by the University and the National Bureau of Standards, it brings together senior staff scientists of the NBS with tenured faculty of the University in an interdisciplinary laboratory devoted to basic and applied atomic physics. Theoretical and experimental approaches are combined to bring the fields of atomic physics, astrophysics, chemical physics, plasma physics and aerodynamics to bear not only on microscopic descriptions of matter, but also the interpretation of observations--both in the laboratory and in astronomy and aeronomy--of matter in the plasma state. The details of the JILA focus of scientific effort are irrelevant to the present discussion, except to emphasize the following features:

1. JILA deals in part with basic research in atomic and radiation physics, and in this area enjoys a worldwide reputation for excellence.

2. The Institute also is deeply involved with areas of applied physics, not only encompassing the observational sciences (most particularly astrophysics) but also hypersonic aerodynamics, plasma applications, laser applications and related standards work. Here also JILA's attraction as an international center is clearly apparent.

The Institute occupies a University building, constructed specifically for this program in the center of the CU campus. Comprising its staff are about 25 tenured senior faculty-staff, divided almost equally between NBS and CU appointees, plus another 25 professionals on temporary appointment ranging in experience from postdoctorals to mature scientists of world reknown. Thus fully half of the senior staff are not permanent. There are 47 graduate students engaged in research for the Ph.D. in JILA. The remaining 30 people in a total staff of about 130 are staff for technical and editorial support. Administrative staff is minimal and inconspicuous: one executive officer, a bookkeeper and two secretaries.

Of the total population in JILA of 130, only 22 hold civil service appointments. Furthermore, only they and the 10 winners of the NBS-funded Visiting Fellowship program receive their salaries at NBS expense. Indeed, a fundamental principle of JILA is that the lines of fiscal and personnel responsibility are clearly drawn. The total budget of a little over $2 million is the sum of resources sought and justified through two different channels: the University and NBS. Thus JILA comprises two legally independent groups, each self-sufficient and voluntarily associated for their mutual benefit.

JILA may be described from three different viewpoints. To the JILA staff, it is a single, unified scientific institution operating in an academic milieu with its primary external interfaces with other centers of strength throughout the world. The University of Colorado looks on

JILA as an interdepartmental research facility providing opportunities in an interdisciplinary context for students and faculty in departments of Physics and Astrophysics, Aerospace Engineering Sciences, Chemistry and Mathematics. The Bureau of Standards sees JILA as an extension of its Laboratory Astrophysics Division, accomplishing NBS research objectives in a context that provides a larger quantity of better quality work at lower cost than can be accomplished in any other way. The essential criterion for the success of JILA is that each of these separate viewpoints must be compatible, while also reflecting the true self interest of the three institutions involved: JILA itself, the University and the National Bureau of Standards.

Because this conference is organized by the Federal Council for Science and Technology for the purpose of discussing how Federal Government agencies can best implement the Council's policies in support of closer ties with universities, I shall place the discussion primarily in the context of how the arrangement looks to an agency. JILA has already been discussed in this context by Ritterbush[1] and the FCST Committee on Federal Laboratories[2].

NBS Objectives Leading to the Formation of JILA

The initiative behind the idea of JILA came from NBS staff scientists who believed that the Bureau's measurement science research in support of microscopic descriptions of hot radiating gases could be pursued most effectively if the basic atomic physics research and the theoretical work on spectroscopic diagnostics were carried on side by side and were subjected to the discipline of being applied to real and current problems in astronomy and other fields. This was the real reason - and the best reason - for the invention of this organizational device. But with the benefit of some hindsight we can take the starting point as a directly operated Government research laboratory, whose management says to itself, "We have excellent talent but cannot be satisfied that we are making the most of our resources. How can we do the following things?

1. Provide the optimum environment for maximizing the quality, originality and quantity of the research output of the laboratory's staff, and maximize the likelihood of their retention on the staff at no increase in operating costs.

2. Minimize the number of civil service positions required to accomplish this without violating civil service principles.

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1 P. C. Ritterbush "Research Training in Governmental Laboratories in the United States" Minerva, 4, 186 (1966).

2 "Education and the Federal Laboratories", Committee on Federal Laboratories of the Federal Council for Science and Technology, March 1968.

3. Give the agency's scientific staff access to experts from international centers of research, regardless of the agency's normal citizenship and security rules or potential commercial conflict of interest sometimes associated with visiting staff from industry.

4. Subject the research work of the agency, intended to provide certain technological capabilities to the country, to the discipline of being used in a variety of both scientific and technological applications, as well as the stimulation of intimate contact with basic research in adjacent fields less appropriate to the agency's mission.

5. Provide the opportunity for the agency's scientific talent to reproduce itself by contributing to the training of doctoral and postdoctoral young scientists, a particularly important objective when the agency's work requires attitude towards reliability and accuracy not always adequately fostered in universities."

These objectives might be summarized as follows. The agency has some top quality staff, who are constantly solicited by universities to take jobs at higher pay, with more freedom and prestige. The agency's main laboratories are constrained in ways that are a political necessity but do hamper free scientific contact, and encourage a dangerous tendency toward an inward-looking attitude by the staff, with inevitable danger of complacency and sinking quality standards. Turnover is low, and the agency's budget is stagnant and will probably continue to be so. How do we keep the best people, make them more effective in the accomplishment of mainstream tasks of the agency? How do we prove to the world that the civil service provides an excellent milieu in which to be fully competitive with the best the universities can offer, all the while linking the agency to the real competitive world around them? And do all this with a budget and personnel ceiling that at best grows very slowly?

Principles Governing the Design of the JILA Partnership Arrangement

There are many ways that scientifically intensive Government agencies can accomplish their work through the medium of university resources. A widely used mechanism is the establishment of a not-for-profit laboratory, managed by a university (or a group of them)and staffed with a preponderance of staff scientists plus an admixture of university faculty, usually on a temporary basis. While I do not want to decry this arrangement, it does have a number of serious disadvantages. The contract staff may not feel the sense of institutional stability (call it "tenure" if you will) that they have learned to depend on for the maintenance of good intellectual environment and scientific working conditions over the long term. Scientists have been brainwashed into believing that "professor" is a more prestigious title than "doctor", not to speak of "chief" or "project scientist". The Federal contract research center (FCRC) often becomes the tail that wags the academic dog, if it is on campus; it is irrelevant to the university if it is not. In

either case, the contract laboratory staffs are second class citizens on the campus. The insecurity of the faculty produces attitudes that enhance the insecurity of the contract research staff. Most important of all, the FCRC often does not belong to any scientific institution of assured permanence. Thus its management has a vested interest in ensuring that their job does not run out. And their struggle for operational independence conflicts with their dependence on support by agencies whose long term interest in the venture cannot be assured.

In an attempt to avoid these problems my colleagues and I derived a set of principles that would have to govern the management structure of the laboratory we proposed in 1961:

1. All "permanent" senior staff must have tenure with an institution (NBS or CU) of assured permanence having a vested interest in the staff's productivity and happiness. Approximately equal numbers should be provided by each institution.

2. The institute must exist as an intellectual unity, but not as a corporate entity with its own budget. Thus every employee would belong in entirety to one institution or the other; the lines of fiscal and managerial responsibility must be crisp and clear.

3. To ensure meaningful integration into the university community and provide an optimum environment for students, the institute must be located within, not merely near, the university campus. The potential for scientific collaboration is of short range, certainly less than about 100 meters.

4. The civil service professionals must be academically acceptable to the university's departments on the same standards used for university paid faculty. All must be permitted not only to teach, but to assume their share (in kind but not amount) of academic responsibilities. The criterion for determining the type and amount of teaching during official working hours by civil service staff shall be the retrospective demonstration that averaged over time their research output has been enhanced rather than inhibited by the teaching. Numbers of permanent research staff at professional levels not participating academically would be an absolute minimum.

5. The agency must conduct its program on the campus in a manner compatible with the traditional style and purpose of a university. Completely open access to the facility and an absolute prohibition against classified work in it are required, along with a suppression to invisibility of the usual trappings of government bureaucracy.

6. The agency must use judgment in the selection of tasks for its group in the institute, for the research work must be appropriate for conduct on a campus and must provide suitable opportunities for Ph.D. and postdoctoral research. Experience shows that this does not preclude a limited number of service activities if properly conducted.

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7. The university must retain full responsibility for academic matters. It is thus best if the institute is not itself an academic department of the university, but all staff of the institute participate as faculty members of appropriate departments, where the number of agency-appointed faculty with a full vote should be limited to a fraction of the departmental total. Teaching by agency personnel should enrich the curriculum and reduce the teaching loads of the regular faculty; dependency on this teaching must be avoided.

8. The university faculty must have confidence in their ability to gain grant support for their own research and not depend on the participating agency for it, for the agency staff members cannot serve both as colleagues and as judges of the research of their university counterparts. The university administration should be prepared to accept the principle of equal cost sharing with its partner in the provision of administrative overhead and facilities.

9. Recognizing that a campus cannot digest an institute of too large a size, the institute must be designed to operate without perpetual growth. (The same thing might be said of any research operation under current conditions.) Key requirement is to build flexibility and turnover into the staff through the irrevocable assignment of a substantial fraction of the senior and junior positions to temporary appointments of 1 to 3 years.

10. It is quite possible for the agency personnel to reflect one set of skills and interests - appropriate to the agency's mission - while the university staff covers a different spectrum of specialties. However, inside the institute there must be a sense of intellectual unity, usually obtained only if there is a unifying scientific purpose to the entire enterprise. This obviously can be broader than the interests of the agency alone.

Organizational Structure of the Institute

A JILA-like structure is difficult to initiate by management action. Faculty acceptance is vital. The danger of fragmentation of the institute's purposes in attempts to satisfy faculty jealousies puts a premium on the initiative of a small group of agency scientists working with a similar group of faculty members willing to move their research into the institute and risk their careers on the institute's success. Once these individuals are identified, action by management in support of the venture must be swift and sure. From start to finish, JILA was conceived and formally begun with a critical sized staff in 9 months, including the move of an entire laboratory from Washington to Boulder. In general, one should assume that the scientists who would form the nucleus of the joint institute will not be willing to let the demands of organization, planning and fighting for support cut into their research for more than a year.

The essential steps in our case required:

1. Conception of the idea by a group of NBS staff members willing to devote their energies to it and be part of it.

2. A decision by NBS to proceed and to provide one expensive new program: a grant to finance the competitive Visiting Scientists program.

3. A legal opinion by the Department of Commerce's General Counsel supporting and defining the propriety of assigning academic duties as part of the job descriptions of the agency personnel involved in this particular project.

4. Selection of the university, in which the prime considerations were university quality and faculty willingness to accept the nucleus group offered by the agency.

5. Resolution of jurisdictional questions within the university faculty.

6. The negotiation and signing of a memorandum of agreement between the governing authorities of the university and the top agency officials. This agreement is analogous to a partnership agreement, even though it does not have force of law. It describes the responsibilities voluntarily entered into by each partner and embodies devices to carry out the 10 principles discussed above. It also envisions operating rules or by-laws that will be constructed by the senior scientific staff of the institute to govern the conduct of their own activities.

The form of organization adopted for JILA provides for the self-perpetuation of a group of tenured senior staff called "Fellows of JILA", whose legal authority is only advisory to the university and agency but is quite adequate in practice when the agency can delegate enough authority to its organizational unit within the institute. These Fellows elect an Executive Committee and a Chairman, who is the principal officer of the institute and serves a rotating two year term. The Chairman and Fellows are formally responsible to the President of the University and the Director, National Bureau of Standards, both of whom receive minutes of formal meetings of the Fellows.

Line authorities in the two organizations are a division chief for NBS and participating department chairmen for the university. Funds are administered and personnel actions initiated by these people; the JILA Chairman need not be one of them. The Fellows exercise influence over these formal decisions by their control of the titles "Fellow" and "Member", their prior approval of all research proposals and the willingness of line authorities to accept the collective advice of the Fellows on policies affecting the institute itself. In order to ensure compatibility of the agency and university appointees in the organization, the

NBS division is internally unstructured. Each of the professional staff members reports directly to the division chief. He in turn reports at a high enough level in the agency that the special circumstances of this division are appreciated.

A special problem facing a joint institute on a university campus is the provision of space and facilities. Most universities are so crowded that a new building will have to be built. How is it to be financed? Even if the university has access to appropriations it is often undesirable for the needs of the joint institute to insert itself into the priority list of academic buildings. To solve this problem ingenuity is required, with the solution affected by the statutory circumstances. In our case the university was authorized by the state to borrow substantial funds. The NBS provides compensation to the university for its share of the space, not as rent payments but as reimbursement on a 50-50 cost sharing basis with the university.

Personnel Policies

In addition to the provision of tenured staff by both sides, the agency follows a parallel course to the university regarding younger staff members. NBS scientists with 2 to 5 postdoctoral years are given term appointments, analogous to those of Assistant Professors. In this way some turnover of younger staff is provided for, as well as quality competition between them. All research staff either hold academic positions (NBS staff are either Professors Adjoint or Lecturers) or else serve temporarily for one or two years. Students and postdoctoral appointees are all on university appointment. Administrative and technical support personnel are largely on university appointment, although some are civil service. Here the criterion is which employer can provide the best staff. Experience shows that for technical administration and highly skilled instrument makers the NBS is superior. Computer programmers and secretaries of higher competence are hired by the university. A cross servicing agreement permits access to all of the services and facilities of the institute by all of its staff.

Every staff member receives his salary exclusively from one institution or the other. The only exception is that CU-appointed faculty are encouraged to accept consulting appointments to other divisions in the NBS central laboratories. A number of such arrangements exist and greatly improve the coupling between JILA and the operating divisions of NBS outside JILA. Control of JILA titles effectively requires JILA consent before either side appoints another staff member to JILA; in virtually all cases the initiative for appointments lies within JILA so that this problem does not arise.

Applicability of the JILA Arrangement

In my view the JILA arrangement has a wide potential applicability. It does require that the agency have high quality, academically acceptable staff members. Wherever an agency has an unclassified long term

research job to do of a nature amenable to pursuit by senior individuals (rather than large teams) the scheme may work. It seems as applicable - perhaps more applicable - to the social sciences than to the natural sciences. For one important advantage of the JILA arrangement is that the agency people remain full-time Government officials who can legally participate in the making of Government policy. The alternative - the FCRC - generates contractor personnel who can only advise the government.

Many groups have expressed interest in the JILA arrangement and some have copied it in various respects. Among them might be mentioned ESSA's Joint Institute for Tsunami Research with the University of Hawaii, and the Cooperative Institute for Research in the Environmental Sciences with the University of Colorado. The Naval Research Laboratory has a similar arrangement with the University of Maryland. Many analogies exist with the Department of Agriculture laboratories at the land grant colleges, and more particularly with the Smithsonian Institution's Astrophysical Observatory at Harvard Observatory. Considerable interest has been expressed by NASA Centers, where this scheme might be an excellent way to establish front line agency competence in astronomy, solar studies and biomedical research without losing access to the talent for participation in decision making for the agency's operational responsibilities.

Special Problems Deserving Careful Attention

Every good management device has its drawbacks; JILA is no exception. Several that must be watched carefully are:

1. A partnership having no resources other than those of the separate partners can only have a Chairman and not a Director. In any case, if there were a "Director" he could not legally direct civil service appointees unless he were one himself. Thus there is a premium on strong leadership ability among the scientific staff of the institute.

2. The agency management must delegate enough latitude for independent action to the agency's division head in the institute to permit him to adjust to the collective desires of all of the Fellows wherever possible. A critical detail is delegation to that division of editorial review since the papers of the agency scientist are so often co-authored with university faculty who cannot be expected to tolerate long delays in editorial release.

3. In the event the "Fellows" are not able to resolve their differences in the selection of institute leadership, the organization structure does not readily lend itself to constructive external intervention.

4. Institutional identification can be a problem, for both the agency and the university departments want to see their names used as identification on professional publications. A workable solution

in our case has been to identify JILA in a footnote as "of the University of Colorado and the National Bureau of Standards". Staff members may give dual credit if they wish.

5. The name and "image" of the institute must satisfy academic and internal requirements to encourage the most intellectually attractive research environment possible. This may create problems for the agency in justifying its investment in the institute to the Bureau of the Budget and Congress if the scope of the institute as a whole is substantially broader than the agency's objectives, and the agency fails to distinguish its group in the institute from the institute as a whole.

6. JILA's policy on salary differentials between government and university is to ignore them. In fact the pay scales, on a 12 month basis, are reasonably compatible except at the two ends. Junior level personnel - relatively well paid in Government - are hired only as students on university funds, thus eliminating a potential problem and saving money (see below). At the upper end of the scale, some well paid university professors have substantially larger gross incomes than supergrade government employees. This compression of the government pay scale is regrettable but the loyalty of the experienced members of the NBS staff in JILA has been excellent. In any event, no dual compensation to rectify inequities is permitted, even where it might be legally arranged.

7. The agency must give careful attention to the achievement of coupling between the university-based group and the activities at the main laboratories. At NBS we have encouraged a number of NBS central laboratory staff members to spend extended periods at JILA. As mentioned above, JILA staff members serve as consultants to the other NBS divisions. The limitations on growth of JILA force its staff members to look to the main laboratories for opportunities to foster additional research in which they are interested. With the NBS Boulder Laboratories only a mile from the campus, where JILA is located, there are a number of such collaborative projects going quite well.

8. One fundamental asymmetry between agency and university is the complete absence of a secure base budget from which the university can operate. Not even the whole salary bill of tenured faculty is assured. In so far as the university is required to enter into extended commitments - either with respect to facilities or appointments, as in the case of the NBS-supported Visiting Fellowship program - authority for no-year funding by government is of great importance. It is utterly unreasonable that universities, which are financially precarious at best, should have to take great risks in their participation in the partnership, when the Government takes none.

Advantages and Benefits to the Government from the JILA Arrangements

A number of advantages of this arrangement have been discussed above. The real advantages all lie in the scientific achievements of JILA staff and students and the quality of talent JILA attracts. Here I will emphasize the kind of evidence that appeals to budget-minded people, while acknowledging that Bowen Dees[1] is correct in pleading for an optimization of the quality of the educational contribution of the Federal laboratories and not the minimization of expenditures.

1. JILA was formed in 1962 from an NBS section of 28 full-time positions, plus its university "charter members". This NBS staff has been cut to 22, while the senior (GS-14 or above) scientists in the group were increased from 8 to 12. In this time research output has at least tripled, with total published manuscripts from JILA at over 100 per year.

2. There are 47 graduate students in JILA, of whom 26 are engaged in research under the supervision of NBS staff members using facilities provided by NBS. These 26 Bachelor's and Master's level physicists cost the NBS nothing; they cost the university (and the funding agencies) $163,400, overhead included. If NBS had to hire them at GS-7, as would be the case if the projects were conducted in the central laboratories, the cost to NBS would be $400,400, including overhead. Thus a net saving to NBS of $0.4 million per year and savings to the taxpayers of $237,000 per year are realized.

3. Of the eighteen postdoctoral Research Associates appointed by the university on funds not provided by NBS, seven are collaborating directly on NBS projects. Cost to the university projects is $131,000 and equivalent cost if appointed as GS-13 at NBS is $229,400. Together with the students, this means NBS is saving nearly three quarters of a million dollars a year, of which the taxpayers are saving nearly half, thanks to different salary scales and overhead rates. This reckoning fails to account for the value to NBS of the talents and research of the university appointed senior staff, together with their students and postdoctoral assistants.

4. From a quality point of view, objective criteria are not available; subjectively there is every reason to be satisfied that individual staff members have matured scientifically as a result of their contact with students and with a steady flux of senior staff visitors and bright young scientists.

5. Perhaps the most important indirect benefit to Government from this organizational experiment has been the new light in which the civil service is seen as a means of employment for top scientific

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1 See Dr. Dees' contribution earlier in this volume.

talent. Two tests are performed frequently in JILA. First, visitors to the institute meet many scientists. When asked to identify which ones work for the Federal Government in the civil service and which are university professors, visitors are usually unable to distinguish them. Even more important, the students are largely unconscious of this distinction. Second, when we add a staff member to the institute with the opportunity to make the appointment either through university or through NBS channels, the candidate may be asked to express a preference. After close inspection of JILA several have chosen the NBS position in preference to the faculty appointment. Thus in our small way we are hoping to restore the prestige of and respect for the senior levels of the government service as a rewarding career opportunity for creative scientists.

Thank you very much.

DR. BYERLY: Are there any questions?

DR. RAYMOND WOODROW (Princeton University): We've entered into an arrangement I think very much similar to yours. The Geophysical Fluid Dynamics Laboratory of ESSA just moved to Princeton on October 1st. We hope it is going to be as successful as yours. One question you haven't mentioned which we've been discussing. Your people, civil servants, teach. Are they given any academic titles when they do this?

DR. BRANSCOMB: Yes. All of the professionals on the Civil Service side, either have the title Lecturer or Professor Adjoint. The distinction is this. Both the Professors Adjoint and the Lecturers may teach graduate courses. Subject to my approval, they may teach undergraduate courses. They can supervise graduate students, they can serve on academic committees and they are invited to attend all the faculty meetings. But only the Professors Adjoint vote in the faculty meeting. They also vote in the academic senate and in college faculties. As an Adjoint Professor I am in fact serving on the Executive Committee of the graduate school. The Adjoint Professors are limited in number to 25 percent of the department faculty as an upper bound. It is, therefore, impossible for the Federal Government appointed faculty ever to control academic issues by voting as a block. In fact we do not find block voting because issues tend to divide along other dimensions -- theorists against experimentalists, astronomers against physicists and so on. I think it is important to protect the university against even that possibility however remote.

DR. MILTON BURTON (University of Notre Dame): I'm very impressed by the charter which you presented here. It's a magnificent thing and it seems to have solved all problems. But I'm minded also of the nature of grammar in language and there are people who think that grammar came before

language, but as a matter of fact grammar followed the language. We discovered the operating rules. Now what I would like to know is this: Was your charter prepared in advance or is this a report of how it developed?

DR. BRANSCOMB: It was substantially prepared in advance. The operational test of that is to compare my written remarks which will be in the proceedings with the memorandum of understanding which was entered into between Dr. Astin and the regents of the University, and which embodies most of these principles. I spent a year working for Dr. Wiesner on the staff of the Bell Commission which looked into the whole Government R&D policy, contracting, in-house, not-for-profit. A great deal of this design resulted from the education that I received at that time.

DR. BURTON: Well, all I want to say is this is a most impressive feat and Dr. Astin, Dr. Wiesner, or whoever was involved in this is to be complimented.

DR. BYERLY: Mr. speaker, I'm attempted to pursue you a bit, but it's been so delightful that my only question, sir, is have you seen Dr. Pangloss in the wings anywhere?

I'm happy that I cut mine short and you asked me no questions. That gave us an extra five minutes for Dr. Branscomb. It has been well invested. And now our next speaker, Dr. Eugene Shoemaker, was born in Los Angeles. As a farmer I'm curious whether he's going to tell us how to raise corn on the moon or to describe the features of the backside of the moon. Dr. Shoemaker.

ASTROGEOLOGY CENTER, FLAGSTAFF, ARIZONA

Development of an academic cooperative atmosphere in an area of mutual scientific interest involving a variety of Federal, university, and non-Federal groups

DR. EUGENE M. SHOEMAKER (U.S. Geological Survey): Well you've just heard a most impressive discussion on how to do something in a very organized and premeditated way. I'm going to tell you how we've done things in a very disorganized and unpremeditated way but with somewhat the same objectives in mind. I might say, in case you are one of the few that reads programs, that what I am not going to talk about is cooperative research in Flagstaff, Arizona. What I am going to talk about is the cooperative research program of the Center of Astrogeology of the Geological Survey, and the Center is headquartered in Flagstaff, Arizoña. Although we do have cooperative research efforts there with a number of other institutions, I won't even talk about those but about much broader cooperative enterprises across the country.

Every time that I speak to an essentially new group I sometimes have to back off and tell them what astrogeology is and tell them that's not

a non sequitur. What we mean by this term is simply an interdisciplinary field between astronomy and geology. The emphasis is on geology, but we use the instruments and techniques of the astronomer and his viewpoint, in some cases, to investigate the earth as a planetary object. Also to apply techniques of geology to other related nearby objects such as the moon or the terrestrial planet. It's a relatively new field. One might say it became recognizable as a distinct discipline about eight or nine years ago with a very small group of people working in it at that time. In 1960 the Geological Survey began a formal program in this field, supported by NASA, focused at that time primarily on studies of impact processes on the earth, on a study of the geology of the moon and on a study of the mineralogy and chemistry of meteorites and other extraterrestrial matter that falls on the earth. Since that time the program has expanded considerably to include a very active participation in the scientific reduction and analysis of data brought back from the various lunar flight projects--Ranger, Surveyor and Lunar Orbiter. We have a very active program going now in connection with the first manned lunar landings and with planning for more extended research in the post-Apollo period. So that's our program.

In contrast to the problems which we've heard about earlier in this symposium, the problem of how to educate or bring training and education to people in the Government laboratories, our problem is somewhat different. It is how to get research and training of this kind going in universities. In other words, how do we reproduce ourselves in a sense? That's our long-term self-interest--to have new students coming along who would be coming into this field and to stimulate interest and research in the universities that provides the environment for this self-duplication. Before going into that more, I might give some of the history of our staff and of what it is, just to give a little bit of perspective.

We started this group in the Menlo Park Center of the Geological Survey and, concomitantly, a small group working at the same time in Washington. We moved the headquarters to Flagstaff about three years after its inception on the occasion of building our first telescope. Flagstaff was selected because of the conditions there of the astronomical seeing in part, but also to take advantage of the natural field laboratory we have there in the geology of the surrounding terrain--the volcanic rocks, Meteor Crater. We have been using this terrain as a test region for various experiments that would be conducted on the lunar flight projects. Flagstaff was attractive not only because of these natural circumstances, but also because there was an on-going tradition of astronomical research. The Lowell Observatory and then much later the main observing station of the U.S. Naval Observatory were located there. Then the large telescope of the Perkins Observatory was established in Flagstaff. In addition to this there is the Museum of Northern Arizona which has its own research program in geology and with which we have cooperative relations. Then of course, finally, there is the University of Northern Arizona, and we do have a close interrelationship with the faculty there. We have about fifty scientists at the Ph.D.

level in the program, not all of them at Flagstaff. Quite a few are still in Menlo Park and in Washington and the total staff is about 200 people. Most of the non-scientists are technicians supporting essentially individual research programs or small teams.

At the present time, we have cooperative research efforts of one kind or another with approximately a dozen universities in the United States and abroad and we have on-going cooperative research projects with about ten other Federal and non-Federal laboratories and observatories. Most of these cooperative efforts are an individual relationship between one or more members of our staff, usually not more than one, and a member of a staff of one of these other institutions. These relationships have been entered into as a result of scientific opportunity and convenience, for the most part. To illustrate the way that we have entered into these situations I have selected three different case histories, just to give some idea of the mechanisms that were available to us and which we employed. They're not necessarily representative of all cases, but I think they will illustrate different ways in which we've entered into these things.

When we moved to Flagstaff in 1963, we found that there was a professor in the Geology Department at the University of Arizona at Tucson who was most interested to begin research in this field. Our mechanism of helping him get started was to appoint him as a WAE member of the staff. We had him join us for the summer, working on the lunar geologic mapping program. When he returned to his university in the fall, he continued his research work with us and continued observing both in Flagstaff, as the opportunity permitted, and at nearby telescopes more accessible to him in Southern Arizona. He was also able then to begin a program of undergraduate instruction essentially on lunar stratigraphy and geology based on his initial experience with us. This program has developed and matured. It's received good support from the department in which he is located. And this, I might add, is an essential element. As we've looked about there have been a limited number of departments in universities that have approached this subject with some enthusiasm, and we've been at some pains to find them and do as much as we can to help them get their own program going. In this case there was a favorable environment supplemented by the fact that there was a strong effort on the more traditional astronomical side also focused in the same area of interest. The Lunar and Planetary Laboratory under Professor Gerard Kuiper is at the University of Arizona. Since Professor Titley has gotten this program going, there have been a number of graduate students entering in a Ph.D. program there. Four of these students came from Kuiper's laboratory and have gone ahead and finished their degrees essentially under the aegis of the Geology Department. We in fact sent two of our own people down for continuation of their post-graduate education there. Some of these men are fairly experienced and contributed as much to the research going on at the university as well as gaining additional training themselves. We also, as a matter of policy, sent one of our own staff members to be headquartered at the university to supplement the university's own in-house program.

Another example of a somewhat different mechanism is the case of Professor Mutch at Brown University. Again the Geology Department at Brown University was broadly enthusiastic about entering into research in astrogeology and in related areas of geophysics. Prof. Mutch in particular had been conducting some research in a nearby but not identical area or field. The opportunity arose, when he was able to take a sabbatical leave, to give him a limited tenure appointment at our institution in Flagstaff. He essentially spent his sabbatical period with us as a member of the staff but with an opportunity to look across the board at the research work being done and to work alongside individual people as he chose. By the time he had finished his sabbatical leave he had completed the manuscript of a text on lunar stratigraphy and geology. It's the best comprehensive work or description of this field that has been prepared. At the same time, he brought a graduate student with him, who also spent that same period of time and continued on after Mutch returned to his duties at Brown University. The graduate student will continue working toward a Ph.D. in essentially a joint program between Brown University and our staff and relying rather heavily upon the instruments and data resources of the Center of Astrogeology in Flagstaff.

A third kind of mechanism is, instead of bringing the professor from the university to our institution, to send our people to the universities on limited appointments. Sometimes these appointments become permanent. There is a rather traditional interchange between the Geological Survey and the universities, so we're not really unhappy about that. We like to see our people go on permanent appointments into the universities. I'll cite my own case as an example. In 1962 I went to the California Institute of Technology as a visiting professor on a one quarter year basis and have continued as a research associate, which is Cal Tech's euphemism for a part-time professor, to spend one quarter systematically each year teaching in the Division of Geological Sciences. During that period of time I have had supervision or partial supervision of five Ph.D. students. While that may not seem to transport the program, on first blush, to the other institution, in fact it works out that way because each of my students there is also jointly sponsored by another member of the faculty. By this means we've brought research interests of individual members of the faculty, usually a different one in the case of each student, directly into play on working on a given problem with a research interest of my own institution. Thus we've developed a broad contact and broad involvement at Cal Tech in essentially the kind of program that we're interested in fostering.

Now, I might say one or two words about some of the other laboratories. As I mentioned, there are about ten with which we have similar kinds of cooperative research effort going on at the present time. I'd like to take just two cases that have been particularly gratifying. The one I like to cite the most is a case of a cooperative program with the Ames Research Center of NASA at Moffett Field which is geographically very close to our Menlo Park Center. In this case the original impetus for cooperative work simply came out of personal contact between myself and the people at Ames, the Director, H. Allen being one of them. These

people were enthusiastic about ideas that we could work on together in a purely informal way. I was interested in the impact process. They had light gas guns to accelerate projectiles. So I supplied the rocks and they smashed them up for me. This led to the involvement of a member of their staff on a regular project basis. I brought in another member of our staff, and, by 1960, we both had formal projects going in this area. More than a dozen joint papers between members of the Geological Survey and the Ames Research Center staff have appeared out of this effort. The most gratifying part is that the program on the Ames side grew much larger than ours. We had the great pleasure of seeing this develop into a branch within the Center. It has produced some of the most outstanding research in the field.

A second kind of interaction might be illustrated by work we are doing jointly with members of the staff of the Jet Propulsion Laboratory. In this case the impetus was a forced marriage. We were interested as experimenters in using television systems on the Surveyor spacecraft. The Jet Propulsion Laboratory assigned a cognizant scientist whose duties were to integrate our effort with the space flight project, and so we came together by this mechanism. It turned out that there was good complementarity between the talents that we had in our organization and the talents of the man assigned to work with us, so we invited him to become a member of our experiment team. The close working relationship has survived the termination of the project and we have again a case of two individuals on our staff working intimately with a member of JPL, continuing in joint papers after the termination of the original program.

I could cite a variety of other kinds of mechanisms. I think you can easily see that what we practice is opportunism. I think it's a very good way to work. It has been possible to do this because of the very liberal administrative policies in the Geological Survey. I might point to a couple of areas where we've run into small problems, however. Actually, as liberal as the Geological Survey has been in its mechanisms, there are not sufficient mechanisms to do all the kinds of things we would like to do. The mechanism of appointing a student, for example, giving him a WAE appointment so he can work on a research project leading to Ph.D., is not always the thing that is needed. Often the student has a fellowship. He doesn't need salary. What he needs is a small amount of funds for other expenses, for instrumentation, for travel, for field work, and so on. Until very recently we didn't have a mechanism for this, so we were sometimes frustrated or we had to resort to legal but indirect subterfuges to try to provide this.

The other problem, a curious one that we've run into, is that a number of students associated with me at Cal Tech have been NASA fellows or NSF fellows and the terms of these fellowships are such that these students cannot accept any other employment. It turned out the only other way we had, in some cases, of supporting the research of these students was to give them WAE appointments. So the terms of the fellowships in which the intentions were good, frustrated the objective of the

fellowships in this case, which was to foster the students' graduate research and training. In a couple of cases it became impossible to go any farther. We could not take a student on and sponsor his work because of the mechanism of the fellowship itself. As it turns out, Congress now has essentially killed the NASA fellowships. It is a very good program and I hope it will be revived. I wish that some of the agencies such as NASA and NSF, however, would look carefully into the terms of these fellowships so that they don't unintentionally inhibit what can be very fruitful opportunities for the students. Thank you very much.

DR. BYERLY: Are there questions for Dr. Shoemaker? While you're waiting with your question, let me ask one or both these gentlemen and let me make an assumption. We've been dealing perhaps with things that you consider axiomatic. I would like to ask two questions of both of you. First, what is the mission of the university? Second, what is the mission of your laboratory?

DR. SHOEMAKER: Well, I think I can state both sides in this case, since it turns out I will be leaving the laboratory to become a full time member of the University. The prime mission of Cal Tech, I use the word university loosely in applying it here, is to train students. It is teaching. Cal Tech is well known for being heavily engaged in research, but as far as I'm concerned, the main raison d'etre of that school is to teach students at the undergraduate and graduate level. As far as the mission of the Geological Survey is concerned, it is to conduct applied research and applicable basic research in geology primarily aimed at the assessment and development of the Nation's mineral resources.

DR. BRANSCOMB: Would you like me to answer?

DR. BYERLY: Yes, I would like very much to have your answer. I'm very much interested because it seems to me that it gets at the basic ground of the cooperation between laboratories and universities.

DR. BRANSCOMB: The University of Colorado to the best of my knowledge has no mission different from that of any other State university--which basically is to increase knowledge, diffuse it to students and perform public service. The National Bureau of Standards' job is to further the science of measurement. These two are entirely compatible where they overlap in the area of research and in the area of training.

DR. BYERLY: Now, you've had time to think. Your question please, sir.

DR. RAY WOODROW (Princeton University): Your remark about NSF fellowship holders not being able to participate in your program surprised me. We have NSF fellowship holders that participate in programs financed by every Government agency. As long as you don't supplement their fellowship.

DR. SHOEMAKER: That's my problem.

DR. WOODROW: In other words you have to supplement their fellowship, is that your problem?

DR. SHOEMAKER: The WAE appointment mechanism that's been used traditionally for a long time by the Geological Survey is very effective for supporting professors who want to go out and do field work. You give them salary for the summer and they can draw field expenses. In this case we cannot give a student field expenses without giving him an appointment to make it legal for him to draw the expenses. What I am saying is that there is a legal limitation in our mechanisms. One way or another a solution needs to be found. Either the Geological Survey has to develop granting mechanisms so that we can just give and provide this support by means of grants or modify the WAE mechanism. Grants have not been used until very recently and are not used at the scale that I am talking about. I'm not talking about vast grants; what you usually want for students is one or two thousand dollars. We haven't had a mechanism for doing it. The other side of the coin would be if there is a way in the granting of the fellowships that allowance can be made for this situation. We've gotten around this in some cases by having the student actually go off of his fellowship for a period of time during the summer so that he's legally able to accept an appointment. This is not always an applicable solution.

DR. BRANSCOMB: I think you've hit on a fundamental question because the Government's use of consultants is terribly constrained and is completely inapplicable for students, but the WAE has to show up at the door, ready to work, at his own expense. A specific travel prohibition is involved. I think that's a point that might be taken seriously in recommendations that emerge from this meeting.

DR. BYERLY: Questioner on the right.

DR. MARION E. FORSMAN (University of Florida): Mine is not a question but a comment, and it may be a little out of order in this session, but I am going to blanket it under the land-grant colleges topic which was introduced a little earlier. First I have been involved in this type of communications between industry, the laboratories, and the University

for some 20 years, first as an employee of General Electric Company at their Hanford Works, Richland, Washington where I taught courses in their program, and at the University of Florida where I have been involved in the graduate program. I was in charge of the Florida graduate program for about eight years and reviewed all of the applicants for our graduate program on and off campus. Let me go back a little bit to the history of our college so you will understand what I am trying to say. The reason I am saying this is that I came here intending to take something home. I am finding that I am not going to take anything home, but I sould like to leave something here with you.

In reviewing the history of the College of Engineering, which was established in 1910, I found that the Dean wrote in his biennial report of that year that with the four faculty members he had in the College of Engineering, including himself, one of them was loaded with 26 contact hours, another one, 25 contact hours, the third with 23 contact hours. He, as Dean of Engineering, Head of Electrical Engineering, and Head of the Physics Department, was loaded with 21 contact hours. He apologized; the next semester he would have 25. There was no secretary in the College of Engineering and it was one-sixth of a mile away to the nearest phone. In his next paragraph, he said that the College of Engineering must provide educational opportunities to the industries of the State and also perform research for the industries of the State of Florida.

What industries did we have in 1910? There really were not any, but the Dean recognized the need for assistance to industry. We have a heritage of interest in this that stems from the beginning of the College of Engineering. I went there in 1955 and became immediately involved in some programs with the Banana River Project, which is now the Kennedy Space Center. These failed because of the University's inability to offer, like the proverbial carrot, a degree to the employees there. Also because the programs were a little premature, there were not enough qualified people available. We were at Eglin in 1956 and General Mechling tried his best to get a program over there with us. He invited our Graduate Council over there, showed them around and indicated that he would buy a $50,000 library for them, if this was required in order to have a program that led to the master's degree in his operation. Our real problem again was that there were not enough students. We found about 25 students qualified to enter our graduate program.

Shortly thereafter, a group of industries in St. Petersburg requested a program and we initiated one there. The same problems occurred, but the industries were interested enough to continue the program and it survived. We also started one at Orlando when the Martin Company moved there, but it closed down because of the lack of the degree. I emphasize this background because, in 1962, we bypassed the Graduate Council through the efforts of the President of the University. We approached the University Senate and received approval to offer our Master of Engineering degree with 100 percent of the work done off campus. There was only one restriction -- that half of the courses should be

taught by full-time University employees. The remainder could be taught by adjunct professors at the locations involved.

Immediately all of these programs began to flourish -- the one at St. Petersburg and a revived program at Orlando. We then established one at Pensacola, and another at West Palm Beach. In all of these programs to date we have granted over 200 master's degrees, with the students coming to the Gainesville campus only for the final admission to candidacy examination in which they take the same exam that the on-campus students do. They all run through the same sieve on campus. This was to help certify that the off-campus students are doing an equivalent job, as our faculty feel they should. One company in St. Petersburg pointed out that, after the master's degree program was introduced, they were able to attract into their employment people with one grade point higher average than they had attracted before. We noticed this in the applications that came to us for our engineering program.

In 1963 the State Legislature instructed the College of Engineering to expand its program into east central Florida, and GENESYS was started. We have a closed circuit TV network that extends from Gainesville to Daytona Beach to Orlando and to the Cape. It is now being extended to West Palm Beach. The industries want to extend it to Fort Lauderdale and the State system wants to go on to Boca Raton where another university is located.

All of these programs have been backed by our College of Engineering faculty, and the University faculty has recognized that they are good programs. I just want to repeat that we are now operating graduate engineering education programs away from the Gainesville campus and I distinctly do not call these continuing education -- they are graduate engineering education programs. We have located them at Pensacola, Eglin, Panama City, Jacksonville, Orlando, Daytona Beach, the Cape, West Palm Beach and Fort Lauderdale. We are the only college in the State of Florida that has the resources to do this, and that is the reason we have had to extend ourselves so far. I merely wanted to point out to this group that it can be done and our faculty in engineering are fully behind it. Thank you.

DR. BYERLY: Thank you.

DR. IRVING: Thank you Dr. Byerly, thank you Dr. Branscomb, thank you Dr. Shoemaker. Coffeebreak for 15 minutes.

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DR. IRVING: We are ready to begin the concluding part of today's session concerning joint research activities involving university and Federal personnel. The moderator knows that we are aiming at getting you aboard the buses at five tonight, but he assures me that this will not handicap

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the participants in the session this afternoon and that you will, hopefully, have opportunity to discuss their points with them if you choose to do so.

DR. BYERLY: Thank you George, and you didn't even tell a story. And so I will have to beg your indulgence in introducing the next speaker. I think well of him and the reasons are purely pragmatic. He was born in Oklahoma. I have five Oklahoma grandchildren. He was educated in part at least in Arkansas and I have five Arkansas grandchildren. He's an agronomist, he's the President of the Mississippi State University, and I like him. Bill Giles.

AGRICULTURAL RESEARCH AND THE LAND GRANT COLLEGES

Small professional staffs interact on campus with numerous land grant colleges

DR. WILLIAM L. GILES (Mississippi State University): Thank you very much. It's such a rare thing for anyone to like a university president in this day and age that he couldn't have said a nicer thing. I do feel honored to be on this program. Certainly we have had two most interesting presentations here this afternoon and very exciting ones by young scientists.

I would like first of all to describe this research relationship for which Ted Byerly gave us an excellent background earlier in his presentation. This is a very old partnership. This partnership is over a hundred years of age and I won't dwell on that part of it, except that this does have meaning in that it has given enough time to both the U. S. Department of Agriculture and the universities working together to work out some of the problems that have been presented here. The second part of the description of this relationship to which Ted Byerly alluded briefly is that it has been eminently productive. There is simply no question about that. This relationship has been a primary part of the development in the United States of the most advanced agriculture man has ever known.

Another characteristic of the relationship is that in some instances the number of Federal employees at a given location is extremely small. In many instances these laboratories do not meet the criterion for size as described by the Committee on Federal Laboratories. Sometimes there is an individual worker working in a department in the university and in other cases a very small group. In other cases these are laboratories, but are not as sizable as those we have heard described in this seminar.

As far as Federal - State relationships are concerned, we find that in some instances the facilities and personnel are totally Federal. These

are Federal facilities, Federal buildings, Federal support, and Federal personnel. In other instances the facilities belong to the State and the personnel are Federal. In still others the facilities and personnel are State and the support is from the Federal, as in the case of Agricultural Research Service contracts and grants. In still other instances the facilities and personnel are State and the support is from matching Federal and State funds.

The location relationships that we have in the case of Department of Agriculture research and universities' research in agriculture again are quite varied. In some instances these are Federal facilities on university campuses. I was interested in what Dr. Glenn Pound said yesterday about the university being quite proud of the University of Wisconsin selling some of its land to the Federal Government for the Forest Products Laboratory of the Forest Service. I guess we should expect that the Yankees are shrewder than Southerners because we have given land to the Federal Government for the laboratories which are on our campus. An example of the kinds of facilities that we're talking about on our campus is the Boll Weevil Research Laboratory, which covers several acres of land. This facility and the staff are all Federal. Staff members are made Adjunct Professors on our faculty at the university. The Southeastern Poultry Environmental Laboratory is another example at our institution which is all Federal and on land that was deeded to the Federal Government by the State. Still a third is the Eastern Tree Seed Research Laboratory, which is just now under construction.

Another type of location relationship which is rather common throughout the United States in these Federal and State research laboratories is that located on off-campus research centers. The research center is a part of the university but is not on its main campus. Quite frequently there have been attracted to these centers clusters of either Federal laboratories or individual Federal research workers. In my own State, as an example, the U. S. Cotton Ginning Research Laboratory is located at our Stoneville branch on land that belongs to the Federal Government by way of deed from the State. Yet all of the facilities are Federal. The Southern Hardwood Research Laboratory is at this same center at Stoneville and is a major Federal laboratory being constructed which will meet the size criterion and some of those others that you've been hearing about here. So here you have Federal facilities and Federal personnel on an off-campus university research center.

A third location relationship is that of a Federal laboratory which is completely separate from the university campus or any of its parts. Here again, by way of example, the Southern Forest Experiment Station has a laboratory at Gulfport, Mississippi, which is a Forest Genetics Laboratory with no location relationship with the university.

Turning to the origin and evolution of these USDA-university relationships, we find that the Department of Agriculture and the land-grant universities were born in the same year only a few months apart. It is rather natural that these two have grown up together as their research

interests have developed and that they have become very close in their relationship. Mentioning 1862 again emphasizes the very long time that these relationships have been under way. I'll not dwell on the passage of the Hatch Act in 1887, but here again is an important part of the development of these Federal-State relationships in that part of this Act authorized that Federal funds could be granted to the States directly. Also there was established as a result of this legislation a part of the U. S. Department of Agriculture which Dr. Byerly now heads and which is now called the Cooperative State Research Service. Here again I believe it's quite evident that when you have this unit as part of the U. S. Department of Agriculture but with its concern primarily toward the universities and research going on there, this has made for very close relationships. Although not always harmonious, the problems have been hammered out in the shop of need and time over this very long period.

As far as operating documents, most of the operations are documented with memoranda of agreement and, as someone mentioned earlier, certainly documentation is important. On the other hand, with the rapidity with which things are changing now, it's quite evident to most of us that these documents should be made broad. Certainly they should be provided with the possibility of amendments which will keep bringing them up-to-date. The documents themselves are not nearly so important as the people who are working under these documents. The attitude of the people toward working with each other makes all the difference in the world. At one time it was very common in these relationships where the USDA research people were in the field that they would be on joint appointments. When I say joint appointments, I mean not only that the university and the USDA agreed on the individual to fill the job but they also had joint salary arrangements. These were discontinued some twelve years ago and most of us are glad that they were. There were all sorts of problems in budgeting. The State Legislatures very often met at two-year periods while the Federal Government had its funding on a yearly basis. Then there were differences in salaries which made some problems in the states. These have been discontinued, but if anything, the cooperative arrangements and the attitudes have been improved since this time.

Some of the components of the success of these arrangements, it seems to me, are these: first, from the beginning of these relationships there has been a sharing of facilities and personnel. This happened from the very moment the USDA and the universities developed research programs in agriculture. They didn't wait for a long period of time but from the beginning they shared facilities and personnel. Second, much of the research is problem oriented. Frequently the results of research have had immediate application in the State or in the region where it's being done. If you think this doesn't have meaning, I disagree with you. It has meaning in that the research worker himself becomes a part of the community. In most any State today one would have difficulty in determining from those who use results of agricultural research whether an outstanding worker is a Federal employee or a State employee. The people couldn't care less, and this is helpful to the development of strong Federal-State relationships. It certainly has been beneficial to the

USDA through the support from the grass roots. This is where all the money comes from, and I believe that the people in USDA would agree that this has been most helpful.

A third, perhaps less important, ingredient in this success story is the fact that many of these research workers were educated in the land-grant institutions. Therefore a common bond exists and the workers come to the field with a willingness to work cooperatively.

I am very much aware of the fine contributions made to the advancement of agriculture through research and development in private industry. It can be said that until about the time of World War II most of the progress in American agriculture could be traced directly to research findings from cooperative USDA-State efforts.

Research areas include excellent fundamental research in human nutrition and genetics as well as applied research in cultural and production practices in crops and livestock. Investigations range from limited scope to involved interdisciplinary broad problems as in the mechanization of cotton production.

A few examples will serve to illustrate. For many years cooperative Federal-State breeding programs have kept hard red winter wheat production ahead of disease and insect pests. At the same time the milling laboratory on the campus of Kansas State University has provided guides for quality in this important food crop.

Soybeans, the most important oil and protein crop in the United States today, owes improvement in both yield and quality to cooperative USDA-State efforts. A major percentage of the acreage planted to this crop is of varieties originated and released to growers from these research programs. USDA Utilization Laboratories have made major contributions in assessing quality, discovering new uses, and improving processing of the crop.

Now we come to the problems associated with the relationships we've been discussing and we could list many of these. Certainly we haven't solved all of our problems in relationships between people, but here the real purpose of this symposium as I see it is to see what we might discover that can be helpful both to the universities and to the Federal laboratories for making better use of the resources at each of these institutions. We have heard mentioned from this platform several times in the last two days the importance of location of the laboratory. This does make a tremendous difference. It is quite easy for us to cooperate with fine Federal laboratories that are on our campuses. We use their equipment and their personnel. In turn their people use our libraries and laboratories. We have graduate students in these laboratories. We believe that this is truly a mutually beneficial experience.

So we come to the real nitty-gritty of the problem of location of laboratories as far as agriculture is concerned. Perhaps I shouldn't

mention the politics of laboratory location in the holy city, but this is exactly what the problem is. Perhaps you other Federal workers and you university people who have had some influence in stimulating the Federal Government to establish certain laboratories have full control over exactly where these laboratories will be located. Either Dr. Irving or Dr. Byerly will tell you that this is not the case in agriculture. Not only has agriculture been told very often where the laboratories would be (and this with no thought at all as to what they might contribute to the university community or vice versa), they have sometimes even been told what laboratories they would have, and some of these were not the ones they would have put at top priority.

The solution to this problem I do not know. I've been working with it for a number of years and I have no solutions to offer. I suppose as a university president I'm just to handle problems and not to solve them. At any rate, this is a serious problem which will grow as time goes on because our costs are going higher and higher. We all recognize this. We must use these fine facilities that are being furnished as wisely as possible and certainly to the greatest good for the largest number of people. Therefore, we do need to find ways somehow to influence those committee chairmen in Congress either to develop some vehicle for helping to locate laboratories or at least to listen to some of the suggestions which we might be able to give them which would certainly not limit a laboratory in its possibilities but would make it even more useful to those people who are dependent upon it. I have to deal with this matter of branches of the university and extension centers and whatnot, and this laboratory problem is in the same category. A Federal laboratory is really very much like an industry moving into a community. It is much sought after by the local community simply as an economic matter, as a source of money. This, we find, is similar to the drive in certain communities for having a branch of the university or for having new institutions of higher learning located in their area.

Thank you very much for listening to this. It's been a pleasure to bring it to you. I have made one observation over the last two days. I noticed that on the first day we applauded when the speaker came to the podium and today we've been applauding only when they leave. Thank you.

DR. BYERLY: I'm going to defer questions if there be any for Dr. Giles until after the next speaker. I spoke of my pleasure in introducing Dr. Giles. My mother always taught me to mistrust strangers and yesterday Dr. Miller was a stranger. He is no longer a stranger. He has a remarkable history. He was born in Berkeley. He is a professor at Columbia and somehow has survived the unusual climate of Brookhaven.

I'm going to indulge myself by reading a paragraph which seems to me anent this conference from the editorial in the Washington Post on Saturday, October 19. It says it is easy to brush off all that the Commission said in its general observations as the mere repetition of cliches. I've heard some here too. In a sense it said nothing that was

new, but sometimes old generalities need new emphasis before they become so well known that their meaning has been forgotten. That, it seems to us, is what happened at Columbia and is at the root of much of the campus unrest today. Underlying the Commission's work is a vote of confidence in the younger generation that inhabits today's campuses. Take them into your consultations, the Commission advises the administrations and faculties. Listen to their ideas. Let them participate in your decision making processes. And give them a role in structuring the education they are receiving. Once this is done, the Commission suggests, the universities will regain their traditional stance as communities of scholars and lose some of the impersonal attributes that have developed in an era in which many universities became businesses employing faculty members and selling their wares to students. And with that stance will come student loyalty and an end to the wide-spread discontent that was fanned so successfully by a handful of radicals at Columbia.

It's nice rhetoric and I hope it's true. Dr. Miller.

BROOKHAVEN NATIONAL LABORATORY

DR. J. MALCOLM MILLER (Columbia University): What I should like to do is to discuss my research activities at the Brookhaven National Laboratory over the past nineteen years in the context of the report "Education and the Federal Laboratories." Let me hasten to say that you are getting a personal report; I did not attempt to achieve any consensus by interviewing colleagues. I hope the picture that I shall give you is not a distorted one, but I am relieved to see many people in the audience who, I am sure, will rise to correct me if my own view has become too narrow.

First, my own prejudices should be exposed. It is no secret that universities in general, and private universities in particular, are in serious financial trouble. No small part of that trouble is the great expense of research that is carried on within the university. At Columbia, for example, of an operating budget of about one hundred and forty million dollars for fiscal 1968, the order of seventy-five million dollars came from the taxpayer and was spent largely for research. It came from the taxpayer via the local, state and Federal Government, the Federal Government being by far the most important. Concomitant with the need of the university of funds for the support of research, goes along, I think, the need for university scientists to take the responsibility to avoid the unnecessary duplication of expensive facilities and thus be willing to do part of their research at other laboratories. The other laboratories may be in other universities, Federal laboratories such as we are discussing here, or federally supported laboratories such as Brookhaven. I am all in favor of this and have been active, in the past, in fostering such cooperation and collaboration. Having said this, let me voice my great worry that this dependence of the university professor on outside funds and facilities may destroy his independence and, to that extent, also destroy the independence of the university. The danger is

obvious when the faculty members and their students feel constrained to take on directed, programmatic research in return for access to funds and facilities. This danger, however, is visible and is not too difficult to identify and thereby guard against. More subtle, and thereby probably more hazardous, is the problem arising from "going where the money and facilities are." In this situation there is no question of programmatic, directed research; the investigation is evolved by the university scientists. But he has come to learn that his interests better be in one direction rather than another if he wishes to get funds and facilities for his work. I do not want to enter into the demonology of good and evil on this question, but I do suggest that the problem is real and it does represent a threat to universities as we have known them. Thus, my prejudices.

Now, a few words about Brookhaven that are designed to provide the proper background for the further remarks that I shall make. Brookhaven was created in the middle forties expressly to solve one of the problems that I mentioned earlier: to supply facilities for research by universities that neither a single university nor a consortium of universities could afford, and of such a magnitude that it would be unwise for the taxpayer to construct the facility at a particular university. Nine universities of the northeast banded together to form Associated Universities, Inc. which in turn became the contractor with the AEC to construct and run Brookhaven. It was clear from the outset that the laboratory could not fulfill its purpose if it merely contained experimental instruments and technical personnel to run these instruments, but rather it was essential that there be a complete inhouse scientific staff at Brookhaven of the first caliber that was actively engaged in research so that the visiting scientists from the universities could work at a research laboratory rather than, so to speak, a scientific laundromat. There are obvious hazards here; the level of activity of the inhouse scientists could reach a point where the visitors from universities began to feel and to be treated like interlopers. While there have been incidents of friction between local and visiting scientists, these are the exception rather than the rule, but this is a continuing hazard that must be continually monitored. In short, the Brookhaven Laboratory has been eminently successful in becoming one of the outstanding research laboratories in the world in its own right and, at the same time, serving the needs of the surrounding academic community. And most importantly, it serves that need while leaving the visiting scientist free to pursue his own scientific interests.

To give some idea of the magnitude of the outside-user participation at Brookhaven, the following data may be considered:

1. About 15% of the papers published from the Chemistry Department include authors from universities. This number does <u>not</u> include publications based on work at Brookhaven but published only from the university.

2. The regular scientific staff at Brookhaven on May 31, 1967 contained 464 people. Considering only visitors who had spent at least one month at Brookhaven the preceding year, there had been 253 visitors representing the staffs of 123 universities, 61 thesis students representing 30 universities, and 173 student research assistants representing 75 universities.

3. If all visiting participants are included, the total grows to 765.

I shall now turn to my own experiences of the manner in which the Brookhaven National Laboratory handles the ideas and problems implicit in the recommendations proposed in the report entitled "Education in the Federal Laboratories."

The very structure and purpose of the Brookhaven National Laboratory guarantees there will be joint research projects between the laboratory and university personnel. The word joint should be explained a bit to make clear that it is not required that work by university professors and students at Brookhaven necessarily be collaborative with part of the permanent staff at Brookhaven. Further, the notion of the research being suitably related to agency mission has a different meaning within the context of Brookhaven because, of course, Brookhaven is specifically designed to provide facilities for the carrying out of basic research. Therefore, the term "agency related" is fairly broad except insofar as one would expect the work to have something to do with subatomic phenomena.

The decisive contributions made at Brookhaven to the field of elementary particles need no rehearsing here. These contributions involve the use by both inhouse personnel and scientists from various universities of the high-energy accelerators at Brookhaven. This cooperation between Brookhaven and university scientists is inevitable because high-energy accelerators are exceedingly rare. There are, though, facilities at Brookhaven that are not as rare, but nonetheless are sufficiently expensive so that it is more appropriate that there be a research center to contain these objects where university personnel other than high-energy physicists can go and work with them. From my own experience these facilities are freely made available except, of course, that I must compete with inhouse personnel for time on these instruments.

There arises, then, the problem of allocating time on popular facilities such as high-energy accelerators. The time must be allocated not only among possible outside users, but also among outside users and the inhouse experimenters. Needless to say, this is a rather sensitive issue. It seems to be handled, on the whole, quite well at Brookhaven by having a panel which contains both inhouse users and outside users who simply pass upon proposals for use of various facilities, give them priority, and allocate time on the accelerator or other oversubscribed facilities.

On the other less competitive facilities, allocation of time is made informally between the outside user and appropriate members of the staff

at Brookhaven. The important feature is that the interaction, whether it be either via a committee or via an informal arrangement, is between the visiting scientist and Brookhaven scientists. There is minimal "help" by administrators from either Brookhaven or the University.

Further, the acquisition of new facilities at Brookhaven often involves consultation with outside users so as to be sure that what is made available will be of maximum use both to inhouse and outside users. Thus, both what instruments are available and how time is to be allocated on these instruments, are determined by processes which institutionalize and explicitly recognize the requirements of the outside users.

In nearly all instances, the operating funds of the various facilities seem to be part of Brookhaven's budget and outside users must support only their own special equipment. There are, unfortunately, some facilities at Brookhaven that are not funded as such, but are essentially run like a hot dog stand in that they "sell" time to the various departments at Brookhaven. They also "sell" time to outside users from universities which thus can de facto make them useless to a university visitor unless he can convince the appropriate department at Brookhaven to buy time for him. This, however, puts the visitor in the interesting position of competing with the inhouse personnel not only for time on the instruments but also for money. It is my experience that this is an unenviable position.

The technical operating structure at Brookhaven makes it particularly convenient for outside users to work there effectively. For example, when my graduate students and I carried out a series of experiments at the cosmotron, we had available to us engineers and other supporting personnel to assist in the design of the experiment with respect to the accelerator and other facilities that were available. We would also be assigned a liaison engineer who would be with us each time we ran and, in addition, was available by telephone call to make appropriate arrangements or to have special pieces of apparatus constructed so that our time on the beam would be as efficient as possible. To not have arrangements like this would have made the whole situation impossible. Further, it was well that these arrangements were institutionalized and thus, were not a special favor from one of the scientists at Brookhaven who would be taking time from his own work to hold our hand while we tried to do something at the cosmotron. In general, not only at the largest instruments such as the cosmotron, whenever one had to use a relatively complicated piece of apparatus at Brookhaven, personnel were made available whose job it was to assist you in your work, instruct you in the use of the apparatus and, in all ways, make the whole operation a well-oiled and feasible one.

The amount of form-filling-out, trotting-about-from-office-to-office, and various other aspects of red tape that are required when either faculty or students work at Brookhaven, while not trivial, is not sufficient to drive one off in disgust. These matters have usually been carried off expeditiously and with a pleasant cooperation from the

laboratory administrative personnel that minimizes the rough edges. Perhaps this should not be an important factor; but I think it probably is. It may be claimed that universities are criminally under-administered; I would not quarrel with that claim. It does, however, leave university faculty with a small tolerance for administrative formalisms. While on this purely personal level, three other factors should be mentioned. Firstly, the mechanics of living can become so difficult as to impair effectiveness when one is trying to do research at another laboratory... particularly at one that is relatively isolated. The Brookhaven administration works hard and successfully to make available food, lodging and transportation during visits of either a few days or even a few months during the summer when they often have to cope with the visiting scientists' families as well. Brookhaven would be a much less effective place without some concern for these amenities. Since man does not live by science, food, lodging and transportation alone, it is important to mention that Brookhaven seems to provide cultural continuity rather than cultural shock to the visiting university scientists. It is not a matter of supplying lectures, concerts, and radical students, but rather, it is an élan, an attitude, a total atmosphere that is familiar and congenial. Perhaps this is partly a consequence of a Board of Trustees composed largely of practicing academicians. Finally, university scientists can often have difficulties in getting enough uninterrupted time away from their own institutions to enable them to use facilities at another laboratory effectively. High-energy physicists would have this problem in the most acute form had physics departments not learned to somehow cope with the problem. I have handled this problem in an ad hoc manner that I like to think is at once a testimony to my ingenuity and to the forbearance of Columbia University which I shall not strain by revealing the details.

Quite often the research that I do at Brookhaven is in collaboration with one or more of the scientists at Brookhaven. Under these circumstances it sometimes becomes appropriate for these people to work for a while at some of the facilities at Columbia. Hence, in this sense there is certainly a two-way exchange between the Brookhaven laboratory and one of the participating universities. In addition, several members of the Chemistry Department have become very much a part of the educational enterprise at Columbia. These people do not, in general, teach special courses, but give instruction in the regular courses that are presented to Columbia undergraduate and graduate students.

This leads to the question of the influence of Brookhaven on the curricula at the universities. The Brookhaven Laboratory has perforce been intimately involved with university education primarily because the research carried out at Brookhaven both by inhouse and visiting personnel has been a decisive source of our understanding of many aspects of modern science. This work is published in the open literature and becomes part of textbooks and curricula simply by the weight of its own significance and quality. This strikes me as perhaps the only healthy way in which a laboratory can cooperate in curriculum changes in universities. How rapidly universities should respond to particular changing social and economic needs as interpreted in Federal programs is a highly debatable

point. Universities certainly have the responsibility of serving the larger community, but it does not necessarily serve that large community by becoming a ping-pong ball with respect to immediate interests and problems. To train people rather narrowly in specific fields that are important at the moment is possibly to make them useful for a few years but then probably to make them useless for many succeeding years. The university has a responsibility for a broad and fundamental training and must be careful not to be influenced to move down narrower and narrower paths. The very "raison d'etre" of Brookhaven makes its activities compatible with this point of view.

The research carried on by university personnel at Brookhaven has, since its beginning, included both faculty and students. The work of the students very often may form part, if not all, of the research that is embodied in a dissertation leading to a higher degree. Thus, at Columbia both the Physics and Chemistry Departments have no qualms about accepting research done at Brookhaven for inclusion in a dissertation, but it must be remembered that that research was carried out under the jurisdiction of a Columbia faculty member and was research that was evolved by the student and his professor. When it is appropriate that the student be in residence at Brookhaven for long periods of time, it has been my practice to ask one of the members of the Chemistry Department at Brookhaven to supervise the work of the Columbia student jointly with me. This is only feasible and works out well when, as a matter of fact, the scientist at Brookhaven and I have a common interest in the work and are thus scientific collaborators who both direct the research of the student. It is true that the Columbia Chemistry Department and, I think, the other scientific departments on campus, have always been and probably will remain unwilling to accept research done at other laboratories as a basis for a dissertation if no Columbia professor is directly involved in the direction of that research. Further, it is highly desirable that the student be in residence at the University for a significant part of his career. The reasons for this are not entirely selfish. Firstly, it must be realized that graduate students in the sciences may well learn more from each other than they do from their professors. Thus, it is unfortunate to have graduate students spend most of their time at another laboratory where they usually will be relatively isolated from other graduate students. A corollary of this isolation is that it is apt to lead to an undesirable narrowing of the interest of the graduate student at too early a stage in his career. Secondly, the granting of a higher degree is a serious matter to a university. We would be remiss in discharge of that responsibility if we did not thoroughly monitor the manner in which the student satisfied the requirements for the degree. Research done somewhere else, under another's jurisdiction, under relatively unknown circumstances makes us unwilling to accept the responsibility of granting the degree.

My own graduate students who have done thesis research at Brookhaven have always been very pleased with the scientific and personal atmosphere attendant upon their appointment at Brookhaven. By the very nature of the situation, Brookhaven leaves the selection of the graduate students

who go to Brookhaven up to the universities from whence the students come. There is, of course, continuing dialogue between the sponsoring professor and the scientist at Brookhaven who is keeping tabs on the student in conjunction with the sponsoring professor.

SUMMATION: To me, Brookhaven is a laboratory containing first rate equipment that I like to use and first rate people to whom I like to talk and with whom I often collaborate. I enjoy both of these activities without feeling entangled either in strings or in red tape..at least, not much redtape. As nuclear chemists, my associates at Columbia and I have often had to use facilities at other universities as well as at Brookhaven. The main difference that we have found is that it is easier to satisfy the creature comforts of life when visiting Brookhaven than when visiting other universities. In short, I feel at home working at Brookhaven; there is a cultural continuity. The point about strings and red tape is, I think, the key to the possibility of mutually beneficial interactions between Federal laboratories and universities.

DR. BYERLY: We have time for questions. So are there questions for Dr. Miller or for Dr. Giles?

DR. BRANSCOMB (National Bureau of Standards): I'd like to make a comment really, not a question. Brookhaven was designed to provide this kind of interaction and you have correctly emphasized the fact that it provides an atmosphere that's conducive for the faculty and students to work in. Most of the Federal laboratories we are talking about at this meeting were not designed from this point of view. I would like to plead that some mechanism be found to have the Federal Council make recommendations, I don't exactly know what they should be, designed to support the efforts of the Federal laboratories to take into account the merits of these educational values in altering some of the present policies that militate against this atmosphere. I dare say, for example, that when you do some work at Brookhaven with a Brookhaven scientist and you publish a paper together, you don't have to wait for him to get editorial clearance from the organization at Brookhaven. But it is probably true at every directly operated Federal laboratory that such clearance is required when the paper is contaminated by one Government coauthor. There are many other examples of that sort, such as the need for security clearances before you can be a guest worker for a year on an unclassified project in a Government laboratory. It may well be that some efforts to try to loosen up on those environmental circumstances would yield great fruits in fostering the collaboration that has to take place at the main laboratories. JILA avoids this by pulling the Government people out of the main laboratories and putting them in the university environment so they benefit from the change in environment. But the opposite problem is a serious one and needs to be addressed.

DR. BYERLY: Are there any other questions? If there are no questions, Mr. Chairman, may I express my gratitude to you for having given me the privilege of moderating these two panels this afternoon. It has been a pure pleasure and I thank you.

DR. ALLEN V. ASTIN: Ladies and Gentlemen, it is my privilege and pleasure as the Chairman of the Committee on Federal Laboratories to introduce our speaker for this evening's session of our symposium and also to introduce the individuals who are here at this head table.

On my left is William Giles, President of the Mississippi State University; then Lloyd Elliott, President of George Washington University; and Brage Golding, President of Wright State University. On my far right is Warren Baum, recent refugee from the Department of Commerce and now President of the University of Rhode Island. And then Neil Barker, Chancellor of the University of Missouri at Rolla. As the representative of the Federal Council for Science and Technology we have John Kincaid, who is also Assistant Secretary of Commerce for Science and Technology. There are many conflicts for this meeting which prevented Don Hornig and some of the other members of the Federal Council from being with us. Glenn Seaborg did join us briefly at the reception prior to the dinner. Also as part of the Federal Council team is our program Chairman for this symposium, George Irving, Administrator of the Agricultural Research Service. And then representing the American Council on Education is John Morse.

Our speaker is a university president and also a refugee of the Department of Commerce. I had the stimulating and unforgettable pleasure of working under Herb Hollomon for five years and it is an experience I value highly. Dr. Hollomon is a native of Norfolk, Virginia. He received a major portion of his education at the Massachusetts Institute of Technology. He had a brief spell at teaching, then went to the General Electric Company where he became Manager of their Engineering Research Laboratories. He came to the Department of Commerce in 1962 as the first Assistant Secretary of Commerce for Science and Technology and his activities there have left a permanent mark on Government activities. As all of you know, Dr. Hollomon is now the President of the University of Oklahoma and there I am sure we are all going to hear great things of his great capacity for innovations and stimulation.

We have reserved for this session of our symposium one of the most important aspects of the cooperative relationships between Federal laboratories and universities. We have been dealing and will continue to deal tomorrow with a number of things involving joint research, training, interchange of people and so on. But one aspect which we are looking forward to having Dr. Hollomon tell us about is how this interaction can affect the formation of curricula in the universities to meet pressing national needs. I don't know of any person who could approach a problem of this sort with more imagination and more vigor than can Herb Hollomon. It is my pleasure to give to you the President of the University of Oklahoma, Dr. Herbert Hollomon.

IDENTIFYING AND PLANNING FOR FUTURE SCIENTIFIC EDUCATIONAL NEEDS

DR. J. HERBERT HOLLOMON: You've been talking today about the use of Federal laboratories and the training of Federal employees in joint research and interchange. Tomorrow you will talk about interchange of personnel between laboratories. And Allen had asked me to talk about how Federal laboratories and the people, the important people, in the Government could affect the purposes and direction of the university. I'm not sure I'm going to say what he wanted me to. He never expected me to do it anyhow.

I would like to start with a general statement about the purposes of Federal laboratories, and the purposes of universities. Later the problems that have to do with the relationship between the two. Finally I will discuss some of the basic questions involved--particularly as they affect the future of the university.

The fundamental purposes of Federal laboratories are, it seems to me, to provide a certain kind of technical effort which deals with the major central functions of government; those that have to do with standards and health, matters of transportation, and matters that affect the general national needs, such as defense. There are also those laboratories that serve a narrow and rather specific interest which vary from time to time; generating out of the new technology on the one hand, such as the Atomic Energy Laboratory; or generating out of a new national need on the other. Some have to do, for example, with pollution or pollution standards. City problems led to creation of the Urban Institute. We had no general city problem a hundred years ago. We have it now. The need for studies of urban affairs generated out of the changing character of the time. The need for the technology related to the Atomic Energy Commission generated out of a potentiality deriving from science.

There are at least two kinds of technical institutions in the Federal Government. One, which might be considered to be functionally related to a generalized need of the society. It will never go away. It will be there forever. The only difference has to do with the technology that will be used for the particular function and the way the function is met. A standards laboratory is a fair example.

There are other laboratories, technical organizations, which have more transient characteristics. Those dealing with atomic energy are cases in point. As the society changes and changes its interests and needs, those laboratories which are connected with narrow missions may come and go.

There are these two types of laboratories, these two types of technical organization, these two types of Government functions. As Government organization is arranged to be more functional, that is, related to power and energy rather than atomic energy or coal resources, then those laboratories connected with the new functions will have a longer life. One of the difficulties that laboratories face is that they frequently are connected with organizations having too narrow a definition of function. That provides a problem both for them and the organizations of which they are part.

Let's now look at universities. The first and foremost characteristic of a university is that it is a conservative organization. Its function is predominantly, no matter what one says, to preserve--to preserve the nature of the culture, the nature of the science, the nature of the society and to provide continuity for the future. But the university permits study, analysis, criticism, and learning; learning more about the society of which we are part, and the world of which we are members. As a result of the new information and the knowledge of the nature of the changing society, the university becomes a participant and often an instigator of the changes that take place in the society.

Basically and fundamentally, however, the university is a place where education takes place, where people are led out, led out of their more narrow, their colloquial views, whether they be faculty or students, and led out into the larger world. Larger because they see things that they did not see before. Larger because they understand diversity. Larger because they learned something about the technique of man's accomplishment and also how he uses it. And thereby, though the university is a conservative place, it is also one that threatens the establishment. It threatens the establishment because it has often been and will continue to be an initiator of change and the change threatens the establishment.

Until recently universities provided a continuity or a new set of values to the society of which they are a part. The tremendous growth of Federal funds, the support for universities, the growth in the number of students, and their complexity have made of many universities and many colleges a caricature of Kerr's multi-university with no values at all, except internal integrity, with no sense of judgment as to the things which they undertake or do not undertake. They have little sense of continuity, but rather are pressed upon by forces outside themselves to be something for everybody--whether or not that function led to education, conservation, or change in the direction which the institution or its members believed. As a practical matter, the president of the university does in fact practice an old profession. And the Federal Government did, in fact, provide the support for which members of that institution did what was asked of them because somebody else wanted it done. In my view the institution which is the university--and I think it has something to do with laboratory-university relations and curriculum change--must begin to have value systems of its own; generated locally and differing across the United States, some institutions

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believing in one thing and other institutions believing in another. For without value, without a judgment of what you do and why you do it, then an institution which is a university is really nothing more than a house in which many people live and no one loves. The university is not a place to undertake tasks for the Federal Government, just because there are tasks to be done and just because they are universities. A university is a place which sets its own standards. If those on the outside support it, they have to believe in that integrity and support it because the institution itself has values in which it is willing to believe.

If these, then, are the differing functions of Federal institutions and universities, then we can next ask "Why should there be a relationship between the two? What is it that each can contribute to the other and how can that contribution be maximized?" First, let's look at the technical institution of the Federal Government.

The fundamental reasons that there should be a connection with the university, it seems to me, are twofold. One is that the people of the Federal establishment from their point of view, from that of the Federal establishment, need to be renewed. They need to be constantly aware of the constant change of things. They need to be brought in contact with things which they might not be brought in contact with if they were simply in a Federal laboratory. This means upgrading of technicians, new courses in physics, and new graduate degrees. And no Federal laboratory nor any other kind of technical organization can long survive unless it does two things: hiring constantly new employees with a changing view, and providing learning opportunities for its staff so that they renew themselves. The second reason for a connection is that the organization itself may need self-renewal. As times change, the means by which the function of the laboratory such as a particular laboratory of the National Institutes of Health or the Agriculture Department, or the Bureau of Standards, is accomplished changes. New technology is necessary. New people and a new orientation of the laboratory are necessary. So the institution itself may need to be renewed.

Let me say something else. That is that there are technical organizations in industry, the Federal Government and universities, connected with narrow aims that ought to be allowed to die. And the first-class manager, director of a laboratory, of an organization whose function is fulfilled, can best serve himself, his people and his society by killing it. The valuable part of an organization is not its facility, not its buildings, not its techniques, not its equipment, but its people. And if people are allowed to continue to operate in a laboratory whose function is dead, that is the same as killing those people. I see too many laboratories of industry and Government seeking connection with universities to try to make something of themselves which they don't deserve to be. And that to me is a shame. It would be better to close up shop and go home and let those bright, intelligent dedicated people get on with another job that is meaningful to the society or to science or to technology or to themselves. If the connection between the university and the laboratory is for the purpose of generating a new function

just to keep the laboratory alive, then I think it ought to be stopped. I said it when I was in the Government in more polite terms. I'm saying it tonight, you know, because I'm trying to tell it like it is. It's time to consider whether a number of AEC Laboratories, for example, should be phased out.

Any laboratory or technical organization needs something else. Not only self-renewal of the changing way in which the function can be met; but something else. No man who does research, in my opinion, except the rare individual, can really learn unless he is associated with students. Most of the learning of great research people goes on by virtue of their teaching. Because the teaching of a student is a process by which both the student and the teacher learn together. The student teaches as much to the teacher as the teacher teaches to the student. Therefore, a connection between a laboratory and a university is extraordinarily important, not only because the staff members need to be able to teach. Not all of them, but most of them. Students ask questions which peers do not ask. Furthermore, a great man will allow his students to ask questions which he can't answer. And by virtue of their questions he begins to learn again. There are, therefore, three reasons for a laboratory to be connected with a university: to renew itself, to provide it with mobility for its staff, to renew its organization and its function, to fulfill its function, and more importantly, perhaps, than anything else, to allow its staff to be teachers--with students coming and going.

Now what's in it for the university? Here the ground is more difficult because a university coop rating with a Federal laboratory just to use its facilities may be, as the young revolutionary would say, co-opted by the technical laboratory. He may be so hung-up with a reactor or a complicated costly piece or equipment that leads its faculty and students to things they should never have done. And they are hooked out. One of the reasons for a university's being connected with a Government laboratory is to use those facilities and equipment. But hopefully the university does not become so dependent upon them that when the task is done and the research field is no longer pregnant, they cannot withdraw with impunity.

A second reason for a university to be connected with a Federal laboratory is that the Federal laboratory brings an expertise and a point of view to faculty and student which its normal faculty and student cannot bring. And it brings it through at less cost, admittedly. It brings a larger and a wider variety of interests than the university itself could afford.

And then there is the third reason. That is that it is possible for a university to obtain a point of view with respect to its education, its curriculum, its means of teaching which more adult and differing faculty may provide as outsiders which the university as insiders could never determine. The way that this can best be done is that the senior members of the Federal laboratory do truly become members of the faculty of the institution in question and not adjunct to it. And this seems to me

crucial to the relationship between the university and the Federal laboratory. Both parties participate in each other's business. The process should be one of participation and not dominance by either party. The faculty of the institution should participate in the decision making in the Federal laboratory and conversely, the same members of the Federal laboratory should participate in the faculty decisions with respect to curriculum and students. If there is only a standoff purchase agreement between the two, then there is hardly any reason for the relationship at all. Too often, the objective of many Federal laboratories in collaborating with universities is simply to dodge the disadvantages of civil service. The university faculty want a sense of participation in the Federal laboratory, and conversely, the members of the Federal laboratory want a sense of participation in the university. And when they have this, fundamentally a new power is given to both parties. Power, responsibility and authority are thereby shared. It's not a question of released time, or how many hours, or what does it cost, but it's a question of joint activity. Joint perhaps only in a small area, but in that area, truly joint. Students then of the university do not know whether or not the laboratory is a part of the institution or the institution a part of the laboratory. That is the only way I believe the relationship can be truly fruitful. It's hard to change a university--this relationship provides a point of view which differs from that of those who have only lived in a university. Our curriculum and our attitudes need changing and hopefully they can be changed without confrontation but rather by participation. One of the agents that would be extremely helpful to us to adjust our curriculum in science or technology is the participation of people from the Federal establishment. For you have a point of view and an interest and a talent which is hard for us to attract.

But let me ask another question. How can we not only change the curriculum but rather the directions of the universities and of the Federal laboratories? Here I'm on less sound ground. The world is changing and changing very rapidly. In my opinion many of the laboratories which are represented in this room should either fundamentally change the way they attack their function or they should cease to exist. And many universities should change the way they are attacking what they do or cease to exist. Let me tell you what I think the problem is. I don't mean to call attention to the fact, but I will. There is one black person in this room. One of the major problems that I have at my university is how to give minority groups a chance for an education which they have never had. The rules are wrong. Because the tests we use are socially determined and because they have been deprived. Can you help me with that? Can you help yourselves?

One of the major areas we wish to examine are the problems that have to do with the complexity of cities. How has the building of roads affected the growth of the city and the suburbs and deprived the poor? How has rehabilitation and renewal in the city provided, not new housing for the poor, but new housing for the lower middle class? How are health services delivered and how does the education system function? Can you help the university with these problems?

Another problem deals with the growth and cultural development of small towns. We might stop the migration to the large towns by making small and medium size towns attractive to America. Can you help the university?

Another deals with traffic safety. Can we really reduce the damage to individuals, reduce the death rate by 75% or so and the property and physical damage by 50 or 60%? We need technology as well as we need innovation. Can you help the university?

How can you help with what I personally consider to be the major issues of the time? And how can you help to make it possible for youngsters to realize that we can change America from within the system; that you don't have to tear it down because we are so welded to old technology or to old establishment or to the rules of the game that we can't adjust? Can you help the university?

The other day I was talking to a fellow who had been briefing the Joint Chiefs of Staff. One of them said, "You know there is only a small minority in this country that's disturbed." My friend said, "You know that's a peculiar thing. It costs tens of millions to build the Pentagon, and tens of thousands of copies of blueprints, and a few thousand people." He said, "Give me about six small boys with coke bottles and explosives on top of the Pentagon, and then you've got to spend tens of millions of dollars and thousands of blueprints and thousands of people to build it back up again." You can't ignore the minority. Not only because the minority is a minority, but because the minority may be right.

Ladies and Gentlemen, if there is going to be a cooperative relationship between the Federal establishment and the universities, let's get on with the job. Let's deal with the problems of America together. They are not the same problems which either the Federal laboratories or the universities have been dealing with in the last several decades. We only have but so much time. Let's not waste it. Thank you very much.

DR. ASTIN: I'm sure we are all most appreciative to Dr. Hollomon for his very profound and stimulating remarks this evening. Our meeting is now adjourned until 9:00 tomorrow morning. Thank you all for coming.

Thursday, October 31 A.M.

INTERCHANGE OF PROFESSIONAL PERSONNEL BETWEEN UNIVERSITIES AND FEDERAL LABORATORIES

DR. IRVING: Our session this morning concerns interchange of professional personnel between universities and Federal laboratories. Our moderator for this session is Dr. Louis B. Howard who is a Purdue and a Chicago graduate and also a chemist, as some of the others on this program have been. Dr. Howard is widely recognized for his research in food processing and for the leadership he exercised in expanding food processing facilities during World War II. He is also recognized by some as a leader in research directed to the industrial use of agricultural commodities and has served in many research and administrative capacities in the old Bureau of Agriculture and Industrial Chemistry where he became its chief in the mid-forties. When Dr. Howard left the Federal service he went to the University of Illinois where he headed the then new Department of Food Technology at Urbana. He subsequently served for some eleven years as Dean of the College of Agriculture and Director of the Agricultural Experiment Station and Director of Extension at the University of Illinois. Since 1966 until his retirement last month Dr. Howard was Director of the International Programs Office of the National Association of State Universities and Land-Grant Colleges here in Washington. With all of that, Louis, if you're up to it, take over.

DR. LOUIS B. HOWARD: Thank you Dr. Irving.

During these past two days much has been said about interaction between the laboratories and the universities with emphasis on unusual, expensive and highly sophisticated equipment, on research programs of mutual interest, on fund sources, on areas of responsibility, and on several other matters. But, it seems to me, that this morning we come really to the gut issue. Is not the scientific manpower that each group possesses the genuine basic resource for which we seek broadened and improved methods of sharing? I think this was one of the key points President Hollomon made last evening in his perceptive and dynamic address.

By some coincidence of fact or fate, during my professional experience I have worked 18 years in a Federal research agency and 18 years in a university, and I have concluded with two years in an assignment that might be said to lie between the two. To what small degree I have gained wisdom from these experiences I am convinced that in almost any worthwhile human endeavor there is no element more vital nor more effective than the harmonious interplay of human talents. In many areas of activity we waste this resource scandalously.

Our program this morning calls for a consideration of means more effectively to utilize our scientific manpower resources between Federal

laboratories and universities. At this point I shall restrain my impulses, highly developed I might say by several years' exercise as a dean, to speak on at length and with confidence on my own prejudices. I assure you this restraint is somewhat painful--probably nothing is more painful, at least to a former dean, than an undelivered speech. But now let me present in turn a distinguished group of panel members. They have some valuable observations to make and I also want to have plenty of time for substantial audience participation during the course of our programs this morning.

The first of our panelists, Dr. William Thomas Pecora, was born and raised in New Jersey and received his baccalaureate from Princeton University in 1933, with honors in geology. He did his graduate work at Harvard University and received his Ph.D. in geology in 1940. In 1939 Dr. Pecora entered public service with the United States Geological Survey and has remained with that organization throughout his professional career. The President appointed him as its Director in September 1965. Dr. Pecora has been elected to the National Academy of Sciences, the American Academy of Arts and Sciences, and the Brazilian Academy of Sciences. He has published more than fifty papers in his field.

Currently he is Chairman of the Federal Government Committee on Solid Earth Sciences and Chairman of the Panel on Marine Research. Within the Department of Interior he serves as Chairman of Secretary Udall's Energy Policy Staff and Program Director of the Earth Resources Observation Satellite program.

Dr. Pecora, we'll be delighted to hear from you at this time.

USE OF WAE (WHEN ACTUALLY EMPLOYED) APPOINTMENTS

DR. WILLIAM T. PE . (Geological Survey): Thank you, Mr. Chairman.

The problem of WAE (When Actually Employed) is a rather important one, I think, in Government service for those of us who are engaged in scientific and technical operations. And because WAE is rather an unusual reference, the Committee on Federal Laboratories thought it would be a good idea if I did explain the background of it, the history of it and how our Institution has used it so successfully since its inception in 1879. I think perhaps the Geological Survey is the only Federal institution that uses the WAE so much and so successfully. The Committee's task group in traveling around the country visiting laboratories and universities found that many laboratory directors were not aware of the value of the WAE nor did they think they had authority to use it. It is a very simple management device approved by the Civil Service Commission, and I think you will find it a rather attractive device.

A temporary employee basically is one who enters on duty, fulfills a piece of work, finishes his duty and is off the roll. The WAE provides

for a permanent "temporary" employee, a continuing "temporary employee, an intermittent employee. And this is the excellence of the device. The entrance paperwork is just as much as for a regular full-time employee. The person must have his complex application form. He must be rated by the appropriate Civil Service Examining group. He must be on a register of the merit system. He must be selected by Civil Service procedures. In this relationship the temporary and the permanent or career employee show no difference. At this point in time they are starting out the same way. But after a tour of duty, if the employee desires to go back to the university or to leave Government service for a period with the intent of coming back at some time in the near future, we flip a switch to transfer him from permanent to WAE. Then when he decides to come back to a mutual advantage, we flip the switch again and he comes back to his full-time position. This flipping the switch back and forth has our minimal amount of paperwork involved and this is one reason why I like it so much.

The WAE employee is protected by the Civil Service Commission. The important thing here is that there is a mutual understanding as to what is to be done and when it is to be done. For this reason I think it has been a very good system.

How did we fall into this? Perhaps our institution, the Geological Survey, or perhaps our discipline is more fitted to this kind of a relationship than many others. But I think all institutions should think of this system as it may apply to problems elsewhere. In 1879 when the Geological Survey was started by incorporating four independent geographical and geological surveys of the west, the first Director, Clarence King, and his successor, John Wesley Powell, found themselves with a tremendous budget for those days, $500,000, and very few people to spend it on. So they, being friendly with many professors and universities, inveigled a few of the professors to take on research projects under the aegis of the Geological Survey with Survey funding. This covered salary plus field expenses and expenses for field assistants--graduate students or others. This turned out to be a rather successful innovation. As you know, many of us prefer to stay in one line of work and the professors therefore returned to the campus, came back on the next summer, returned to the campus and did work during the school year. During this period, they were paid for their work as were their graduate assistants.

There is a second relationship here that is rather important. In our geologic work, solid earth science work, the laboratory concept is twofold. We have the inside laboratories as the more rigorous sciences have, but our bigger lab is the outside laboratory. Anybody but a glaciologist is a damned fool to go out and do field work in six feet of snow. So the best time to do our field work is in the summer season from late spring to early fall. This summer season is quite fortuitous for the university as well, because the summer season is the free season at most universities. There was a coincidence here leading to a beneficial relationship. So the seasonal effect of the principal time of work and the necessity for research support at some universities has kept the WAE

system alive since 1879. And we use it today as a major device in our association with universities.

Let me give you some numbers to show you the magnitude of the situation. At the present time on our rolls are the order of 1,200 WAE appointments. They are not all working at the same time, nor are they all working from one year to the next. Some have been idle for some years, but they decline to get off the rolls. They like to stay on the rolls for that occasion when they may have some joint work to do. This group is distributed among some 80 universities and colleges. In our profession of solid earth science there are some 300 degree-granting colleges and universities, but we would consider about a hundred to be the major research-producing campuses. In our profession of solid earth science we would consider about 30,000 to be the number of all workers in the field throughout the country. Half of them are employed by the petroleum/gas industry and other parts of the minerals industry, universities, State surveys, private institutions, the Federal survey, and private consultants. In the research area we would say that perhaps four to five thousand might make up the research community. I'd like to restrict the comments on the WAE essentially to the research solid earth scientists and show you the relationship or the relevance of this system to the Geological Survey as an operating Federal organization.

First let me withdraw from our consideration those aspects of our mission which are in the technical operations field. For example, in the public land concept, one half of all of the area under the jurisdiction of the United States belongs to the people of the United States. This means one third of the land area on the continent and all of the off shore. We are the technical supervisors for production and exploration and resource exploitation of these public lands. We help collect the royalties, put them in the account of the Bureau of Land Management, for the Federal Treasury or for redistribution in part back to the States. This is a technical operation and although scientists and engineers are engaged in this, and we recruit men who are qualified for the work, basically the work is not a research operation.

Secondly, in another area, which is the supervision and description of the land and the making of what we call our National Topographic Map Series, there are a number of cartographers and topographic engineers who are in the process of making maps. This is an engineering operation and it is very detailed and carefully done. But here again they are not research oriented in the actual operation, although ten percent of the total effort is in research techniques concerning photogrammetry and related subjects. It is in areas like ground water and the solid earth science itself that is the principal research is going on. In our community in the Geological Survey this involves, as part of the total appropriation, something in the order of $50 million. The balance of it, $35 million, is in technical operations. Of the $50 million, about one to one and a half million dollars is put into the WAE system every year. It is a very small part of our budget in comparison to some of the other institutions like NSF or AEC. The important part of this is that it

supports a relationship with a great many people on many campuses. The program dollar goes a long, long way and has done this for decades. It has led to an easy interchange and migration back and forth of professional people to and from the Geological Survey, to and from the campus.

Within the solid earth science group itself, I would break down the population among the universities to make a group of about 1500 faculty members of the university system who are engaged in the solid earth sciences of our kind. In our own group in the Geological Survey there are about 1200. I could stretch this a bit and make it about an even population on either side, so that we are dealing with two groups of about the same size. All of us engage in the acquisition of knowledge for publication. On the one hand the university is emphasizing education; on the other hand we're emphasizing application to land and resource evaluation for that is our primary obligation by congressional authority. In the area of geologic sciences in particular, we have about 560 WAE's presently on our rolls, but not all of them are engaged all the time. In this last year about 300 from 64 different universities have been actively engaged in this part-time research work. This is the total of the actively engaged geologists in our program participating in the execution of our mission, and I'm going to be very frank to say that the primary purpose of the WAE system from the Federal point of view is not to educate graduate students or to give money to the faculty. The purpose is to execute a mission as given to us by statutory obligation. We find the best way to do this is to engage the services of our research colleagues in the university, whether they are faculty or graduate students.

What's in it for the university person, the graduate student or faculty member? He will be getting a salary at the prevailing rate for that qualifying grade for the period of his work. This could happen several times during the course of the year as reported by him. We will take the reporting sheets every two weeks when he's on duty and process it through our computer for payroll. This is a very simple matter. One of my colleagues in the Federal Government said: "What checks do you have that the person is really working?" I said that if there's that doubt, he would never be on our rolls in the first place. I think you have got to have this element of mutual trust and faith and understanding. Also, the WAE employee receives travel expenses, his vehicles for his field work, and minor equipment in his own laboratory at the university. He sends his samples into our laboratory for chemical analysis. He will send his maps for professional drafting. We will solve all of the problems that he needs to solve in editing and things of this kind. In other words he is doing this as if he were a regular employee. If he prefers to publish his information in an outside journal after we look at it for policy or goofs, he is permitted to do that. If he prefers to publish it through the Government Printing Office as one of our regular book publications, we handle that for him. So in a sense he is being supported in his research. The professor may have one or more graduate students helping him. This again follows the same system. Through all of this he must recognize that as a part-time employee of the Federal Government he has in a sense the equivalent of an oath of office for conflict of interest.

If he encounters any information, be it privileged as given to him by a company or observed by him or his party during his own work, he must protect this in the public interest. He cannot give this to a private individual for private benefit. Our primary obligation is to make the information available across the board to everyone at the same time. We do this through the public announcement or the publication system.

This privileged information concept or the conflict of interest is an overriding principle as to whether a person can or cannot come on to our WAE rolls. Some individuals do consulting work for private corporations. There would be, therefore, a conflict of interest. We cannot permit this. Some individuals may wish to appear as consultants for a litigant at court taking one side or other. We cannot do this. We are friends of the court. We help the judge in understanding the general situation and answering questions that would benefit both sides or explore the situation for both sides, but we cannot be a litigant for or against. For example, the Geological Survey member does not appear in court as a witness for the Federal Government against a private institution or for one Federal institution against another Federal organization. These are the things that must be understood by the system, so that there's trust and faith throughout the program.

A number of graduate students, of course, are receiving active help in this program. At our recent count, there was something on the order of 157 graduate students actively engaged in our WAE system this past summer working on material for a master's or a doctor's degree, or just earning while they're learning. In my own career with the Geological Survey I have filtered some 60 graduate students through my research projects and most of them went on for either an M.A. or Ph.D. Some are now with industry, some are teaching at universities, some are in state surveys, some are private consultants, some are with the Federal Survey.

This program has become a major recruitment device for our organization. It is the most important recruitment device we have. In our Geological Survey community of about 1200 geo-scientists, between 40 and 50 percent have the Ph.D. degree and I would say that a hundred or more of them have developed their dissertations through starting out with the WAE system. That's how I started out. I had a position with the Survey one summer, I was put on WAE and went back to the university. When I quit, they flipped the switch and put me on full time. So the WAE system has been a truly effective device. For our kind of work it has been the most effective device of all of those available. We do use the post-doctoral research associate; we use the research contract procedure. We're not authorized in the giving of grants for the sake of grants because our appropriation committees feel that we have a mission and we can go to the university to secure help in the execution of our mission. In my preparations of budget justifications before the Bureau of the Budget or the Congress my justification is the practical application of understanding the resource characteristics of the United States--putting this in the form of availability to the private sector. So it is as a mission and an applied approach on which I make my justification; but 80 percent

of the money is being used in research to accomplish that mission. In my concept, and I speak of this freely, the research is the bridge to resource evaluation. We cannot do it by ourselves in the Federal structure. We must get the help from people on the outside.

The university community is our equivalent in the research community. Vis-a-vis we're on par in our general aims toward acquisition of knowledge and publication. Since we represent essentially a publishing organization, it's rather important that the WAE be given a lot of freedom in the publication of his results. This, of course, we urge. It's no effort on our part because we are also urging our own people to publish their information. In the history of the Survey for example we have had book publications coming out through the Government Printing Office on a continuing basis. If they were to be measured end to end on a bookshelf, the last measurement was about 250 feet of linear distance. In addition to that there have been ten to twelve thousand scientific articles in our national scientific professional journals and something like 30 to 35 thousand editions of maps--geologic maps, hydrologic maps, topographic maps, geographic maps and other special maps. We are a major publishing house and we get our information by primary observations and measurements in research. In this effort there has been a joint participation throughout the whole history of the Geological Survey with the university community. At the present time I don't know of any major department in the United States that does not have at least one person who has come through this WAE system. Since the campus is the life blood of our organization, for us to remain viable and to go on to new programs and to do our work, we rely very heavily on the continuance of the WAE system. It has been a most successful method for us in the Geological Survey.

I think many other Federal organizations can use this system. I have talked about it freely and I find that it's avoided, for many reasons. Some administrators on campus--and perhaps you feel this way and I hope I can disabuse you of this position--some administrators on campus prefer the grants or contract system. The reason for this of course is that a chunk of overhead goes to the department and to the university and there's more flexibility in assigning those funds. From our point of view the research man on campus and his graduate students are getting complete support for his research effort. No funds are coming out of the university except for space and the usual equipment which he needs in his teaching procedure. I think that is a good balance.

Recently of course we've all been suffering with constraints on the fiscal side in Washington and many of you on campus who rely heavily on research grants and contracts are being hurt. But our program has not decreased. Our WAE program is increasing every year, because as our programs increase we need more and more variety in the total effort of participation. I believe, inasmuch as we've been so successful for over 90 years, that others ought to try the system because it has given us a great contact with the campus. It has given us a sense of equality with the campus in the research area. It has provided a wonderful source of recruitment. It has provided a wonderful in and out relationship between

the Federal Survey laboratory and the university. I think we have achieved in our discipline, in the geologic sciences, the ideal balance between the Federal side and the university side.

Perhaps there is another factor which has helped this relationship. On the Federal side about seventy-five percent of all of those who are engaged in the solid earth science research are in the Geological Survey. It is likely this one mass relationship has helped the situation. But I think it's more than that. I think it's been the philosophy put down by King and Powell, our first Directors. The philosophy that has been retained by subsequent directors and our research chiefs is that in the acquisition of knowledge you support the man who is going after the knowledge and you help him get his stuff out into the publication area. This philosophy has been a strong one in the Geological Survey, as it has been in other science-oriented Federal organizations. For this reason, also, our administrators come up from the research ranks. Some of them don't like it. I didn't. But we also have the "in-and-out" system. A man will come in for administration for one or two years and go back on the line for research. He has a dual ladder for advancement. Eventually, if his friends push him hard enough, he will take on a job as a program research leader, or a branch chief, or a division chief or even the Director of the Geological Survey. I've had 25 years in what I would call the ivory tower; in the last four years I've been sitting on the other side of the coin. So I think I can speak with credentials on the WAE system and what it has meant to the viability of a major prestigious research organization. I think you should all look into it. Thank you very much.

DR. HOWARD: Thank you very much Dr. Pecora. We have two or three minutes for questions, and here's one right back there.

MR. LESLIE B. WILLIAMS (American Society for Engineering Education): I want to ask Dr. Pecora, "What do you do about manpower training allocations? For WAE appointments as I remember it you have to have allocations to fit your requirements, or you cannot simply hire the people whether you have the budget to do so or not."

DR. PECORA: Allocation meaning personnel ceiling?

MR. WILLIAMS: Yes.

DR. PECORA: All right. The WAE is exempted from our present difficult situation which I could have mentioned as a very positive factor. Congress has passed a law that for every four vacancies that occur for one reason or another only three may be filled, to reduce the personnel complement until a certain base is reached. The WAE is exempt from this,

fortunately, so that we're not bothered with that problem. In our normal personnel calculations they do separate the permanent or full-time employee from the temporary employees and the WAE is classified as a temporary employee. So that is a different consideration. Thank heaven for this and I hope they don't ever change it. There's no immediate problem so far as we can see.

DR. HOWARD: Are there other questions?

MR. JOE B. ROSENBAUM (U.S. Bureau of Mines): Dr. Pecora, what is the interplay in the selection of a research problem for on-campus research?

DR. PECORA: First, I think it must be understood that our mission has to be the overriding factor. If there is any relevance to our mission in a research problem or project of the faculty member or the graduate student, and if they are good people, we'll back them. Quality and relevance! I don't think there needs to be a lot of justification. A man does not have to write a twenty page justification as to what he's trying to do. It's a matter of personal judgment on our side. Since we have such a widespread relationship throughout the academic community and former Survey people who are on the faculties throughout the country, we can get a first hand judgment as to the quality, potential and relevance of the research project. It's an easy procedure and we keep it easy. We don't want to go through the hard, long justification procedure. In the long run we would be hurt.

DR. HOWARD: Another question right here.

DR. JOHN C. EBERHART (National Institute of Mental Health): Dr. Pecora, do I understand that most of these WAE's work at their universities rather than at a Geological Survey installation?

DR. PECORA: That is correct. They may work in either place and they can go back and forth.

DR. EBERHART: Would you give me an example of one man and tell us something about what he does and what the ordinary arrangements are for this?

DR. PECORA: Yes. One man, Professor Waters, formerly of Stanford, Johns Hopkins, now at Santa Cruz. Professor Waters is interested in studying volcanic phenomena and formations in the Pacific Northwest. Each summer he is on our rolls. In the field he will have his graduate students. He is mapping, making a study, and taking his collections.

He goes back to the campus, puts his university hat on and his institutional relationship is as a full professor there. His students are working in the laboratory. Every two weeks, they will turn in a slip as to how many hours they worked on the project. He is the guardian of this relationship. He will send specimens to us for thin sections. We slice them up and send them back in the mail. Since this is a three thousand mile trip, he might get thin sections made locally and then put in a bill which we would honor. Although he is operating essentially as an independent, we have frequent consultations. Thus, he is a Survey man who happens to be a professor at the same time. He is watching over the graduate students and he is supervising the dissertations which we are financing.

DR. HOWARD: We'll take one more question.

DR. BERNARD W. MARSCHNER (Colorado State University): I would like to comment from the university point of view. I don't see very much difference as far as the university is concerned in this arrangement from the normal consulting arrangement that a professor may have. Therefore, the small details that you pointed out as overhead, lab space, room, light, heat and power. I don't think that that arrangement really takes into account the university's problems in terms of bringing up other people who are not at this time capable of making consulting arrangements. So that I don't look forward to that particular plan with tremendous enthusiasm.

DR. PECORA: Well, I'd like to talk with you at greater length or have you, since you are so close to our Denver Office, drop in there. Because I think, frankly, you are making a mistake if you don't see the value of this to the development of faculty research program and graduate student support and training. A consultant really doesn't produce these benefits. The consultant is providing a service for a purpose. He is an on and off proposition too, I would admit, and WAE could be considered in a broad sense a variety of a consultant's relationship. But the intent and the conceptual aspect for the long term relationship is not a consulting relationship, it is a joint participation in the acquisition of knowledge and publication and the development of graduate students coming along the way.

DR. HOWARD: Hopefully we shall have a little additional time at the end of this session for further questions.

Now we shall move on to the next member of our panel, Dr. George Burroughs Mider. It is reliably reported that he was born in Windsor, New York and that he took his A.B. and his M.D. at Cornell University--the second one obviously in Cornell Medical College. Following that he moved about with such rapidity and over such a wide geographic range that

I shall make no effort to detail this for you. I would refer you to the standard reference works for additional information, but simply add that he moved from his internship in Albany Hospital up to Assistant in Surgery. He then became a fellow in Surgery at the University of Rochester School of Medicine and Dentistry. He then was at Cornell Medical College again, as Instructor in Pathology and moved up through various positions, then to the National Cancer Institute, where he served as Associate Director in Charge of Research from 1952 to 1960; then at the National Institutes of Health as Director of Laboratories and Clinics from 1960 to 1968. Now he is Special Assistant to the Director for Medical Program Development and Evaluation, National Library of Medicine. Dr. Mider, we should be delighted to hear from you.

USE OF LIMITED TENURE APPOINTMENTS

DR. G. BURROUGHS MIDER: Mr. Chairman, Ladies and Gentlemen.

Among the most valuable assets of the Public Health Service are two paragraphs in Section 207 of its basic statute. The first permits the appointment of fellows "without regard to the civil service laws and compensated without regard to the Classification Act" for duty with the Service "for studies or investigations either in this country or abroad during the terms of their fellowships." The other permits the employment of persons who are not citizens of the United States as consultants or as fellows. The authorities first became available in 1944 and have been used most extensively though not exclusively by the National Institutes of Health in designing limited tenure appointments.

The Visiting Program, oldest of the limited tenure appointments, recognizes the importance of engaging with scientific issues on a global basis because no nation has a mortgage on ideas or on the capability of initiating new areas of inquiry, a thesis requiring no further development for this audience. The program has brought to Bethesda many scientific innovators from many countries. Some were individuals with records of important achievements--mature scientists. More often, however, they were comparatively young people whose steeply ascending curves of productivity marked them as those most likely to have an important impact on their area of biomedical interest. All introduced novel concepts and new technologies into our environment. More recently an increasing proportion of the visitors have been recent graduates of foreign universities, younger people of great promise who want our scientists to contribute to their intellectual growth early in their careers. As a result, the program today contains three categories: Visiting Fellow, Visiting Associate, and Visiting Scientist. All three are "fellows" in the legal sense. However, the Visiting Associate and Visiting Scientist have an employee relationship, while the Visiting Fellow is appointed for advanced training.

The ground rules are comparatively simple. The Visiting Fellow, not more than three years past his degree, receives the same stipend as our own citizens who succeed in the competition for postdoctoral fellowships. A senior investigator may have only one Visiting Fellow. The Visiting Associate has more than three years of postdoctoral experience and his salary parallels grades GS-11 and -12 in the General Schedule series. The Visiting Scientist has a minimum of six years of postdoctoral experience, hence receives a higher stipend up to the maximum allowable under the Civil Service; in practice a salary exceeding $25,000 has been so exceptional as to require specific authorization by the Director of NIH. A number of scientists at home and abroad would be most welcome participants in our Visiting Program, but the initial appointment is for one year, renewable for a second and, with sufficient cause, for a third. Most prestigious, productive, mature scientists can ill afford to absent themselves for so long a time from their home locales where they have assumed major responsibility for scientific and institutional leadership. People of such distinction can rarely be enticed to our campus for more than several weeks to a few months.

The associate and scientist categories together are limited in each fiscal year to 10 percent of the personnel and personnel services costs as determined by those on board at the end of the previous fiscal year in appropriate series at GS-11 and above and commissioned officers in the Public Health Service at O-4 and above. When one considers that the personnel complement of the NIH includes almost 2,000 people with doctoral degrees, the potential allotment could approximate 200, whereas the total of 138 visitors from 28 countries during September 1968 is the largest complement to date. Since the inception of the program about 25 years ago, 1,126 individuals from 44 different countries have participated. Japan, the United Kingdom and West Germany have consistently provided the largest numbers, but this month the next most represented countries are Australia, Israel and Czechoslovakia.

Support for the Visiting Program is contained within the direct research appropriations to each of our institutes and divisions. There is no separate budget and no identifiable number of billets. Rather, each Scientific Director and his Laboratory and Branch Chiefs must make a deliberate decision as to how many and what types of investigators he may invite to join the family through this program. It can be relatively expensive because it may support the travel of each participant, his wife and dependent children, from their home base to Bethesda and return.

The ruling that the associate and scientist categories provide service to the NIH, as indeed the statute stipulates, enables us to offer important fringe benefits to those participants. While we make health insurance available for the Visiting Fellows, their status as guests rather than employees provides lesser capability in coping with unforeseen contingencies, including catastrophe. The problem is similar to that of the college student at a great distance from home in a somewhat different cultural environment where language may constitute some barrier

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to communications albeit temporary. We have learned that ability to write in English does not necessarily reflect the same facility in handling our American brand of the mother tongue.

No statistical data quantify the value of the Visiting Program. Some of course have achieved high distinction as their careers have developed. Probably they would have attained such repute in any case, but the abundance of new ideas generated by intimate interaction has continued long after the visitors have returned home. Communication remains free and easy, facilitating attainment of program objectives through mutuality of interest despite geographic dispersion. We have always thought our people to be among the best informed biomedical scientists in the world in the areas of their special interest, which has to be due to the vigorous interaction with other scientists at home and abroad, encouraged in part by the Visiting Program.

Our other limited tenure programs, available only to our fellow citizens, are much younger. The Clinical Center, a 500-bed research hospital, admitted its first patients in July of 1953. This facility permits concentration of people with specific illnesses, often in particular stages of their evolution, to be cared for in the research environment as a means of developing better and more effective methods of treating and, hopefully, preventing some diseases. Apprenticeship in the immediate postdoctoral years is deeply ingrained in medicine. It is a competitive system, first involving internship in what the emerging physician regards as one of the best hospitals, carrying through to specialization in a graded system with increasing responsibility at each successive step of the way. The journey from intern to chief resident is usually interspersed with a year of research, though a continuum of research experience extends throughout the training years. The difference is that the particular year is spent in full time research, while the continuum provides for part-time involvement; the difference in commitment is important.

A good hospital of a few hundred beds or larger will identify interns and residents as the "house staff" who participate with the attending staff in caring for the patients. Clearly, the Clinical Center needed such a house staff although the availability of interns was deemed undesirable in the best interest of professional education because of the potential for a highly skewed sample of disease. Therefore the Clinical Associate Program as it is now known was designed to fill the need for a house staff at the assistant resident or resident level, capitalizing on the known research interest and tradition in the development of medical specialists.

The initial appointment for two years affords an opportunity to participate in research integrated with patient care, usually as a commissioned officer of the Public Health Service. Some of the institutes require more initial experience than afforded by an internship, hence a limited number of deferments is available in the Commissioned Officer Residency Program developed and conducted by the Public Health

Service with the cooperation of the Selective Service system. The CORD program parallels the Berry Plan in the Department of Defense. The NIH is a national resource. Therefore we felt that Clinical Associate appointments should be competitive, and so they are. Each medical school and many hospitals receive information on the program, updated annually so that all may be fully informed; interest has grown.

About 1958 the staff was so favorably impressed with the quality of the Clinical Associates that they recommended extension of the program to the generality of biomedical research, including study in sciences critically important to medicine. The proposal was accepted. Today the Research Associate program selects about 40 young physicians each year who in addition to their regular assigned duties agree to participate in a series of formal tutorial seminars and informal discussion groups designed to furnish training in the basic medical sciences normally received by Ph.D. candidates but not generally by candidates for the M.D.

These two Associate programs are popular. About 1600 inquiries are received each year, 750 complete applications, and 500 are invited to Bethesda at their own expense for interview, of whom 120-150 are selected for appointment. Aptitude for research can be recognized in the student careers of each of those who come for interview, and the level of intellectual attainment is extremely high in their academic records. It is so difficult to make meaningful selections from this large pool that the choices of the candidates are matched against the choices of the institutes by an impartial group, exactly as interns are matched against hospitals by the National Intern Matching Program operated by the American Medical Association and the Association of American Medical Colleges. Probably those who are not selected have fully as great a potential for leadership in biomedicine as those who are selected. After their two-year stint approximately 10 to 15 percent are invited to continue at the National Institutes of Health for another year or so, but the great majority return to the academic environment to complete requirements for certification by one or another of the American Specialty Boards.

The careers of these bright young physicians are being monitored. The last study, made in 1965, included those 509 who completed the two-year program prior to 1961, so the data reflect the activities of the Clinical and Research Associates 5 to 10 years after completion of the program and age of about 33 to 38. At that time 68 percent had academic appointments, 18 percent were in private practice, 12 percent remained in government but not entirely at NIH, and the remaining 2 percent were lost to biomedicine usually through personal catastrophe, although one became a music teacher. Of those in academic medicine, 230 had some professorial rank, including 29 full professorships, and (I hesitate to report this figure) two were already deans. It would appear that the NIH is contributing to medical education through these programs, but I hope that some day we may be able to determine the status of the control group--those who were interviewed but not selected.

Another measure of the impact of the Associate program on the NIH would be the research productivity of the group. We know in general terms that they continue to be productive. Since "research ain't research until it's published" it should be possible in the near future to obtain a computer print-out of their bibliographies through the MEDLARS system that produces Index Medicus for the National Library of Medicine. The tapes now contain bibliographic references of the last five years, and the new generation MEDLARS II something more than a year away should facilitate searches and reduce the cost.

The success of the venture could also be measured by the number who return to the NIH as mature scientists. Very few have done so. The reasons may be complex, but one finds that academe cherishes these young leaders and locks them at an early stage of their careers into a system providing substantial economic advantage over that offered by Federal employment.

The obvious benefits accruing to the NIH by including such bright, enthusiastic people in the ferment that is research led to the inauguration of a Pharmacology Research Associate Program in 1965. This made available the unusual capabilities of our staff within the NIH to provide a training center for research in pharmacology and related disciplines for which the national manpower demand far exceeds the supply. The program is funded through the National Institute of General Medical Sciences and coordinated by a committee of preceptors in participating institutes. It is a three-year program accepting only 10 candidates annually as fellows, commissioned officers or civil servants. It is already oversubscribed.

Finally, the Staff Fellowship Program aimed at attracting superior youngsters with scientific as opposed to medical backgrounds is based on these considerations:

> First, postdoctoral fellowships of two to three years are desired by doctors in the life sciences as they emerge from graduate school; many prefer a different environment in which to gain experience before settling down to a particular job.
>
> Second, the probationary period in the Civil Service of only a year is too short a time to identify the true capabilities of new recruits in a research organization; only the obvious misfits can be recognized.
>
> Finally, probably the most important decisions a laboratory director makes are selections of those to whom his organization makes commitment for continuing employment; that may set a pattern for years to come.

The Staff Fellowship uses one of the authorities on which the Visiting Program is based. It is now limited to citizens within five years of their doctoral degree in any science important to biomedicine or in

medicine, dentistry and allied health professions. Awards are made for two years, renewable for one additional year. Stipends are in the GS-11 to -12 range and provide for annual increments based on the Fellows' progress. They participate in Social Security and in all employee benefit programs excepting retirement, but if the Fellow enters the Civil Service system at the completion of his program the service is creditable toward retirement upon application and payment into the Civil Service retirement fund of a deposit covering the period during which payroll deductions were not made.

None of these programs is separately funded. Each has grown through experience, not because we are the National Institutes of Health but because at the NIH are respected leaders in many fields of biomedical research with whom some of the best talent emerging from institutions of higher education want to work, if only for a limited period, on a basis of mutual interest and respect.

Common to all is the objective of providing a goodly supply of bright young minds to keep all of us stimulated and to select from them those with the greatest potential for contributing to our mission, for which individual initiative and enterprise are prime requisites. We also believe that any organization that continues such excellent people in its employ assumes a very real obligation for their continuing education and career development--but that is another story.

Thank you very much.

DR. HOWARD: Thank you Dr. Mider. Are there questions you would like to address to Dr. Mider?

DR. ERNEST K. SMITH (ESSA Research Laboratories, Boulder): Did I understand that much of your capacity to carry on this program is due to special legislation which comes to you from Congress?

DR. MIDER: Yes, it is. It's fellowship legislation in the Public Health Service Act. On the other hand, the Civil Service Commission authorizes tenure appointments which we could use if this authority were not available to us and I believe that a visiting program will be introduced into the legislature very shortly. I know that is has been the subject of great interest by the Civil Service Commission and I think that a draft has already been through the Bureau of the Budget. Mr. Leich can probably answer that.

MR. HAROLD H. LEICH (U.S. Civil Service Commission): Yes, I will be glad to, Dr. Mider. You are correct. A draft of legislation to authorize a Visiting Scientist and Scholar Program was approved by the Bureau of the Budget last summer and was transmitted to Congress, but in the last days

it was not introduced. We hope to be successful in getting it introduced next session. It is modeled very much along the lines of Dr. Mider's program. It would allow scientists and scholars to come to this country from overseas with full travel paid both ways, and would not be limited at all to aliens. People in this country could be appointed as well for terms up to two years under much the conditions that Dr. Mider mentioned.

DR. HOWARD: Thank you. Are there other questions or comments?

MR. HERBERT B. QUINN (NASA): Dr. Mider, do you have any programs that allow the career civil servants to go out into the academic world for periods of one or two years?

DR. MIDER: Yes, we have the same authority as all the rest of you do. If there is a job to be done that could be done better in a different environment including the academic world, we're perfectly willing to send our people away for long or short periods of time to get the job done. We send as many as the constraints imposed by the Bureau of the Budget will permit abroad each year too. This has helped us a great deal. Disease, you know, has a curious spectrum around the world. You don't see the same diseases in the same places all the time and some are concentrated in geographical areas. That doesn't mean they only occur there. That means you can study them best there. We capitalize on the opportunities that become available to us by working assignments for the most part.

DR. HOWARD: Is there anything else?

All right then we shall move on to our next speaker on the panel who is Dr. Frank D. Hansing, a native of Illinois who received his B.S., M.S. and Ph.D. degrees from the University of Illinois. At the conclusion of his formal study, Dr. Hansing engaged in agricultural research at the University of Illinois, at Virginia Polytechnic Institute, and the University of Delaware before coming to Washington. He joined NASA in 1962 and helped to begin the Sustaining University Program. For five years he was Chief of the Training Division and was responsible for awarding of predoctoral training grants to 152 universities. He is now the Director of the Sustaining University Program Division in the Office of University Affairs. In addition to NASA duties, he is active with the Federal Interagency Committee on Education and is Chairman of the Subcommittee on Student Support. Dr. Hansing, will you tell us about the NASA Interchange Programs?

NASA INTERCHANGE PROGRAMS

DR. FRANK D. HANSING: Thank you very much Mr. Chairman, Ladies and Gentlemen.

For the past two days we have heard many presentations concerning education and training activities of Federal laboratories. In addition to NASA Headquarters which is located here in Washington, the Agency has ten major research centers or launch facilities. Yesterday we heard a great deal about the size of various establishments and their test ranges. If we consider the outer space as a test range, one of my colleagues has estimated that the NASA test range is something like 6×10^{19} cubic miles.

In the "Education and the Federal Laboratories" report, the Committee referred to programs which involve "flow-in" of university people to the laboratory and a "flow-out" of government people to the universities. As a "flow-in" NASA provides many opportunities for students and faculty to participate in summer programs, cooperative work-study programs, apprentice training, intern training, various graduate programs, and other more specialized opportunities. Some of these have been mentioned yesterday by Dr. James Youngblood of the Manned Spacecraft Center, and Dr. Russell Shelton, speaking for the Marshall Space Flight Center.

As an example of the "flow-out" side, NASA employees last year earned 206 advanced degrees from 41 universities under sponsorship of the Government Employees Training Act.

This morning the topic is interchange of professional personnel between the universities and Federal laboratories. NASA has some programs which do have an interchange of personnel between the universities and laboratories. These arrangements are not easily developed. Some have been successful, others not. I will briefly describe a few of these programs.

Goddard Institute for Space Studies

First is an example of a successful program which is based on informal arrangements rather than formal or contractual agreements. This is the Goddard Institute for Space Studies which was established in 1961 as a New York office of the Goddard Space Flight Center. It has a small permanent Civil Service staff who work closely with neighboring universities to develop a maximum university contribution to the space science program.

Associations between the Institute and New York area universities are an integral part of the Institute operations and constitute the greatest single source of strength and vitality in the Goddard Institute program. The most important element in these associations is the fact that a substantial number of graduate students perform research in space sciences on the Goddard premises under the guidance of the Institute staff who hold

adjunct faculty appointments in New York area universities. These appointments enable Institute staff members to offer courses in space science in neighboring universities and to supervise Ph.D. research of graduate students working in the space-related fields. The courses are important because they enable the Institute staff members to interest science students in doing graduate work towards the Ph.D. on space science topics. In 1967-68, 16 courses were offered by Institute staff at universities in the New York Metropolitan Area.

Ames Agreement

Another example of NASA-university interchange, while still in its formative stages, is that being pioneered by the Ames Research Center. The relationship is based on a number of cooperative agreements entered into between Ames and the University under NASA's statutory authority to enter into such agreements. Under these agreements NASA and University personnel in related disciplines are brought into a closer day-to-day working relationship with each other through participation in joint endeavors or through use of each others' services, equipment, personnel, or facilities. University faculty and students are afforded an opportunity to work on problems of immediate interest to Ames, sometimes utilizing the facilities of the Center, and Ames personnel benefit through access to the facilities and services of the University. Due to the mutually beneficial nature of the relationship, only very nominal sums of money are exchanged between the parties.

A specific example of this type of cooperative agreement is that involving Santa Clara's Institute of Contemporary Law and the Ames Chief Counsel's Office. This agreement has two facets. First, it involves the law faculty of Santa Clara in far-reaching basic legal research that is important to Ames, while Center personnel are given access to law school courses and the library. Secondly, the agreement provides valuable summer and part-time legal research employment for disadvantaged law students in part through funds made available under Title 1-C of the Economic Opportunity Act of 1964 and in part through nominal funding by Ames.

Similar types of cooperative agreements are in being or are under development in the areas of biology and engineering and with other nearby universities.

The important point here is that these cooperative agreements allow for variables and are not tailored to specific disciplines. They contemplate and permit open-ended, viable cooperation between individuals having like interests on day-to-day matters of mutual concern. They rely on cooperation between such individuals and, since they principally involve mutual exchanges of services and the use of equipment or facilities, tend to involve only limited financial resources. As a result of the pioneering efforts at Ames, other NASA centers are now becoming interested and are opening discussions with educational institutions in their own vicinities.

Virginia Associated Research Center (VARC)

Another example of an interchange program which has not been quite as successful as the others is our Virginia Associated Research Center working with our Langley operations. The Virginia Associated Research Certer, hereafter referred to as VARC, was established by the 1962 General Assembly of Virginia as a cooperative venture between the College of William and Mary, the University of Virginia, Virginia Polytechnic Institute and the Medical College of Virginia. The Center has three main functions: (1) to manage and operate NASA's Space Radiation Effects Laboratory (SREL) located near the Langley Research Center, (2) to develop a research program in which quality institutions of higher learning and other research organizations may use the laboratory, and (3) to arrange for a coordinated program of resident graduate instruction under the joint sponsorship of participating institutions.

The concept of the joint VARC-SREL complex was to establish a major center of science and engineering that would provide the needed resident graduate educational programs for the state and region. The Space Radiation Effects Laboratory would be the initial research facility for use by both Government and the universities. In addition, the Langley facilities could be used in support of the VARC program.

VARC now operates SREL through a contract with the Langley Research Center. The operation of SREL by VARC was expected to act as a catalyst in the interaction between the university faculty and the Langley staff and lead to further research projects and interaction to expand the scope of the university-Government relationship to include other phases of academic interest with resulting mutual benefit to both Government and universities. SREL was dedicated at the end of 1965, and the operation has expanded to a presently scheduled 24-hour day, 7-day week for the cyclotron. SREL operation has been successful in attaining its initial objectives.

The fundamental objective of the proposed VARC was aimed at the establishment of a graduate center wherein all the on-campus resident requirements at the participating schools could be satisfied locally. The degree would still be awarded at the participating schools. The sponsoring institutions are to develop full-time faculties locally so that full resident credit could be awarded for both master's and doctoral degrees. The combined staff concept was to be employed wherein basic courses would be accepted at any of the participating universities. Instructional efforts began at VARC in the fall of 1966 with a relatively small enrollment in classes in engineering and radiation biology. Classes peaked at a total enrollment of 70 in 1967 with predictions of about 30-35 in 1968.

The educational program of VARC has not lived up to its expectations. A reorganization was requested by the Governor of Virginia and in August 1967 the joint agreement was terminated. The responsibility for the management of VARC was delegated to a single school-William and Mary;

however, the remaining Virginia schools, to which was added Old Dominion University, continue to have responsibilities for the educational activities at VARC.

Two principal reasons have been suggested for the failure of VARC to fulfill its original educational goals. (1) The State and its educational institutions were unable to agree on the details of the educational programs and administration. (2) The failure of VARC to provide for on-campus resident credit for its courses offered for advanced degrees. I would like to point out that VARC is not dead; but a prompt establishment of policies to resolve these issues is required before VARC will become a viable activity.

Summer Faculty Fellowship Program

I would like to mention two other programs which are principally "flow-in" types; however, considerable information is exchanged both ways.

One, our Summer Faculty Fellowship Program, consists of two separate activities, one in research, the other in engineering systems design, both starting with a common purpose and sponsorship. Both programs share the three-way cooperation of the American Society for Engineering Education, one or more universities, and a NASA center. The principal objectives of the program are to further the professional knowledge of young engineering and science faculty members, who go back to their home institutions to enrich the research and teaching activities there, and hopefully they will bring in some new ideas into the research center. Contracts are awarded to a university located close to the center and the program is managed by co-directors, one each from the university and the research center.

The research fellows spend about eighty to ninety percent of their time in the NASA center working on individual research projects of mutual interest to them and the center. Each fellow works with a center colleague and is associated directly with the ongoing activities of the aeronautics and space program. The remaining ten to twenty percent of their time is spent in seminars, workshops, or lectures usually on the campus of the sponsoring nearby university.

The program runs for ten weeks and last summer about 250 faculty members participated in nine locations.

The engineering systems design fellows participate as members of multidisciplinary design teams. Each group selects and designs a complex system, such as an applications satellite. The system design concepts have proved to be highly effective in stimulating student innovation, and in teaching the application of engineering theories to actual engineering problems.

These programs have resulted in the development of many new courses on university campuses, participants have arranged consulting situations

with the centers, and many of them have obtained grants and contracts not only from NASA but from other Federal activities.

Resident Research Associateship Program

Last but not least is our Resident Research Associateship Program which is administered by the National Research Council of the National Academy of Sciences and the National Academy of Engineering.

The purpose of this program is to provide postdoctoral and senior postdoctoral investigators an opportunity to carry on advanced research in space-related science or technology in a NASA research center. This program enhances the exchange of scientific knowledge with other countries in the free world through the training of non-U.S. nationals and provides for the dissemination of space knowledge from NASA laboratories to universities.

The number of Associateships held since the beginning of the program in 1959 now totals 442; 36 countries, including the U.S., are represented in these appointments. As of August 31, 1968, 167 Associates were on tenure. More professors from U.S. universities should apply for participation in this program. Brochures on each of these programs are available on the table in the rear of the auditorium.

In the remaining few minutes I'd like to point out some current activities which will help both the "flow-in" and the "flow-out."

NASA has opened its doors in Headquarters and the research centers for cooperative arrangements with universities. This applies not only to the conduct of research in science and engineering, but also to the study of management and administration problems. The Office of University Affairs for instance over the past few years has had university professors on board for periods of a summer to a full year. Other program offices have done likewise.

Memorandums of Understanding as mentioned by Dr. Pelczar yesterday, are also used by NASA with a number of universities involving training and research activities in both the area of engineering systems design and management and administration for the purpose of stimulating the "flow-in" of both students and faculty.

In our Fiscal 1970 budget, the Office of University Affairs has asked for more funds for programs which will involve closer university-center relationships.

On the "flow-out" side, arrangements are scarce and limited in magnitude. We are presently in process of preparing a policy directive, the purpose of which is to encourage "leave without pay" up to three years for NASA employees seeking advanced degrees and accepting faculty positions with universities. This is a positive step to promote a continuance of the technical and managerial expertise developed in the highly complex

aerospace activities. Employees are encouraged to take advantage of fellowships, traineeships, and assistantships to advance their technical and management knowledge, and/or to accept teaching and research positions. This will strengthen individuals and universities by having experienced NASA personnel work with faculties and students. Universities however must take the initiative to identify positions in their organizations and try to recruit the necessary individuals to fill them.

Conclusion

To conclude, it seems that many mechanisms are available both for university staff to affiliate with Government laboratories and for civil service personnel to participate in university activities. It remains for a creative and imaginative management to use the methods now available. Both university and Federal laboratory personnel should be exploring new methods and procedures for bringing about closer working relationships involving the exchange of personnel.

Thank you.

DR. HOWARD: Thank you Dr. Hansing. Here's a question right back here.

MR. DONALD F. SULLIVAN (Naval Missile Center, Point Mugu): Yesterday Dr. Hoyem mentioned that the Council of Southern California has a program and a lot of projects including a sabbatical program. Also a project for summer work for professors and faculty members and also graduate students. What I'd like to mention here is a mechanism following up on this talk and that is the College Federal Council of Southern California. I have an extracurricular job this year as Chairman of the College Federal Council which is an organization that's been in effect for twenty-one years. It covers the eleven or twelve counties in Southern California. We have an executive committee that's made up of about twenty people, ten from universities and ten from government, and we meet on a monthly basis. The Council promotes and prosecutes projects of common interest to the universities and the government. We cover a little wider scale, more than just the science and technology, but it is a mechanism. We meet monthly, and end up with an annual program--one year hosted by universities, the next by government. At these annual programs we bring together as many as two hundred top people from the universities and government for a two day session. Through the projects we work on and the annual meeting we do get information back and forth, this flow-in and flow-out that you're talking about. Thank you.

DR. HOWARD: Question here.

DR. JACK B. CHADDOCK (Duke University): I'd like to ask a little more about the formal arrangements you have in this leave without pay to

employees. Apparently this is some sort of program in order to encourage perhaps some of your senior people to participate in the university. I wonder if the structure is a little more formal than you indicated.

DR. HANSING: Jack, this is in the process of being developed now. Our personnel people and members of our office are developing the policy directive. As far as the actual details involving the payment of the withholding for insurance and retirement benefits and these details I'd have to defer that to some of the people from the personnel office. I don't know if Grove Webster is here. I don't know if Grove wants to speak to this issue or not.

MR. GROVE WEBSTER (NASA): I think it's too early.

DR. HANSING: Right. The details will be worked out. The main thing I wanted to mention is that this is a mechanism. We do want to follow up on this, but there are many things that need to be ironed out yet.

DR. HOWARD: There's a question right here.

MR. HAROLD LEICH: There is another bill which we have great hopes for, called "the Intergovernmental Personnel Act," which was sponsored by Senator Muskie and which actually passed the Senate a year ago. Unfortunately it died in the House. This is primarily aimed at interchange between Federal, State and local governments. Fortunately some words were slipped in there including universities. This would provide for formal interchange arrangements between Federal, State, local governments and universities with full protection of the various rights mentioned (health, retirement, various insurance and other employee benefits) during such a period of exchange say from a Federal laboratory to a university or back and forth.

DR. HOWARD: Thank you. Are there any other questions?

MR. C. GUY FERGUSON (NASA): I would like to address a question to Frank Hansing. Frank, I believe you mentioned about five examples of interchange programs in use in the space agency. In view of the specialized legislation of that agency, would you care to mention which of these perhaps do not depend upon specific space agency legislation and therefore may be of general application without legislation?

DR. HANSING: I'm not sure I can answer that. Our Summer Faculty Fellowship Program is not specifically mentioned in any legislation. As a

matter of fact, I don't think any of these are mentioned by name. They all stem from one of the sub-items in the Space Act. I think particularly the Ames agreements, those of Section 203b6, are examples of this kind.

DR. HOWARD: We have just one or two minutes if there is a question any of you would like to address to either of the two previous panelists we can have that now. If not, there will be a fifteen minute coffeebreak.

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DR. HOWARD: We will move on now to the first after-coffee speaker, Dr. Lloyd Elliott, who is a native of West Virginia and who secured his A.B. and A.M. degrees in West Virginia. He then went to the University of Colorado where he received the Doctor of Education degree. Since that time Dr. Elliott has received several honorary Doctor of Laws degrees, including the University of New Hampshire, Colby College, Concord College and West Virginia University. His first academic effort was that of a teacher in the public school system in a relatively small community in West Virginia and he moved into the principalship. He went back to Boulder, Colorado, to become Assistant Superintendent of Schools. He next returned to Cornell University at Ithaca as an Assistant Professor and moved up through the ranks to become Professor of Educational Administration and Executive Assistant to the President. In 1958 Dr. Elliott went to New England as President of the University of Maine at Orono where he remained until 1965 when he came to Washington, D.C., to become President of the George Washington University. President Elliott,we would be delighted to hear from you on the subject of use of Federal employees as part-time university instructors. Are they good or not?

USE OF FEDERAL EMPLOYEES AS PART-TIME UNIVERSITY INSTRUCTORS

DR. LLOYD H. ELLIOTT (The George Washington University): Thank you Mr. Chairman, Ladies and Gentlemen.

It is said and I'm sure it's true that a college president can speak at the drop of a hat. It's probably more correct to say that a college president will speak, does speak, won't resist speaking at the prospect of a drop of a nickel. Maybe that's the reason that I've had such difficulty in preparing remarks for this audience--because I feel a scarcity of nickels dropping. In fact I wonder as I have listened with great interest over these past couple of days, if science and technology is really motivated by the prospect that the shower of nickels may be drying up.

About 1959, due to the arrangements of a very good friend of some of us, a group of university presidents spent an evening with Harry Truman in Kansas City. At that particular time a fellow by the name of C. P. Snow had just published a book on the two cultures. It was a matter of conversation in academia at that time, if you recall it. Scientists couldn't talk to humanists and humanists couldn't talk to scientists, and so on. And Harry Truman gave a wonderful evening to us, starting off with four or five minutes of comments. Then he said "I want your questions." A vice chancellor representing a British association of universities got on his feet among the first questioners and said, "Mr. President, how should the Government treat its scientists?" Now this is a vice chancellor from a distinguished British university. He's read all of C. P. Snow and he's heard all of the debates in the Parliament and he asks Harry Truman this question. Well Harry Truman in his typical diplomatic fashion said, "How do you treat scientists?" He said, "Yes sir, how should the Government treat scientists?" "Well," Harry began, "Well hell, you treat scientists like you do all other citizens." And this man interrupted and said, "In time of peace, in time of war?" President Truman said, "It doesn't matter. What's so special about the scientist?" (See, I told you he was a diplomat. I assume,Mr. Chairman,I'm speaking to scientists and engineers.) And he said, "What's so special about scientists? They, when called on to serve their country or to serve humanity, ought to respond like any other buck private."

One of the things that's bothered me for these two days, gentlemen, and I'm a non-scientist surrounded by scientists and engineers, is a statement made the first day. "We have done well. We have been uniquely successful." I'm saying to you as scientists that you are not doing well enough today, and I'd like to go on for just a few minutes to say something about this. Your objectives I think are unclear on the campuses today. Many of your ways do not show to be the beautifully organized, logically defensible ways of the scientist so far as the way of science is being interpreted on the campuses today. The first faculty committee I ever sat on as a member of the faculty at Cornell engaged in a series of debates on the humanities content of the major in the sciences and very little in the way of the scientific content of the major in the humanities.

This morning I read with pleasure and with pride that the Nobel Prizes this year in science were all won by Americans. I'm sure you did too. But I'm deeply concerned about what the score may be ten years from now or twenty years from now. My question, therefore, is something like the following: "Do you know what's happening on the campuses today?" If you have not sat down with two or ten "liberal-radical" students in the last three months or six months, I don't believe you do know what's happening. The thing that bothers me is that good students, those with outstanding minds, able students who were going to chemistry and physics and biology and mathematics, are now being confronted with the question: Is science an answer to the problems of our day? Does science have an answer? Herb Hollomon really stole part of my speech last night after my spending two or three hours the night before putting it together. He said it more eloquently than I. But this is what's happening on the campuses.

The story of the success of science in alleviating man's suffering--whether we turn to the medical fields, whether we look at the agricultural production, whether we look at improved nutrition and the great input in terms of science and technology into jobs and productivity and a better way of life--I believe, is being challenged to such a point at this particular moment on most of our campuses that many able students are turning away from it. And as a President I am deeply concerned with this because I fear that scientists are continuing to talk to scientists and professors of engineering to professors of engineering, whether you be in the government or out of the government, whether you be in a university or in a private research laboratory, and furthermore that you are continuing to talk about the advances of research rather than the absolute necessity of what I shall call the teaching process. I'm going to rely on an author whose book was published recently to throw in a revolutionary note here. I quote from Professor Mayhew writing in Campus 1980, which was published recently.

> "Within the teaching institution" (he's looking ahead to 1980) "professors will have accepted that their chief duty is to help young people. They will come to see that teaching goes on in a counseling situation just as much as in a formal class. They will accept the fact that they earn their salaries as much through not teaching in an orthodox fashion as in delivering formal lectures. This shift will come hard for professors who are products of a Calvinistic ethic of work and with this shift will come the creation of a new system of ethics which will be not unlike those of the medical and legal professions. College teaching will be viewed as a helping profession to which the interests of students are of first consideration. No longer will a professor feel that his own work comes first and that work of students is an infringement on his own valuable time. Work with a student will come to be of greater worth than the preparation of a research paper or the acceptance of a consulting assignment."

I think we in the colleges and universities today have a right to ask of every professor of English, every professor of chemistry, right across the board of the disciplines of arts and sciences, "What is your private time?" I sat in a meeting a few days ago with a committee on our campus in which one professor made the point very strongly: I give of my private time to the students in such and such ways. I had also the experience within the last few years of talking to a professor who had been a member of the faculty of one of these universities with which I have been associated for three years. He came to see me to tell me about a problem which he faced. I happened to be sitting in the President's chair. The problem was an offer of a six thousand dollar increase in salary at another institution versus his request for a five thousand dollar raise to stay in his present university. This is a very difficult decision. But I said, "Have you discussed this with your departmental chairman?" He said, "No. My departmental chairman and I don't really agree on very many things." I said, "Have you discussed it with the dean

of your college?" And he said, "What is his name by the way?" This is a fact. I think it is a rather blunt fact in the diplomatic fashion of President Truman.

I learned of another professor recently who has office hours from six to seven on Friday and I immediately asked, "Is that a.m. or p.m.?" Those are the only office hours during the week. What is the private time of a professor?

All of this is preliminary to bringing before you my chief concern today as an educator, and that is that unless scientists and engineers or professors of technology undertake the task of clarifying their work and of making vivid the objectives which you seek, you are going to be replaced in the academic marketplace by those who are engaged in day to day conversations with the students whom you must have if the Nobel prizes ten or fifteen years from now are to continue to come to the United States. Science on campus is no longer sacred. It may have been at the time of Sputnik. But it is not now. Administrators are being confronted with the question of why is it that the professors in the sciences have the consulting days where the professors in the history department are expected to do the chore work of students and committees, etc.? Ladies and Gentlemen, I don't make this as a personal indictment of you. I make it because my concern is for the long-range health and strength of this Nation. And unless you continue to get in your areas of study a reasonable share of the high class talent among the college students of today, this leadership will certainly go by the boards.

I suspect, Mr. Chairman, that my remarks may have raised some questions. Let me just conclude with the topic which was assigned to me. I tried, as other speakers I noticed have done, to speak to my subject with liberties. We have eight hundred, I am told by the various deans and departments of George Washington University, people who serve as adjunct professors in one role or another during the course of a twelve months period. Let me add, however, that eighty percent of all courses taught on our campus are taught by full-time professors. What I have said makes no distinction between the full-time professor and the adjunct professor. One of the greatest strengths of a Washington area university is the tremendous array of high talent on which it may call. We take advantage of this. We pay all of our adjunct professors less than we should. We have every arrangement in the book with adjunct professors. We hope all of them are legal. We do know that some of the very work of which I was critical is being performed just as well if not better by adjunct professors than by full-time professors because the full-time professor is very hard to come by. Thank you very much.

DR. HOWARD: President Elliott, thank you very much for those very perceptive and sincere and suggestive comments you made. We have a few minutes for questions or comments.

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DR. HILTON A. SMITH (University of Tennessee): Mr. Chairman, may I make a remark?

DR. HOWARD: Yes, please do.

DR. SMITH: If President Elliott didn't startle you enough, I think I can startle you still more. I sat earlier this month in Denver at a meeting of the American Council on Education. I don't know whether President Elliott was there and, if so, whether he heard the same remark. But I heard a young student who is a graduate of my own undergraduate alma mater and now a graduate student in a very creditable university make the statement to the President which I interpret loosely in this way. Science and engineering has no part in the curriculum of a university and within a reasonable period of time we're going to see that it gets out of a university. In fact, anything that has to do with ways of making a living or preparation for a profession is not a logical part of a university. Of course I'm not quoting this myself as being my opinion. It's far from it. But I think that President Elliott really has a point when he is stating the viewpoint which some of the students are now presenting and which I think they really intend to push for.

DR. ELLIOTT: May I just add to that? Ladies and Gentlemen of the fields of science and technology: If you expect that people in chairs such as presidents and deans will answer these charges adequately, you are absolutely wrong. This is perhaps something that I gather has been taken all too tacitly for granted. Because in the give and take around the conference table, that voice cannot possibly be stated in its true perspective and its depth of meaning except by you. So don't avoid it.

DR. HOWARD: Comment?

DR. MALCOLM MILLER (Columbia University): I find myself in the interesting position of disagreeing with essentially everything that I've just heard. To make an adequate comment would take twice as long, because I'd have to repeat what was said and then try to rebut it. But I shan't. But let's talk about one last remark. I, too, have had the opportunity in the last several months of talking with enthusiastic students who have a vision of changing universities. Their objection that I've heard--perhaps they're being polite to me since they were friends--had not too much to do with the science and engineering schools, except insofar as they were worried about the interaction of these schools with the Department of Defense, the horrors of Viet Nam, etc.; but they were really angry at the humanities, at the sociologists, at the anthropologists and at the economists who were filling them with irrelevancies. They didn't worry so much about the sciences and the engineering fulling them with irrelevancies.

Perhaps these weren't science and engineering students. But they were concerned about the other side of the curriculum, and this you haven't mentioned at all.

DR. ELLIOTT: Your point is well taken. But the reason that they are not confronting the engineers and scientists with these questions is because they don't even bother to see you. They are talking only to the sociologists and the psychologists. And the statement made by my colleague here, I think, is the position being taken. Don't bother with those fellows in hard science and the biological sciences and engineering. They have nothing to offer except a job, and who wants a job? Who wants to work for a living? We have other ideas.

DR. HOWARD: Are there other questions or comments?

All right, we shall now move on to the next panelist, Dr. Hilton A. Smith. Dr. Smith is a native of Massachusetts, received his A.B. degree from Oberlin and his A.M. and Ph.D. degrees from Harvard in physical chemistry. Since that time he has taught at Lehigh University for six years and been a professor at the University of Tennessee. His present position is Vice Chancellor for Graduate Studies and Research. Dr. Smith, will you come forward?

ASSIGNMENT OF UNIVERSITY PERSONNEL TO FEDERAL LABORATORIES

DR. SMITH: Dr. Howard, Dr. Elliott, Ladies and Gentlemen.

I should like to share with you two problems which I now have. The first problem is that as the last speaker on the regular program, I ought to do more than repeat what others have said. I hope that I will be able to do this. The second problem relates to the title which I have been given, "Assignment of University Personnel to Federal Laboratories." If you accept the definition of a professor as one who thinks otherwise, you will understand that one simply does not assign professors to work in installations of this nature. He tries to interest academic personnel in cooperating with Federal laboratories and to demonstrate the advantages of such a relationship.

The University of Tennessee has an obligation to make the best possible opportunity available for each of its students. This requires an examination of the utilization of personnel and facilities of the

three major government laboratories in Tennessee. None of these was included in the assessment of Federal laboratory-educational institution interactions made by the Federal Council for Science and Technology, and published in March, 1968.

The first of the three Tennessee laboratories is the group of Oak Ridge installations of the United States Atomic Energy Commission. Towards the end of World War II these were located in an area from which all inhabitants could be removed but at which there was available an ample supply of electric power. The proximity of the University of Tennessee some 25 miles away was completely accidental. The project was considered secret and the work strictly classified. In fact, originally entrance into the town of Oak Ridge was restricted to those with special passes. At the end of the war there were at Oak Ridge three major plants or laboratories administered under contract with the Atomic Energy Commission by three separate companies: The Monsanto Company, the Tennessee Eastman Corporation, and Union Carbide. Many young men had been brought into the area from graduate schools throughout the country and desired to return to their Universities in order to complete their education. Representatives from the three companies visited the University of Tennessee with the request that graduate courses be provided so that the education of some of these young people could go forward while they remained at Oak Ridge. In addition, a certain number of University of Tennessee professors were employed as consultants. Approximately one year later a group of southern institutions founded the Oak Ridge Institute of Nuclear Studies whose prime purpose was to facilitate relations between the Oak Ridge installations, particularly the Oak Ridge National Laboratory, and academic institutions in the South. The Oak Ridge Institute of Nuclear Studies, now known as the Oak Ridge Associated Universities, has aided in the development of the University of Tennessee Resident Graduate Program at Oak Ridge and many students have taken advantage of the opportunity to achieve both Master's and Doctor's degrees while employed at Oak Ridge. This program has been described by one graduate dean as the only really successful off-campus graduate program in the country.

The Oak Ridge Associated Universities has also fostered many other activities. These include research participation by both faculty members and students, training of teachers in special fields of science, training of personnel in radioisotope techniques, and administration of advanced fellowships of several types including Oak Ridge Graduate Fellowships. The latter are available to students from any university who wish to do their dissertation research at one of the Oak Ridge installations. The Oak Ridge Associated Universities has also sponsored mobile laboratories for high school visitations, a successful program in training and technology, and several summer institutes.

Approximately six years ago, the University desired to take further advantage of the pool of eminent scientists and engineers available at Oak Ridge. With the aid of funds from the Ford Foundation an arrangement was made whereby the Oak Ridge work load of selected individuals was reduced by 20%. These scientists and engineers came to Knoxville to teach

in the fields of biology, chemistry, chemical and metallurgical engineering, engineering mechanics, mathematics, mechanical engineering, nuclear engineering, and physics; and they have been a great asset to the University. They have been appointed as permanent though part-time teachers and participate regularly in departmental, college, and university affairs. Their pay at Oak Ridge is reduced to correspond to their work load, and they are compensated directly for their services to the University of Tennessee performed at Knoxville.

Two years ago the University of Tennessee established the University of Tennessee--Oak Ridge Graduate School of Biomedical Sciences. There are three regular full-time professors plus some 40 part-time professors, the latter made up of outstanding biologists at Oak Ridge. The program is strictly interdisciplinary in nature and brings faculty and students into close contact within the facilities of the Biology Division of the Oak Ridge National Laboratory. Another example of cooperation involves the appointment by the University of Tennessee of a chemistry professor who works part time in the new transuranium facility at Oak Ridge. The University also operates at Oak Ridge a Nuclear Engineering Practice School which is open not only to University of Tennessee students but to those of other institutions as well. Graduate students are provided access to the many reactors and other nuclear facilities at the Oak Ridge National Laboratory.

The University of Tennessee also operates the University of Tennessee-Atomic Energy Commission Agricultural Experiment Station under direct contract with the Commission. Here the influence of radiation on large animals and on plants is studied. The personnel of this experiment station are employed directly as staff members of the University of Tennessee.

Finally the University has recently started on the Knoxville campus an Archival Center for Radiation Biology. The Director of this Center is Dr. Alexander Hollaender, former director of the Biology Division of the Oak Ridge National Laboratories. Dr. Hollaender is presently in Europe making arrangements for procurement of material to be used in this Center.

All of these cooperating ventures have encountered resistance of one type or another either on the Knoxville campus or at Oak Ridge. All have required conferences between affected groups before they could be put into operation. I wish particularly to acknowledge the interest and assistance of the officials of the Atomic Energy Commission, of the Union Carbide Nuclear Division, and of the Oak Ridge Associated Universities all of whom have been instrumental in the success of these ventures.

The second major government installation in Tennessee is the Arnold Engineering Development Center located about 160 miles from the University. It was also located in a place well isolated from populous areas. It houses facilities for the performance of simulated tests showing the performance of air and space vehicles in the upper atmosphere. It is operated by ARO, Inc. under contract with the United States Air Force. This organization also found that educational programs were

required at the graduate level if it was to attract and obtain satisfactory employees. Approximately ten years ago the Head of the University of Tennessee's Department of Mechanical Engineering spent one year in residence at the Center and organized a graduate program for its employees. This venture has been quite successful. Three years ago the University built near the Arnold Center the University of Tennessee Space Institute, which has been described as the most beautiful educational building in the most beautiful setting in the country. In a sense, University personnel are assigned to work in the Center through a regular consulting contract with ARO, Inc. However, this duty is agreed upon at the time the scientist or engineer is employed. The students in the Space Institute represent employees of the Center; full-time officers assigned by the Air Force Institute of Technology; personnel sent from industries; persons employed as research assistants; and international students, particularly those who come under an exchange agreement with the Technical University at Aachen. Each staff member of the Space Institute is also a member of a department and college at the University of Tennessee, Knoxville. Course descriptions, preliminary examinations, etc. are the province of an entire department including members from Knoxville and the Space Institute.

One of the major functions of the University of Tennessee Space Institute has been the offering of a wide variety of short courses to engineers and scientists from industry, educational institutions, and government. These have been very successful. Already two "spinoff industries" are located close to the University of Tennessee Space Institute.

The third major government installation, and the oldest of the three, is the Tennessee Valley Authority. This is perhaps the most successful flood control system in existence. The University over a period of years has not taken full advantage of cooperation with the Tennessee Valley Authority, perhaps because it is very extensive with its operations covering a number of southeastern states. With increased interest in water pollution, water resources research, river basin development, and the soft sciences, there is a growing interest in programs of cooperation. Three years ago, a small social science internship program was started which was subsequently expanded to a number of universities through the cooperation of the Oak Ridge Associated Universities and now the Southern Regional Educational Board. Undoubtedly, there will be future interaction in many areas.

One recent development with all three of these government installations, which has already been mentioned in connection with the Tennessee Valley Authority, is the increased interest in the soft sciences. A group at Oak Ridge is already working with the University and is making use of professors in economics, sociology, political science, planning, etc. It is evident that this relationship will be expanded. At the University of Tennessee Space Institute there is now one professor whose prime interest is in the area of cybernetics and bionics, and NASA has

expressed the desire to see studies in the management science field performed in connection with major government centers.

In summary the presence of these three Federal installations in the state of Tennessee has already been of considerable advantage to the University and the potential for further cooperation is great.

Thank you very much.

DR. HOWARD: Thank you, Chancellor Smith. The Chancellor has left us a few minutes for discussion or questions. Do you have some you would address to him?

DR. ZOLA BRONSON (National Science Foundation): I would like to ask Dr. Smith to comment further on his observations about the movement toward recognition of the soft sciences. If you don't mind I would rather call them the complex sciences. I'm wondering if you could tell us just what this area of involvement includes. Is there any effort to make it interdisciplinary in the same sense as you talk about interdisciplinary natural science? To what extent have you considered giving exposure or understanding to your natural-science trained people in a complex science, particularly in terms of the interface of what this new science and technology is doing to the community in micro basis and how they must better understand these skills and knowledges they have as scientists in relation to the larger community?

DR. SMITH: I'm sure I cannot answer all that question satisfactorily, but I'll do my best. I can give an example of a recent involvement of the Oak Ridge National Laboratory. Alvin Weinberg, whom many of you know, came to the University of Tennessee and expressed interest in the area of what I'll call again the soft sciences. Can you help us? Does the University have people in sociology and political science, and economics and such areas who can work with us in trying to develop an understanding of this type of research?

Now, Oak Ridge hires primarily what I'll call hard scientists and engineers. There are very few soft scientists there, although more have been added in recent years. But the man who actually is heading this endeavor from the Oak Ridge standpoint is a chemical engineer. This request was taken up with our departments and we are now cooperating. We have a group of people trying to explore what the effect, if I can put it that way, of the hard sciences on the soft sciences or vice versa will be and how we can make progress in understanding some of the problems which the world now faces. I cannot say that we have been successful yet. We're just starting. I can't tell you how much involvement the hard scientists will have or how much understanding. But I can say that the problem is located right in their midst. They are worried about it. They are really interested in it.

I might mention something that I should have said in my talk. One of the things which was started in a small way by the University of Tennessee, then taken over by Oak Ridge Associated Universities and then, more recently, by the Southern Regional Education Board is known as the Social Science Internship Program whereby students from these so-called soft sciences are taken primarily in the TVA areas all over the river basins and are given an internship working with the people residing in these basins. Once again I don't know that this will influence the hard scientists very much, but it gives our students actual experience in the soft sciences.

At the University of Tennessee Space Institute, interest in these subjects started in two ways. One was by the employment of a professor in the main areas of cybernetics and bionics who is bringing his message, if I could call it that, to the hard scientists and engineers. The second is via interest particularly from NASA in certain management science areas at both the University of Tennessee Space Institute Arnold Engineering Development Center and the Huntsville complex. This we're looking into now.

I don't know that I've answered your question, but I've tried to describe the sorts of things which are developing and which I think the University will participate in fully. Our people in the soft sciences are firmly committed as far as I can tell to this type of participation.

DR. BRONSON: Can I ask one further question? You mentioned that the interfield involvement was under the direction of a chemist.

DR. SMITH: A Chemical Engineer.

DR. BRONSON: Chemical Engineer. Assuming as valid the observation that Dr. Hornig made not too long ago that in dealing with the larger social situation science and technology is only one element in a broad spectrum of determining factors. Have you ever given consideration to the possible reasonableness of having a social scientist as the coordinating and directing planning mechanism within which your natural science people will participate?

DR. SMITH: I might say that from the University standpoint the liaison is with a person in the soft sciences, a person whose prime interest is in our graduate school of planning who is coordinating the efforts of all our people. I think, however, your point is well taken. I do point out again, though, that this push came from the Oak Ridge National Laboratory and the people whom they employ are primarily hard scientists. I understand that this interest also came in part from the National Academy of Sciences through Alvin Weinberg into the Oak Ridge National Laboratory.

DR. HOWARD: Is there another question?

DR. ERNEST K. SMITH (ESSA, Boulder): I would like to direct a question to President Elliott. The question is as follows. It is our experience in Boulder that by and large we have a lot of people who would like to teach in the Federal research laboratories and when the opportunity comes their way, we are then faced with two problems. The first one is: should they be paid directly? Should an already well paid civil servant, if you will, increase his salary through teaching? Something that by and large is an honor not available to everybody who would like to teach in the Federal laboratories. If he is not paid, then what is the quid pro quo between the university which gets something out of it and the Federal laboratories? I wonder if I could inquire among your 800 adjunct professors just what is the major arrangement that you have?

DR. ELLIOTT: If you want the job done, you pay them. Interest, mutual concern, all of these things will last a few months. But in the final analysis, as someone said here yesterday or the day before, you are buying and the university in this case ought to buy this service. You can always write this off as another step to keep up with inflation.

DR. FREDERICK D. ROSSINI (University of Notre Dame): (See Appendix D for a statement regarding the Argonne National Laboratory and its interaction with the universities in educational affairs.)

DR. HOWARD: I think we must conclude our question and discussion session. I would like to take one brief moment to express my appreciation to a most cooperative group of panelists, Drs. Pecora, Mider, Hansing, Elliott, and Smith. I appreciate their cooperative spirit in adhering to our time schedule and will now turn over the program to Dr. Irving for the conclusion.

DR. IRVING: Thank you very much, Dr. Howard and gentlemen of your panel. We have all but completed the symposium we came here day before yesterday to start. And now, since he started it, I am happy to turn the podium back to the Chairman of the Committee on Federal Laboratories, Dr. Astin, for his remarks to conclude this session.

CONCLUDING REMARKS

DR. ALLEN V. ASTIN: Thank you very much, George.

I'm billed as making concluding remarks, not a summary, and the essence of what I want to talk about before I let you go is where do we

go from here. We've had, I think, an interesting and fruitful exchange of ideas during the symposium which, hopefully, will result in some action programs. I know that on behalf of the National Bureau of Standards I picked up some things which I think will be useful. Also, as Chairman of the Committee on Federal Laboratories, several things have come up which I will deal with later, hopefully as a source for constructive action by the Committee.

As a minimum the Committee would like to have from you the completed questionnaire that George Irving referred to and which was in your registration packet. Your completion of this questionnaire will be most helpful to the Committee on Federal Laboratories in planning followup activities--either for additional symposia, other topics, or in terms of constructive action programs. But I would sincerely hope that your willingness to contribute ideas will not cease with the completion of the questionnaire, and that you would continue to think about the problem of collaboration between Government agencies and universities and let the Committee have your ideas on this topic from time to time.

As has been demonstrated during the meeting, collaboration is a fact. There are a number of imaginative ideas in process in one or another Government agency, and hopefully this type of collaboration will be expanded upon. Don Hornig told us that collaboration was going to be, in his judgment, necessary in order to share the major resources provided by means of taxes in a more effective manner. Although, I think, we have to accept this as a fact of life, I hope that we will approach collaboration and attempt to increase it more because we want to than because we have to. Many of the initiatives that have been taken so far in developing collaboration, I think, have come from the Government laboratories, with the possible exception of some of the AEC and NSF National Laboratories. These initiatives have been taken by the people in the Federal laboratories because they have realized the benefits to them through greater collaboration with university people.

It has been mentioned several times during the meeting that there is an absence of great enthusiasm for such collaboration on the part of many university professors. The phrase was used once, "They want to know what's in it for me." Well, my automatic response to this is to think of the oft-quoted phrase from President Kennedy's inaugural: "Ask not what your country can do for you, but what you can do for your country." I think this is equally applicable here. Still in all, we have to live with facts, and people want to know what's in it for them. Those of us who are here and believe in collaboration should take some responsibility in trying to broaden an understanding of the benefits.

One of the benefits--a bit abstract perhaps--is that through greater collaboration of university people with Federal laboratory people and programs, universities have an opportunity to come a little bit closer to real life problems. I sense that a tendency to be isolated from real life problems is one of the factors leading to the unrest which has been talked

about. Certainly Federal laboratories, if they are to justify their existence as tax supported agencies, should deal with real life problems. If they don't, as Herb Hollomon pointed out last night, they ought to go out of business.

I think it is also useful to point out here that, although we have been talking about university-Government laboratory cooperation, cooperation between universities and industry laboratories has similar opportunities and problems. Likewise there are opportunities for greater Government collaboration with industry laboratories, but that is a separate topic. I think we are all aware of it. It is not the subject of this conference, but it could deal with other activities of the Committee on Federal Laboratories and by the universities.

The general plan for this conference was to deal with a number of separate but related activities all of which are a part of university-Government collaboration. These activities were separated in the sessions of your program. One of the things that impressed me was the difficulty of separating these activities. I think in each session of the program there was discussion about the sharing of facilities, about the use of facilities for graduate training, about the training problems of Government laboratories, and about joint research and the interchange of staff. Essentially, if we have real collaboration between Government agencies and universities, we will unavoidably get involved in all of these problems.

Another thing that impressed me throughout the conference is the fact that the AEC national laboratories really have most of the things we want. As a matter of fact, the AEC labs, as you all know, were set up to provide major facilities to be shared with the universities for both research and graduate education. To some extent it was the success of the AEC national laboratory programs that led the university people on the National Science Board, under Phil Handler's leadership, to send a resolution to President Johnson urging an extension of this type of sharing to the major facilities of other Government laboratories. This proposal was one of the major inputs to the Report of the Committee on Federal Laboratories, which is the essential background of this meeting.

I would like now to come to the business of what the Committee on Federal Laboratories might do. I see at least three types of activity. One is in connection with information collection, analysis and dissemination. We do, of course, plan to publish the proceedings of this conference and to include all of the ideas that were presented and comments that were exchanged. But I'm not sure that this is enough. It would seem to me that the Committee might do more. It should probably make an analysis of the symposium, summarize the different types of reasonably successful interchanges, and outline some of the roadblocks or problems that have to be overcome in order to utilize the ideas that have been presented. This could be, I think, a rather useful document. At any rate, it is one of the things I'm going to ask the Committee to consider.

Another is, I think the Committee must enlarge its scope. Actually its membership now is limited partly to administrators and partly to laboratory directors in the Washington area. I think we must extend the participation of laboratory directors in the Committee, including participation representative of the successes and activities of the AEC National Laboratories. I plan to make such a proposal to the Chairman of the Federal Council for Science and Technology.

The Committee can, in addition, identify from the deliberations that have gone on here a number of administrative problems on which policy guidelines issued through the Federal Council could be helpful. For example, some of the problems that have been brought up are publication policies that inhibit the joint publication by university and Federal people and the problem of the joint direction of graduate students or postdoctorals. These types of things I think could be considered by the Federal Council and policy guidelines that would help could be issued.

We've heard a lot about the problem of the isolation of Federal laboratories and the very easy successes, if we could call it that, when a Federal facility is located right in a campus. This can happen only in special instances. I think in most cases the requirements of the Federal laboratory are such that it must be located separately. One of the things which I have heard about a number of times, but didn't hear discussed at this meeting, is the use of closed circuit television and video tapes as a means of overcoming in a way this problem. I would think that the Committee on Federal Laboratories could accumulate and disseminate information on such activities.

The final thing is matters that lead to legislation. At the moment there is only one pending piece of legislation dealing with this problem, and that is the Visiting Scientists and Scholars Program that was referred to earlier. This is a piece of legislation which the Committee has favored for some time. It finally got through all of the clearances within Government and was submitted to the Congress, but the response there has been extremely lukewarm. This may be due to the fact that normal procedures of the Congress send this to the Post Office and Civil Service Committee, not the Science and Astronautics Committee. I think if we're going to have this legislation passed, we've got to develop some interest and support in it. We plan to give this our attention.

Another thing is the problem of compensation. One of the points that impressed me during the conference, I think it was Dr. Smith that mentioned it, is that their program of collaboration--use of Government people as instructors, and so on--did not succeed until it ceased to be a moonlighting or overtime activity. If it's to become a regular part of a man's regular or official work week, there are two ways of doing this. He can have two part-time jobs, or the teaching assignment, if he is a Government employee, can be considered part of his official duties. This is justified in some cases now, but we have to go through a rather circuitous legal argument to do it. It might be helpful if we could get legislation which would clearly make this possible.

We've also heard of problems that come about because the long-term arrangements necessary in interchanging scholars or research people require a long lead time and all agencies do not have the no-year money that makes this possible. This again is a type of legislative matter.

What I have tried to do is to indicate some of the things that the Committee on Federal Laboratories might do, and I hope will do, to make sure that we go ahead with the business of increasing collaboration between the universities and Federal laboratories. But we will need your support and cooperation on this. I would like to ask you to look on the Committee on Federal Laboratories as a continuing center to be fed information and to receive information on this problem. Don't lose touch with us.

In closing, please let me extend to you my sincere thanks for your interest and your willingness to spend two and a half days here with us. I hope that you got as much out of it as I did and that your interest in this topic will not cease with this meeting. Thank you very much.

APPENDIX A

GRADUATE TRAINING AT NASA FACILITIES

By James L. Youngblood
NASA Manned Spacecraft Center

I. NASA'S INTEREST IN TRAINING OF GRADUATE STUDENTS

The National Aeronautics and Space Administration and its predecessor, the National Advisory Committee for Aeronautics, have developed and supported a diversity of programs designed to promote closer, more active cooperation between themselves and university faculty and students. Part of the motivation for this, as observed in the report, "Education and the Federal Laboratories," has been to keep our staff up-to-date and maintain viable relations with the academic community. However, these benefits are added attractions as far as NASA is concerned. Both NASA and NACA were charged with the responsibility of leading the nation in aeronautics and, more recently, space research. This leadership requires that the Agency not only develop science and technology, but in the words of the National Aeronautics and Space Act of 1958, also "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." Sec. 203(a)(3) This charge was not new to the organization. In fact NACA began in 1915 with 12 non-paid members who were to "supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and application to practical questions." (Rosholt, 1966) Thus this organization has a responsibility for national education which dates back some 53 years.

Education of the public by NASA has taken many forms. These have included elaborate committee/subcommittee structures, conferences, symposia, publications, audio-visual aids directed toward elementary and secondary level schools, technology utilization programs directed toward industry, and in-residence programs for university faculty and students.

These latter in-residence programs are a relatively recent development stemming from the growth both in magnitude and importance of university education in our national life. Because the participants of in-residence programs work as an integral part of the NASA team, these programs provide to a degree not possible otherwise an in-depth understanding of complex developments. Therefore, such programs are currently among the most valuable of NASA's activities. The Agency has invested $3.2 million in summer faculty fellowship programs, and $11.4 million in Postdoctoral Resident Research Associateship Programs over the past 8 years. For this investment NASA has received countless important contributions to the ongoing program, and the nation has received better qualified educators.

II. CURRENT GRADUATE ACTIVITIES IN NASA

The training of graduate students at NASA facilities has moved slowly for several reasons. Realizing that the return for investment in a teacher is considerably greater than in a student, NASA intentionally developed faculty programs first. In addition, the graduate training of students demands a far closer relationship between the NASA laboratory and the university, and hence these programs are inherently more difficult to establish. Nevertheless, the Agency has developed a number of graduate programs. The Goddard Institute for Space Science (GISS) was located in New York City specifically to take advantage of the universities in that area, and GISS has worked extensively with graduate students since its beginning in 1961. Currently 37 Ph.D. students from 6 New York area universities are working on their dissertations at GISS. The Goddard Space Flight Center has 2 grants with Maryland University and a third with Howard University which support a total of 25 graduate students conducting their research at the Center. Ames Research Center has agreements with Santa Clara University which provide support for 30 students working at the Center part time and an agreement with Iowa State University which supports 2 Ph.D. students working there full time. Marshall Space Flight Center is now developing similar agreements with Louisiana and Mississippi State Universities to make available part of the Mississippi Test Facility for graduate training. The Manned Spacecraft Center has a Medical Externships Program in cooperation with 9 medical schools. This program has provided each of 35 M.D. students with 10 weeks' professional experience since 1965. Another program of graduate research in business and public administration involving 8 graduate schools has provided research experience at MSC for 18 M.S. and Ph.D. students since 1966. A new program in engineering and scientific research is just starting at MSC with initial agreements involving four universities. This program should bring 10 M.S. and Ph.D. candidates to the Center in its first year.

The above summary is not exhaustive, but it does indicate the extent of NASA's inhouse graduate training activities. Students are supported either by a grant, contract, or reimbursing agreement with the school, or by the When Actually Employed (WAE) mechanism.

III. ACADEMIC REQUIREMENTS FOR A GRADUATE PROGRAM USING FEDERAL LABORATORIES

Let us consider at this point the conditions to be met in establishing a healthy climate for graduate education in laboratories which have as their primary goal research or development rather than the teaching of students.

In order to succeed as an educational activity, a resident graduate program should place primary emphasis upon the academic needs of the students. This is not to say that the interests of the sponsoring

laboratory are unimportant. In fact, from a practical standpoint the educational interests of the student must complement the work of the laboratory in order to insure continuing enthusiastic support by the student's host. However, the prime objective must be to educate students.

A. Research Versus Practice Orientation

Graduate programs in universities divide naturally into two basic types: research-oriented programs which traditionally lead to the Ph.D. degree, and practice-oriented programs which often lead instead to professional degrees such as the M.D. or Doctor of Engineering. Both classes of graduate programs include an applications phase which can be performed at Federal laboratories.

The applications phase of research-oriented programs consists of a thesis project, the successful completion of which contributes to man's store of knowledge. The student thereby demonstrates his capability to conduct independent research. In contrast, the applications phase of a practice-oriented program provides the student with practical experience functioning as a professional under the guidance of other more experienced members of the profession. Let us compare the academic requirements for these two types of graduate programs in several general areas:

1. Advice and Counselling:

a. Research - The student should be guided by an experienced researcher. This usually implies supervision by a Ph.D. level faculty member. In some cases the Federal laboratory personnel are fully qualified in this regard and in others they are not. It is the university's responsibility to insure that the student has competent research supervision.

b. Practice - Usually the student goes to a Federal laboratory to gain experience in his profession because the professionals practicing there represent a level or type of experience not available on the campus. Thus the primary responsibility for guidance of the student ordinarily should be upon the laboratory staff.

2. Freedom and Responsibility:

a. Research - Since the student's primary goal is to demonstrate his ability to conduct independent research, he should not be required to take on "duties as assigned." Nor should he respond to detailed directions in carrying out his research. The laboratory should guarantee the student adequate freedom to allow him to do his own study.

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b. Practice - The student should be allowed to practice his profession in a realistic situation. Freedom and independent effort are usually subordinated in favor of participation in the organization's ongoing activities. "Duties as assigned" are appropriate. However, these must be carefully planned.

3. Facilities and Support Services:

a. Research - Care must be taken to insure that the host laboratory will provide the necessary support to the project. This usually implies a selfish interest by the laboratory in the outcome of the student's project.

b. Practice - Since the student works as an integral part of the organization, this requirement will be satisfied automatically. One must merely insure that the organization is so structured that the contributions of an inexperienced professional will be welcomed.

4. Evaluation:

a. Research - The traditional method of public oral defense of a written dissertation presents no special problems. We recommend that the NASA supervisor be added to the student's advisory committee. This evaluation is primarily a measure of the student's academic qualifications.

b. Practice - For the same reasons that advice and counselling is a host laboratory responsibility, the NASA supervisor should rate the student. If the professional activity does not normally produce written publications (e.g., medicine), this will not be a part of the degree program. The evaluation should involve all of the important attributes of the profession such as interpersonal competence, creativity, initiative, judgement. To the extent to which these factors are important for the profession they should be included in the evaluation.

5. Mutual Understanding

a. Research or Practice - Because the student, in either case, is removed from the campus, care must be exercised in clearly defining the specific responsibilities of each member of this educational team.

One can see from the above comparison that rather fundamental differences in the applications phase do exist between research- and professional-oriented graduate programs. These differences are significant and they should be recognized in the administrative arrangements for each type.

IV. FUTURE PROGRAMS AT THE MANNED SPACECRAFT CENTER

The Manned Spacecraft Center was created primarily to develop the spacecraft and technology for manned space flight. The demands of the Mercury, Gemini, and Apollo Programs required a heavy involvement in engineering design and development, in project management, and in mission planning and operation. In recent years the Center has begun to develop the scientific capability which the manned vehicles are making possible. The Center has many well equipped laboratories, and more importantly has identified the critical problems needing solution. Thus it appears that the conditions are suitable for an active graduate involvement in both the research- and the practice-oriented programs. Because the research-oriented degree is more widely developed in the universities, we expect that our graduate programs will develop principally in this direction. However, the Center's major strengths are in professional engineering and management fields, and as schools develop programs in these areas it is hoped that our involvement with this type program will grow.

V. ADMINISTRATIVE ARRANGEMENTS OF THE MSC RESIDENT GRADUATE ASSISTANTSHIP PROGRAM

A number of administrative procedures have been developed in an attempt to establish a sound academic program. These procedures are outlined below.

A. Administration of research-oriented programs

1. Basic Agreement - The university and the Center sign an agreement which outlines the goals of the program. MSC insists that the students be acceptable to the laboratory supervisor and that the selected project be of vital interest to his organization. MSC agrees that a student's sole responsibility will be the pursuit of his agreed-upon project. The university gives assurance that any project selected and agreed upon will constitute an essential part of the student's degree program. A sample agreement is shown in Attachment I.

2. Proposal - Based upon the general agreement, the school then submits a proposal to MSC which spells out the details of administering the program. We insist that the universities treat this as their program and include those ground rules and safeguards felt necessary to retain its academic integrity. The Center then either funds a grant or contract with the school or agrees to reimburse the school for expenses incurred in administering the program.

3. Statement of Intent by Student - A student candidate for the program with help from his faculty advisor and the MSC laboratory supervisor prepares a written statement of intent regarding his intended research. Both advisors then endorse the project and acknowledge their

specific responsibilities in support of the project. The laboratory supervisor is appointed to the student's advisory committee. A sample statement is shown in Attachment II.

4. Appointment - Once the above requirements are satisfied, the student is officially appointed and begins his program.

5. Evaluation - The usual public oral defense of a written thesis is appropriate. The host laboratory advisor should be part of the student's graduate committee.

B. Administration of practice-oriented programs

Preliminary discussions have been held with university representatives concerning professional-oriented graduate education. However, no agreements have been established, and the following remarks are tentative.

1. Basic Agreement - A similar agreement to that used in research programs should be used. However, emphasis on research projects will be replaced by emphasis on areas of experience. The Manned Spacecraft Center agrees that the duties assigned will be on a professional level and supervision of the students will be performed by highly qualified and experienced professionals. The school as before agrees that the work experience is an essential part of the student's degree program.

2. Proposal - Exactly the same remarks as above apply to the professional-oriented program proposal.

3. Statement of Intent by Student - A student candidate for a professional degree with advice from his faculty advisor and the MSC program director selects the areas of professional experience to be obtained at the Center. Individual supervisors are designated. The student prepares a written plan for his program which is then endorsed by each supervisor as well as the faculty advisor and the MSC Program Director.

4. Appointment - Same as for research-oriented programs.

5. Evaluation - Each supervisor will appraise the student and provide the faculty advisor with an evaluation of his performance. This becomes a part of the student's academic record. The faculty advisor must maintain an awareness of the professional activity of his student. The overall evaluation of the student's performance is his responsibility.

APPENDIX A
Attachment I

AGREEMENT

National Aeronautics and Space Administration
Manned Spacecraft Center

and

William M. Rice University
Departments of Science and Engineering

BACKGROUND

The Manned Spacecraft Center of the National Aeronautics and Space Administration is responsible for the conduct of this nation's manned space flight program. Because this program is at the very forefront of current technological capability, many studies being conducted are in the realm of fundamental engineering or scientific research. Furthermore there are engineering design activities which demand high levels of creativity using the most advanced techniques.

The various Departments of Science and Engineering of the William M. Rice University are responsible for educating students and extending the current state of knowledge within their disciplines.

The intent of this agreement is twofold:

1. To provide outstanding graduate students from Rice University to the Manned Spacecraft Center for the purpose of conducting research or engineering design work of vital interest to the Center.

2. To provide Rice University's Engineers and Scientists and its graduate students an opportunity to engage in professional research or engineering design which will complement those activities being pursued at the University and which will advance the current knowledge in these areas.

AGREEMENT

To carry out this joint program the following specific agreements have been reached:

1. The University will nominate, and the Center will select outstanding graduate students to conduct research or engineering design in a given discipline. The selections will be based upon the applicant's academic record, the recommendation of persons acquainted with his capabilities, and the appropriateness of the proposed research.

2. The tenure of each Fellowship appointment will be established at the time of selection. The appointment may be extended provided the Fellow's progress is satisfactory and more time is needed to complete his project.

3. The University will recognize the professional stature of this joint Manned Spacecraft Center/Rice University cooperative effort by making the successful completion of an agreed upon project an essential part of the student's degree program.

4. The Center will appoint the selected students as Resident Graduate Fellows during their tenure and will compensate them accordingly. The agreed-upon project will be the student's sole responsibility. A Manned Spacecraft Center supervisor will be appointed to assist the student's permanent faculty advisor in providing day-to-day guidance in conduct of the study.

5. The University and the Center will jointly review the effectiveness of the program at the end of the first year and make necessary adjustments.

/s/ Robert R. Gilruth
Robert R. Gilruth
Director
Manned Spacecraft Center

DATED: May 25, 1967

/s/ William E. Gordon
William E. Gordon
Dean of Engineering and Science
William M. Rice University

DATED: May 22, 1967

APPENDIX A
Attachment II

RESEARCH PROPOSAL FOR MANNED
SPACECRAFT CENTER RESIDENT
GRADUATE FELLOWSHIP

Applicant:	Martin Hirsch
University:	Rice University
Department:	Mechanical Engineering
Degree Program:	PhD
University Faculty Advisor:	Dr. F. A. Wierum
MSC Thesis Supervisor:	D. H. Greenshields

An Investigation of the Effects of Ablation Product Radiation in a Hypersonic Boundary Layer

Introduction

As re-entry velocities increase, the contribution of radiation in the shock layer becomes a significant part of the total heating on the vehicle. The primary purpose of this analysis is to determine the relative importance of radiation from the ablative products injected into the boundary layer. The ablative product radiation will be determined as a function of density of the material and geometry of the model.

Experimental Section

The experimental portion of this work will be performed in the MSC 1.5 megawatt arc jet facility. Nine models will be used; three geometries (2", 3" and 4" diameters) and three ablative materials have been selected.

The radiation intensity will be measured with a scanning spectrometer (Warner-Swaysey) and a Jarell-Ash 3.8 meter Stigmatic spectrograph. The scanning spectrometer will allow the shock layer radiation to be measured before injection of ablative particles begins. When ablation starts, the shock layer will be scanned again, recording the total radiation. The difference between these two measurements (over the wavelengths from .8/u to 3.5/u) will yield an accurate measurement of the radiation contribution of the ablative particles.

The thickness of the shock layer and the species boundary layer will also be determined experimentally.

Theoretical Analysis

The theoretical analysis will focus primarily on the stagnation region. The boundary layer equations, mass, momentum, energy and species conservation, will be formulated for the radiating viscous shock layer. These equations will be reduced with usual boundary layer assumptions. The energy equation will account for convection, conduction and radiation.

Two extreme radiation approximations will be used in the energy equation:

1. The optically thin approximation
2. The optically thick (Rosseland) approximation

The temperature distribution obtained will be compared to the experimentally determined temperature profiles. The heat transfer will also be calculated.

Schedule

An approximate schedule for the experimental portions of this work is as follows:

1. Models completed 7/1/67
2. Equipment delivery 7/15/67
3. Completion of equipment set up 10/1/67
4. Completion of testing 1/1/68
5. Completion of Data Reduction 2/1/68

The theoretical portion will be carried out simultaneously with the experimental phase.

This work should be completed about April of 1968.

/s/ Martin Hirsch
Martin Hirsch

Date: 7/6/67

The above project, if successfully completed, should form the basis for Mr. Hirsch's dissertation, an essential element in his PhD Degree Program.

As Mr. Hirsch's thesis advisor, I share an appropriate responsibility for assuring the quality of his work and for maintaining an awareness of its satisfactory progress.

/s/ F. A. Wierum
F. A. Wierum

Date: July 7, 1967

The project proposed by Mr. Martin Hirsch is of vital interest to the Manned Spacecraft Center.

I am aware that Mr. Hirsch's appointment as a Resident Graduate Fellow is an academic appointment and that his sole responsibility will be the pursuit of the described project. As his MSC supervisor, I share an appropriate responsibility for assuring the quality of his work and for providing day-to-day guidance in its progress.

/s/ D. H. Greenshields
D. H. Greenshields

Date: 7/6/67

APPENDIX B

COOPERATION BETWEEN MIDWESTERN UNIVERSITIES AND ARGONNE NATIONAL LABORATORY

A Report to Argonne Universities Association by
Paul W. Gilles, University of Kansas, and
Robert J. Thorn, Argonne National Laboratory
December 13, 1967

I. INTRODUCTION

Having worked jointly over a period of thirteen years in several cooperative efforts within the scientific community involving Argonne National Laboratory (ANL) and midwestern universities, and now recognizing that some changes must evolve in this community, we have searched for new ideas which will help produce the environment desired by working scientists. The purpose of this report is to sketch our experiences and to present our suggestions.

Cooperative activities of several types, beginning with a summer appointment for one of us (PWG) in 1954, have served to help each of us to develop his scientific interests, to contribute knowledge in the field of high temperature chemistry, and to assist in the development of high temperature chemistry in the Midwest. It is in the context of this close association in chemical research and our shared interests and objectives that we put forward this report.

Most of our thoughts and ideas were formulated prior to the appearance of the report "A Challenge to Midwestern Universities" by Philip N. Powers, President of Argonne Universities Association (AUA). The intent of our thoughts is so intimately directed toward answering the questions formulated in that report that we believe the time is propitious for our comments. We address ourselves, as parties interested in the midwestern academic community, to the challenges presented by the questions in the president's report.

To accomplish our purpose of describing our experiences and making our suggestions, we present our comments in the following sections: (1) a description of the cooperation between the two of us and with other personnel, (2) a listing of the accomplishments of the cooperative efforts, and (3) our projections and suggestions.

II. PERSONNEL

Table I identifies the scientists in high temperature chemistry who have been associated with ANL and the University of Kansas (UK) in our endeavors, the natures of their associations, and their present locations.

TABLE I

Scientists with Experience in High Temperature Chemistry
At Both Argonne National Laboratory and the University of Kansas

	UK					ANL							
Scientist	F	TF	PD	GS	AS	S	TS	C	PD	GS	US	SA	Present Location
P. W. Gilles	x						x	x					UK
R. J. Thorn		x				x							ANL
W. A. Chupka		x				x							ANL
R. J. Ackermann				x		x				x			ANL
K. D. Carlson				x						x			CWR
E. D. Cater				x				x	x	x			SUI
E. R. Plante				x					x				NBS
H. A. Eick	x						x	x					MSU
P. G. Wahlbeck	x							x					IIT
T. R. Dunlap				x							x		UK
D. E. Peterson				x							x		UK
R. W. Sandford, Jr.				x							x		UK
J. R. McCreary			x									x	ANL

F - Faculty Member
TF - Temporary Faculty Member
S - Staff Member
TS - Temporary Staff Member
C - Consultant
PD - Postdoctoral Appointment
GS - Graduate Student
US - Undergraduate Student
AS - Research Assistant
SA - Scientific Assistant

CWR - Case Western Reserve University, Cleveland
SUI - University of Iowa, Iowa City
NBS - National Bureau of Standards, Washington
MSU - Michigan State University, East Lansing
IIT - Illinois Institute of Technology, Chicago

Foremost among our cooperative activities is the codirection of graduate students. Three students spent the first years of their graduate work at the University of Kansas where they completed their course work and examinations and where they began research activities. During the latter part of his graduate work, consisting of approximately two years, each student spent full time in research at ANL. One essential element in the success of this arrangement was a bona fide scientific interest in the research activities by the student and by both of us. The particular research problem was chosen jointly by all three of us. One of us (RJT) was in daily contact with the student, and the other (PWG) received periodic written reports, usually biweekly. About once every three months, the three of us assembled at Argonne for a two-day period during which the status of the work and the future plans were discussed in great detail. The basis for this discussion was a comprehensive report written by the student. Near the end of the research the student prepared an initial draft of his thesis which constituted the basis of a joint session approximately three days in length during which we studied the results and their analyses, meanings, interpretations, and presentation. After the thesis was completed and approved, the final examination was conducted on the University campus with both of us as fully participating members of the examining committee. The subsequent publications were joint ones involving all three parties. Much of the credit for the success of the venture we wish to attribute to the outstanding ability and ambition of the three students, Raymond J. Ackermann, K. Douglas Carlson, and E. David Cater.

The second activity involved interchange of personnel. In addition to the interchanges involving us (PWG spent one summer at ANL and RJT is spending a semester at UK), Dr. William A. Chupka was a visiting professor for part of a semester at UK.

The third aspect of the cooperation involves persons who have taken positions at one of the two sites after finishing at the other. After the entries in Table I for Ackermann, Carlson, and Cater, who have been discussed earlier, the entries for Plante, Eick, Wahlbeck, and McCreary indicate that after these men received training and experience at the University of Kansas they became associated with Argonne. Dunlap, Peterson, and Sandford became graduate students at the University after undergraduate experience at Argonne under one of the programs of the Associated Colleges of the Midwest.

In addition, at least three other Argonne personnel in high temperature work, one from Chemistry and two from Chemical Engineering, have visited the University of Kansas. Probably at least eight or ten University of Kansas graduate students and postdoctoral research associates in high temperature chemistry have visited Argonne.

III. ACCOMPLISHMENTS

We cite below some of the specific accomplishments of these cooperative activities. These are arranged in two groups: those accomplishments which are of special significance to the Atomic Energy Commission program

of development of nuclear reactors for operation at temperatures above 2000°C; and those which have contributed to activities in high temperature chemistry at midwestern universities. In the first group are:

(1) Nine individuals detailed in Table I educated in high temperature chemistry.

(2) Ten people listed in Table I performing research under AEC contracts.

(3) Three undergraduate students guided into the University of Kansas, where two are studying high temperature chemistry, and the third is studying analytical chemistry.

(4) The first work on the sublimation properties of uranium dioxide.

(5) The first work on the sublimation properties of uranium sulfides.

(6) Eleven publications

In the second group of accomplishments are those which contribute to activities in high temperature chemistry at midwestern universities.

(a) Four persons, as detailed in Table I, guided into midwestern university professorial positions.

(b) Meetings. Cooperative discussions involving both of us, Dr. Dieter Gruen of ANL, and Dr. Robert D. Freeman of Oklahoma State University led to three formal meetings. These were the International Symposium on High Temperature Chemistry held at Argonne in May 1967, and the two Midwest High Temperature Chemistry Conferences, the first one held in Lawrence, Kansas, in June 1965, and the second one held in Stillwater, Oklahoma, in June 1967. The next meeting of the Midwest High Temperature Chemistry Conference will be held at the University of Iowa in June 1969.

(c) Calibration of optical pyrometers. Several years ago we realized that the precision and accuracy of the measurements of temperatures with optical pyrometers could be improved by as much as an order of magnitude if the user of an optical pyrometer performed a calibration from first principles. With the cooperative help of several persons from the University of Kansas, a temperature scale for the pyrometric range was established at Argonne National Laboratory. This scale and the equipment and procedures defining it have been and are available to those scientists who wish to transfer them to their laboratories. To date, persons from Case Western Reserve University, the University of California at Berkeley, Iowa State University, and the University of Iowa, in addition to the University of Kansas, have done so. We believe that such an activity has greatly improved the precision of temperature measurement and

that it illustrates the role of a national laboratory in accomplishing cooperative efforts in an academic community.

The success of the educational endeavors and the scientific accomplishments are attributable first to the genuine interest on the part of all parties at the working level and their willingness and eagerness to work together, and second to the environments at ANL and UK which encouraged the joint activities. The cooperation has produced results of importance to the AEC program as listed previously, has enhanced the statures of both institutions in the high temperature field, and has contributed significantly to the supply of trained scientists in the field. The accomplishments have helped make high temperature chemistry stronger in the Midwest than it is anywhere else in the country.

IV. PROJECTIONS

We now present our thoughts about future joint activities of ANL and the universities. These thoughts are based on our experience in chemistry, but we believe that they are applicable in all scientific fields in which ANL has resources and activities. The following three objectives are those toward which our specific suggestions are made.

(1) To increase the effectiveness of the education of scientists.

(2) To increase the rate of transfer of knowledge from research to education and vice versa.

(3) To encourage the initiation and completion of research problems in new areas which would ordinarily not be easily entered within a traditional organization.

We now discuss these objectives in order.

To increase the effectiveness of education one can expose the student to the excitement of research. To some students the excitement can come in on-campus activities; to others it can come in the form of opportunities to use the splendid unique facilities at Argonne and to be exposed to experienced scientists there; and to others it can come from research on substances and ideas which are currently greatly in worldwide vogue because of atomic energy goals. These facts suggest that opportunities for university-Argonne cooperation in the education of students should be extended.

The achievement of rapid and direct transfer of knowledge from research to education and vice versa can be most readily accomplished through a transfer or an exchange of scientists. Thus, continued and expanded activities of the type we have described are indicated.

Opportunities to initiate research problems which cut across group or divisional boundaries that exist in any organization are enhanced by the enthusiasm of students, by the appearance of a professional scientist

from a different group, and by an atmosphere conducive to interdisciplinary activity. Thus, the notion of extended cooperation involving two codirectors and a student is again indicated.

To accomplish these objectives, we present below a list of mechanisms or specific suggestions which our experience leads us to propose. Some are in existence; some are new.

(1) Education of graduate students through research at Argonne. The experiences presented earlier in this report persuade us of the viability of the three-way arrangement involving two codirectors and a student, and we urge its extension. The time spent at the different sites could be adjusted as the nature of the problem demands. The stipend for the student would be provided as circumstances warrant. The bona fide scientific interest of all three parties and their willingness to work must be vital elements.

(2) Education of graduate students at the university. A new dimension of interorganizational activity is opened by including an Argonne scientist as a codirector of a student's research, even though it is done on the university campus. We are now engaged in an endeavor of this kind with Mr. Paul C. Nordine, a graduate student at the University of Kansas. This arrangement is the first outside the Chicago area of which we have knowledge.

(3) Education of postdoctoral research associates at Argonne with ANL and university staff members codirecting the work. The comments in (1) above apply to this case also. An additional advantage of this arrangement is that the postdoctoral scientist would have a direct connection with a university during this period of his training.

(4) Education of postdoctoral research associates at the university with ANL and university staff members codirecting the work. This suggestion is a new one so far as we know. The arrangement should permit the postdoctoral research associate to have the advantage of connection with Argonne and would permit the Argonne scientist to broaden the scope of his activities beyond that which could be accomplished at Argonne itself.

(5) Education of postdoctoral research associates at Argonne with two ANL staff members from different divisions codirecting the work.

(6) Temporary (e.g., one semester, one summer, or one year) research appointments for university faculty members at ANL.

(7) Short-term (e.g., one week or one month) research appointments for university faculty members at ANL or for ANL staff members at universities to facilitate the codirection of research.

(8) Visiting professorships for ANL staff members at universities.

(9) AUA-ANL-wide professorships to provide some scientists with joint appointments.

(10) Traveling professorships either for ANL or university personnel.

(11) Courses at ANL of an experimental type to open new areas.

(12) Refresher courses at ANL for university personnel, and at universities for ANL personnel.

(13) Joint monographs. Their preparation might be accomplished through panel meetings resembling those sponsored by the International Atomic Energy Agency.

(14) Attendance at seminars at ANL or universities on a regular basis.

(15) Jobs for undergraduate students at ANL.

(16) Exchange of administrators to achieve wider viewpoints.

(17) Joint committees of working scientists to achieve better communication.

(18) Development of atmospheres of fluidity at ANL and at universities so that new scientific areas may be probed without the necessity of a long-range commitment.

V. CONCLUSION

Central to our thoughts is the conviction that many future opportunities for ANL can be achieved through close cooperation with the midwestern universities and that many future opportunities for the midwestern universities in the scientific field can be achieved through close cooperation with ANL. In part this reciprocal relationship arises because of the AEC-AUA-UC contract, but also it arises because of future scientific needs and accomplishments. Scientists trained in atomic energy fields will be needed; students must be stimulated to enter these fields; knowledge must flow rapidly between research and education; mechanisms and organizational structures must encourage research in new, wide areas.

We have described our cooperative efforts, have cited some of the attendant results, and have made for the future some suggestions to which we have been led by our joint endeavors. The specific ideas we have presented emphasize the desirability of a tripartite scientific association of a junior scientist with two staff members in different organizational units, i.e. either in different cities or in different divisions or departments at the same site. We believe that such a pattern of cooperative efforts serves well for educating the student and for best

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achieving a rapid exchange of knowledge among institutions. The suggestions contained herein are of a specific nature. Another report based on ideas broader in scope is in preparation.

The suggestions in both reports emphasize the desirability of encouraging within the universities, within AUA, and within ANL an attitude conducive to a fluidity of organizational structure which will enable programs of wide interest to flourish.

APPENDIX C

THE APPLIED PHYSICS LABORATORY
PART-TIME STUDY PROGRAM

The objective is to promote the professional growth of staff members.

To be eligible the participant must be a full-time APL staff member. To remain eligible for participation in the program, the staff member must maintain a normal on-the-job growth pattern. It is the practice of the Laboratory that Part-Time Study be performed largely or entirely on a Staff Member's own time.

The benefits are four:

(1) Repayment of tuition and laboratory fees for approved credit courses when a grade of "C" or better is received in a course taken outside Laboratory hours. This amount is limited to $400 or the cost of 12 semester hours in the period from September 1 through August 31 (or fall, spring, and summer terms).

(2) Time-off to attend classes which are not offered after working hours. The amount is limited to 6 hours per week and to a total of 156 hours per calendar year (the latter by ASPR regulations).

(3) Rearrangement of a work schedule to attend classes given only during the working day. All time-off is made up.

(4) Remission of tuition for JHU courses. Senior and Principal Staff members receive full remission. All other staff members receive one-half the cost of the first four credit hours. Remission may be given for the purpose of credit or audit but the courses must be offered for credit.

Tuition not covered by remission can be repaid under benefit (1) if the criteria are satisfied.

The first two benefits must meet the criteria that the study is at a four-year regionally-accredited college or university and that the course or degree program is pertinent to the development of the staff member's APL career. Courses below junior year level are not approved unless they are part of an approved bachelor's degree program and the participant has achieved junior standing (at least 60 credits).

APPENDIX D

ON THE ARGONNE NATIONAL LABORATORY AND ITS INTERACTION WITH THE UNIVERSITIES IN EDUCATIONAL AFFAIRS

The following statement was submitted by
Dr. Frederick D. Rossini, University of Notre Dame
subsequent to the symposium.

The Argonne National Laboratory is one of the large AEC National Laboratories, has a staff of more than 5000 persons, has an annual operating budget near $85 million, and has strong programs in chemistry, physics, mathematics, biology and medicine, and chemical, metallurgical, and nuclear engineering. It is a great scientific-technological resource for the Midwest and for our country as a whole.

The Argonne National Laboratory is operated by the University of Chicago, with policy and program guidance by the Argonne Universities Association, a consortium of 30 universities, mainly in the Midwest but extending to the Universities of Arizona and Texas in the Southwest and to Pennsylvania State University in the East.

As has been made clearly evident in the reports and discussions of this Symposium, the ultimate success of any National Laboratory, such as the Argonne National Laboratory, requires appropriate and adequate cooperation between the Laboratory and its constituent Universities.

Most of us are agreed on several points regarding this needed interaction and cooperation:

1. That the interaction and cooperation should take place at all intellectual levels, undergraduate, graduate, postdoctoral, and faculty.

2. That the interaction and cooperation should cover all practical forms, including short-term or long-term appointments, lectures, conferences, seminars, workshops, etc.

3. That the interaction and cooperation should be a two-way operation as appropriate in each case,-to and from the Laboratory and to and from the Universities.

Since there is substantial agreement on the foregoing points, one may properly ask what is the real problem. The real problem, as has been pointed out several times in the discussion here, is to get the people involved all working together. To be successful, any cooperative undertaking must have benefits for both sides, for the Laboratory on the one hand and for the Universities on the other. Each must share equally in the rewards.

The Argonne Universities Association (AUA) and the Argonne National Laboratory (ANL) are approaching this problem with a calculated view to achieving these desirable goals. To this end, the President of AUA has established the position of Assistant to the President for Educational Affairs and the Director of ANL has established the position of Associate Laboratory Director for Educational Affairs. The former position is occupied by Dr. John H. Roberson, who was Executive Director of the Associated Midwest Universities until June 30, 1968, when it was merged into AUA. The latter position is occupied by Dr. Shelby A. Miller, part-time from October 1, 1968 and full-time beginning March 1, 1969.

Dr. Roberson's task is to work with the AUA Committee on Education and bring the capabilities of the Universities into play through the several existing and future AUA-ANL Committees related to educational affairs, including the Committee on Fellowships, Committee on Biology, Committee on Nuclear Engineering Education, etc. The actual educational operations resulting from the actions of these Committees will be carried out by ANL under Dr. Miller in his capacity as Director of the ANL Center for Educational Affairs, which will deal directly with undergraduate students, graduate students, faculty, etc., under the policy and program guidance provided by the AUA through the Director of ANL and the University of Chicago. Dr. Roberson and Dr. Miller will thus work closely together to bring to bear on the educational problems the capabilities of the Universities and the capabilities of the Laboratory, operating in such a way as to provide appropriate intellectual benefits to both University and Laboratory participants in the programs. Through their combined efforts, and with increased communication at all levels, it is hoped that interaction and cooperation between the Laboratory and the Universities will not be limited to one or two universities, but will cover many, with the disciplines of chemistry, physics, mathematics, biology, and engineering becoming involved.

APPENDIX E

NATIONAL RESEARCH COUNCIL

RESEARCH ASSOCIATESHIP PROGRAMS IN FEDERAL LABORATORIES

This material supplements, and in some cases corrects, the necessarily brief information concerning the National Academy of Sciences - National Research Council Research Associateship programs contained in the March 1968 Report of the Committee on Federal Laboratories, Federal Council for Science and Technology, "Education and the Federal Laboratories."

The Office of Scientific Personnel of the National Research Council is delighted that the many real problems of the relationship between the Federal laboratories and the university community have been sympathetically and constructively reviewed. OSP is glad that its own Research Associateship programs have been recognized in the report as playing some part in this interaction between the two communities. A slight amplification and clarification of the description of these programs may be relevant to the present study.

The National Research Council Research Associateship programs were introduced at the National Bureau of Standards and the Naval Research Laboratory in 1955 in an effort to utilize the excellent resources of these Federal laboratories for postdoctoral research, providing further professional development of carefully selected recent recipients of the Ph.D. degree. Since that time a growing number of Federal laboratories and centers have recognized the benefits a laboratory may derive from participation and have asked to join the program. Attachment I is a copy of an announcement of the 1968 competition for the twenty research organizations then participating in the program. Some of these have a single geographical location. Others, such as the Agricultural Research Service, the Air Force Systems Command, ESSA and NASA operate research laboratories at many locations. The numbers of applications received, and appointments made, are detailed in Tables I and II. In Fiscal Year 1968, 839 applications were received and 207 new appointments made.

Variety of Programs

In recognition of the diverse needs of the several participating organizations and the diverse opportunities for postdoctoral education, a wide variety of practices has grown up among the programs. This is best

TABLE I

APPLICATIONS AND NEW APPOINTMENTS 1966–1968
NRC POSTDOCTORAL RESEARCH ASSOCIATESHIPS*

		1966	1967	1968
Agricultural Research Service	(applications)	38	60	78
	(appointments)	17	30	16
Air Force Systems Command	(applications)	4	7	8
	(appointments)	3	2	5
Environmental Science Services Administration	(applications)	9	10	15
	(appointments)	5	6	6
Food and Drug Administration	(applications)	4	4	5
	(appointments)	2	2	3
Fort Detrick	(applications)	11	8	7
	(appointments)	5	3	5
National Bureau of Standards	(applications)	67	92	108
	(appointments)	20	16	16
Naval Electronics Laboratory Center	(applications)	2	0	4
	(appointments)	1	0	1
Naval Medical Research Institute	(applications)	3	12	17
	(appointments)	1	4	6
Naval Ordnance Laboratory	(applications)	3	4	8
	(appointments)	2	0	2
Naval Postgraduate School	(applications)	First Competition		7
	(appointments)	1968		2
Naval Research Laboratory	(applications)	19	33	57
	(appointments)	8	18	9
Naval Ship Research and Development Center	(applications)	0	2	1
	(appointments)	0	1	0
Naval Weapons Center	(applications)	First Competition	8	10
	(appointments)	1967	3	2
U. S. Geological Survey	(applications)	First Competition		27
	(appointments)	1968		7
Totals	(applications)	160	240	352
	(appointments)	64	85	80

* Evaluation of applications by NRC, appointments by the laboratories at Grade GS-12.

TABLE II

APPLICATIONS AND APPOINTMENTS
NRC RESIDENT RESEARCH ASSOCIATESHIPS*

	FY 1967			FY 1968		
	Applications Received	Appointments New	Renewal	Applications Received	Appointments New	Renewal
Army Materials and Mechanics Research Center	New program 1968			6	3	--
Army Natick Laboratories	19	5	3	18	3	3
Feltman Laboratories (Army Munitions Command)	2	1	1	7	2	1
NASA	231	114	76	317	94	109
Office of Aerospace Research	11	4	1	58	11	3
Smithsonian Institution	80	14	1	81	14	4
Totals	343	138	82	487	127	120

* Evaluation of applications and appointments by NRC. Stipends for recent recipients of the Ph.D. are comparable to salaries at Grade GS-12. Senior appointees receive stipends set after consideration of their present salary.

illustrated by the following general statements about the 1968 competitions, each qualified by certain exceptions:

1. Most of the programs were limited to citizens of the United States, BUT those of the Agricultural Research Service, Air Force Office of Aerospace Research, Army Natick Laboratory, NASA, Naval Medical Research Institute and Smithsonian Institution welcomed applications from foreign nationals. The new appointments in the NASA program in 1968 were almost equally divided between U.S. citizens and foreign nationals.

2. Most of the programs were limited to very recent recipients of the doctorate, BUT those of the Office of Aerospace Research, Army Natick Laboratory, NASA and the Smithsonian Institution welcomed applications from senior investigators and offered suitably larger stipends to such individuals.

3. Most of the programs held an annual competition, BUT selections were made on a quarterly basis for appointments at the Army Natick Laboratory, NASA and the Smithsonian Astrophysical Observatory.

Programs Approved by NRC

NRC, through its Office of Scientific Personnel, must approve each research organization for participation in the program. This is in no sense an evaluation or criticism of the research program of the laboratory. It is a determination (1) that the resources and research atmosphere of the laboratory are favorable for the professional development of the associate, and (2) that the work of the laboratory and the staff members proposed as scientific advisers are sufficiently well known in the profession to attract a reasonable number of qualified applicants among whom a competitive selection can be made. These determinations are based on site visits and a review of the professional publications of newly nominated scientific advisers.

Selection of Associates by NRC

OSP announces the program to the academic and research community and receives applications which are evaluated by the NRC appointed selection panel. In the case of the first group of programs listed in Attachment I, the Postdoctoral Research Associateship programs, successful candidates receive temporary Civil Service appointments at Grade GS-12. In the second group of programs, the Resident Research Associateship (Postdoctoral and Senior Postdoctoral) programs, candidates who are recent recipients of the Ph.D. receive NRC appointments at a stipend comparable to Grade GS-12. Senior appointees receive stipends set after consideration of their present salary.

NRC experience in selection at the postdoctoral level goes back to the establishment in 1919 of the National Research Council Fellowships. Thanks to the care and dedication of panel members, NRC selection in competitive programs is highly respected throughout the academic community. Panel members find that the confidential reference reports provided by faculty members in connection with these competitions are quite discriminating.

Advantages to Participating Organization

Participating research organizations value the contact with carefully selected young Ph.D.'s whom the program can bring to the laboratory in greater numbers than the laboratory could permanently employ. The young investigators contribute directly to the research program of the laboratory by their own work. They contribute indirectly by the searching questions they ask about the on-going programs of the laboratory. Those that return to universities for faculty appointments provide new campus contacts for the host laboratory.

At the end of one or two years in the program, some of the associates may become permanent employees of the laboratory. NRC is pleased that the program can give some assistance of this sort, but feels strongly that the principal purpose of the program is educational rather than recruiting. Laboratories are asked to limit such recruiting, averaged over several years, to one third of the associates appointed.

The number and caliber of the applicants for these programs is clearly related to the reputation of the host Federal laboratory in the eyes of the academic community. In the sense of the report, "Education and the Federal Laboratories," those laboratories which already have "warm" relations with the academic community are most likely to have successful research associateship programs.

Advantages to Associates

Substantial numbers of recipients of the Ph.D. degree in the sciences in recent years have sought further research experience before accepting regular employment. There is growing evidence that better career positions are in fact open to such individuals than to those who have just received the Ph.D. degree.

Conversations with applicants and with appointees, and the growing number of such applicants, clearly indicate that young Ph.D.'s see those NRC appointments as a way to acquire further research experience, to use the unique equipment of a particular Federal laboratory, to work with a particular staff scientist, to acquire additional research techniques and to broaden their understanding of their field. One or more research papers resulting from tenure as an NRC Research Associate are a distinct asset in seeking a career appointment, whether in the Government service, on a university faculty or with industry.

Stipend Levels for Associates

NRC believes that its associates who have just received a Ph.D. should receive a salary equivalent to that paid to superior quality new Ph.D.'s regularly employed in the same laboratory. Because of this, the first step of Grade GS-12 applicable in the candidate's discipline has been accepted as the standard. Currently this is from $12,174 to $12,580 per 12-month year.

This rate is substantially higher than stipends paid to postdoctoral fellows and to research associates appointed by universities. For this reason, it seems questionable whether postdoctoral associateship stipends for new Ph.D.'s should be set higher than this Grade GS-12 level.

As noted earlier, programs including Senior Postdoctoral appointments provide appropriately higher stipends for the senior associates.

Summary

The NRC Research Associateship programs represent one of a variety of devices which can contribute to good relations between Federal laboratories and the university community. They can be most helpful for laboratories which have reached a certain level of development, but even in these situations they must not supplant other links between the two communities. In the program context, these NRC Associateships contribute alike to the development of high quality manpower and to the research program of the individual laboratory. The NRC Office of Scientific Personnel would be glad to provide further information to the management of any Federal laboratory and to postdoctorals and their advisers.

September 30, 1968

APPENDIX E
Attachment I

NRC POSTDOCTORAL APPOINTMENTS IN FEDERAL LABORATORIES

In association with certain Federal laboratories, the Office of Scientific Personnel of the National Research Council announces the availability of Postdoctoral Research Associateship appointments for 1968-1969, tenable at the following locations:

FEDERAL LABORATORY	LOCATION	DISCIPLINE
Agricultural Research Service	16 Laboratories in the U.S.	Physical Science, Plant Science, Human Nutrition
Air Force Systems Command	10 Laboratories in the U.S.	Medical Sciences, Biological Sciences, Engineering and Physical Sciences
Environmental Science Services Administration	13 Laboratories in the U.S., 1 in Peru	Physical Sciences, Earth Sciences
Food and Drug Administration	Washington, D.C.	Physical Sciences, Nutrition, Pharmacology, Toxicology
Fort Detrick, U.S. Army	Frederick, Maryland	Biophysical and Biological Sciences, Plant Sciences
National Bureau of Standards	Washington, D.C. area and Boulder, Colorado	Engineering, Mathematical and Physical Sciences
Naval Electronics Laboratory Center	San Diego, California	Mathematical and Physical Sciences, Oceanography, Psychology
Naval Medical Research Institute	Bethesda, Maryland	Behavioral, Biological, Medical Sciences
Naval Ordnance Laboratory	Silver Spring, Maryland	Mathematical, Physical, Engineering Sciences
Naval Postgraduate School	Monterey, California	Engineering and Physical Sciences
Naval Research Laboratory	Washington, D.C.	Mathematical and Physical Sciences, Engineering Psychology
Naval Ship Research & Development Center	Washington, D.C.	Engineering, Mathematical and Physical Sciences
Naval Weapons Center	China Lake, California	Engineering and Physical Sciences
U.S. Geological Survey	4 Locations in the U.S.	Geological Sciences

Deadline for submission of applications (on forms available from the address given below) for the above programs is February 10, 1968.

In the closely related Resident Research Associateship programs, the National Research Council makes appointments at the postdoctoral level (and in some cases at a senior postdoctoral level) for six other government agencies as follows:

FEDERAL LABORATORY	LOCATION	DISCIPLINE
Air Force Office of Aerospace Research	2 Laboratories in the U.S.	Engineering, Mathematical and Physical Sciences[a]
National Aeronautics and Space Administration	8 Laboratories in the U.S.	Engineering, Life, Mathematical and Physical Sciences[b]
Smithsonian Institution	2 Locations in U.S., 1 in Panama Canal Zone	Zoology, Botany, Physical Sciences, Mineral Sciences[c]
U.S. Army Munitions Command	Feltman Laboratories, Dover, N.J.	Mathematical and Physical Sciences[d]
U.S. Army Natick Laboratories	Natick, Massachusetts	Physical and Mathematical Sciences, Biology, Anthropology[e]
U.S. Army Materials and Mechanics Research Center	Watertown, Massachusetts	Solid State Physics, Metallurgy, Physical Chemistry[f]

Deadline for submission of applications: [a] February 10, 1968. [b] Anytime. [c] Anytime for Astrophysical Observatory, early January for others. [d] February 10, 1968. [e] Anytime. [f] February 10, 1968.

The purpose of the awards is to provide to scientists of unusual ability and promise an opportunity for advanced research or investigation in the various sciences. Senior staff scientists at the laboratories act as advisers for the research associates. These laboratories have excellent and unique facilities for conducting research.

Both types of programs are identical in purpose. The Postdoctoral Research Associates are appointed for one year as non-career employees under Civil Service. A reappointment for a second year is possible if mutually agreeable to the laboratory and to the associate. The Resident Research Associates receive appointments and stipends through the National Research Council. In both cases, the Office of Scientific Personnel receives and evaluates all applications.

Annual stipends for these appointments range from $10,927 to $12,000 for the recent recipient of the doctorate with an adjustment made for the senior candidate.

A senior candidate is one who received his degree at least five years before making application for an Associateship. Senior Associateships are available at laboratories of NASA, Natick, Office of Aerospace Research, the Smithsonian, the U.S. Army Munitions Command.

Many of the programs are limited to citizens of the United States; however, non-citizens may be considered for the Agricultural Research Service, Naval Medical Research Institute, Natick, NASA, Office of Aerospace Research, and Smithsonian.

More detailed information regarding these programs may be obtained from the Office of Scientific Personnel, Room 603, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Applicants should state, in some detail, their field of specialization and should indicate laboratory of interest.

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