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Proceedings of International Science Foundation Brainpower Forum, 1958

International Science Foundation

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INTERNATIONAL SCIENCE FOUNDATION

BRAINPOWER FORUM CONFERENCE PROCEEDINGS

Conference of the Brainpower Forum.

PROCEEDINGS

of the

INTERNATIONAL SCIENCE FOUNDATION

BRAINPOWER FORUM

1958 CONFERENCE

August 6-8, 1958

U. S. Naval Postgraduate School

Monterey, California

The following members of the International Science Foundation have served as the sponsors of this 1958 Conference of the Brainpower Forum--

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OBJECTIVES OF THE FORUM

During the past several years we have become increasingly preoccupied with the so-called shortage of brainpower, which is considered to be our most important scientific resource. This has generated a drive to "produce" more scientists and engineers and to revise high school, college, and university curricula to better meet the needs of potential scientists and engineers.

In 1956, it was the opinion of a group of members of the International Science Foundation that the "shortage" was not as critical as it seemed. It was also felt that we were not effectively utilizing all sources of scientific manpower available to us and that there were hidden sources of brainpower which should be explored.

This, then, was what motivated five of ISF's members (the Army Ballistic Missile Agency, Cooperative Research Institute, U. S. Naval Radiological Defense Laboratory, California Academy of Sciences, and National Association of Manufacturers) to propose that, in keeping with the Foundation's objective of stimulating the development of scientific resources by increasing the flow of ideas between professional personnel throughout the world, a Brainpower Forum be established to focus attention on unexplored sources of scientific manpower and facilitate an exchange of ideas on this subject between science, industry, and government.

Accordingly, at the invitation of Rear Admiral Earl E. Stone, USN, then Superintendent of the U. S. Naval Postgraduate School, approximately sixty leaders in industry, government, and education met in Monterey, California, October 24-25, 1956, for the first conference of the ISF Brainpower Forum.

This conference served to highlight the fact that we had not effectively utilized all sources of scientific manpower which were presently available. At the recommendations of the Forum participants, the International Science Foundation initiated a continuing program in the area of scientific manpower and suggested that several of its members set up projects which would provide answers to some of the problems considered at the 1956 conference. As a matter of first priority, it was decided to give consideration to the gains that

might be realized by giving recognition to and seeking better utilization of retired or senior professional manpower. The 1958 conference was held to give Forum participants an opportunity to report on projects in the area of senior scientific manpower that were conducted as a result of suggestions made at the 1956 conference.

CONFERENCE PARTICIPANTS

R. D. Bennett, Manager, Vallecitos Atomic Laboratory, General Electric Company, P.O. Box 846, Pleasanton, California

Howard L. Bevis, Chairman, The President's Committee on Scientists and Engineers, Washington 25, D.C.

Remsen Bird, President Emeritus, Occidental College, Carmel, California

J. Whitney Bunting, Consultant on Educational and Corporate Support Research, General Electric Company, 570 Lexington Avenue, New York, New York

Robert L. Champion, President, International Science Foundation, San Francisco, California

Jim R. Chown, Assistant to Vice-President, Customer Relations, Northrop Aircraft, Inc., 1001 E. Broadway, Hawthorne, California

C. David Cornell, Special Assistant to Vice-President and Division Manager, Convair, Pomona, California

Mitchell L. Cotton, Assistant Professor of Engineering Electronics, U. S. Naval Postgraduate School, Monterey, California

Henry David, Executive Director, National Manpower Council, Columbia University, New York, New York

Christian de Guigne, Chairman of the Board, Stauffer Chemical Company, 636 California Street, San Francisco, California

David R. Domke, Jr., Philco Corporation, Palo Alto, California

Raph M. Dorman, Manager of Industrial Relations, Bechtel Corporation, 220 Bush Street, San Francisco, California

Captain Paul Foley, Jr., USN, Chief of Staff, U.S. Naval Postgraduate School, Monterey, California

Austin R. Frey, Chairman of the Department of Physics, U.S. Naval Postgraduate School, Monterey, California

Captain Raymond Fusselman, Office of Naval Research, 1000 Geary Street, San Francisco, California

H. I. Gibson, General Manager, Guided Missile Division, The Firestone Tire & Rubber Company, 2525 Firestone Boulevard, Los Angeles, California

Roy S. Glasgow, Dean, U. S. Naval Postgraduate School, Monterey, California

Captain H. M. Heming, USN, Director, Engineering School, U. S. Naval Postgraduate School, Monterey, California

E. M. Hicks, Branch Manager, Personnel and Administration, Chrysler Missile Division, P. O. Box 2628, Detroit, Michigan

Joel H. Hildebrand, Professor of Chemistry Emeritus, University of California, Berkeley, California

Reynold B. Johnson, Manager, Research Laboratory, International Business Machines Corporation, Monterey & Cottle Roads, San Jose, California

C. Mansel Keene, Chief, Standards Division, U. S. Civil Service Commission, Washington 25, D. C.

D. P. Krotz, California Research Corporation, 200 Bush Street, San Francisco, California

Frank E. LaCauza, Academic Chairman, General Line and Naval Science School, U. S. Naval Postgraduate School, Monterey, California

L. M. Limbach, Vice-President and General Manager, Aircraft Division, Rheem Manufacturing Company, 11711 Woodruff Avenue, Downey, California

Edward Martin, Ford Motor Company, San Francisco, California

Robert F. Mello, Director of Civilian Personnel, U. S. Army Ordnance Missile Command, Redstone Arsenal, Huntsville, Alabama

Robert C. Miller, Director, California Academy of Sciences, Golden Gate Park, San Francisco, California

Don M. Muchmore, Director, Museum of Science and Industry, P. O. Box 77610, Station D, Los Angeles, California

Harvey C. Paige, Cooperative Research Institute, World Trade Center, San Francisco, California

Gerald R. Parrish, Regional Representative, Bureau of Employment Security, U.S. Department of Labor, San Francisco, California

Vernon Pick, Director, Pick Laboratories, P.O. Box 67, Saratoga, California

Gilford G. Quarles, Chief Scientist, U.S. Army Ordnance Missile Command, Redstone Arsenal, Huntsville, Alabama

Richard S. Rheem, Director, Rheem Manufacturing Company, 120 Montgomery Street, San Francisco, California

Edwin W. Randle, Romano-Randle Properties, 248 W. Parking Plaza, Sunnyvale, California

Eugene L. Rowden, Personnel Placement Officer, Army Ballistic Missile Agency, Oakland, California

Merritt K. Ruddock, Belvedere, California

Edward N. Saveth, Project Director, The National Committee on the Aging, 345 East 46th Street, New York, New York

Admiral Raymond A. Spruance, USN (ret.), P.O. Box 192, Pebble Beach, California

Rear Admiral Earl E. Stone, USN (ret.), P.O. Box 4148, Carmel, California

Jos. S. Thompson, President, Federal Pacific Electric Company, 5815 Third Street, San Francisco, California

Russell H. Varian, Chairman of the Board, Varian Associates, 611 Hansen Way, Palo Alto, California

CONFERENCE PROGRAM

Wednesday, August 6

11:00 a.m. Registration, Oak Room, Mark Thomas' Inn

12:30 p.m. Luncheon, Terrace Room, Mark Thomas' Inn

Welcome: Christian de Guigne
Chairman, Board of Governors, International Science Foundation, and Chairman of the Board, Stauffer Chemical Company

2:30 p.m. Opening Session, Spanagel Hall, U.S. Naval Postgraduate School

Presiding: Christian de Guigne

Welcome: Captain Paul Foley, Jr., USN
Chief of Staff, U.S. Naval Postgraduate School

Summary of First Brainpower Forum Conference
Rear Admiral Earl E. Stone, USN (ret.)

Report on Yale Conference of February, 1958
Dr. Howard L. Bevis
Chairman, The President's Committee on Scientists and Engineers

5:30 p.m. Cocktails, Windjammer Room, Mark Thomas' Inn

6:30 p.m. Dinner, Terrace Room

Toastmaster: Jos. S. Thompson
Secretary, International Science Foundation, and President, Federal Pacific Electric Company

The Critical Element in Our Brainpower Picture--Quality not Quantity
Dr. Joel H. Hildebrand
Professor of Chemistry Emeritus, University of California

Thursday, August 7

9:00 a.m. Second Session, Spanagel Hall

Presiding: Merritt K. Ruddock
Governor, International Science Foundation

The Utilization of Older Scientists and Engineers
Dr. Edward N. Saveth
Project Director, The National Committee on the Aging

Senior Industrial Personnel for the Colleges
Dr. J. Whitney Bunting
Consultant for Educational and Corporate Support Research, General Electric Company

Cooperative Marketing of Senior Brainpower
Dr. Robert C. Miller
Chairman, Board of Trustees, Cooperative Research Institute, and Director, California Academy of Sciences

12:00 noon Luncheon, Terrace Room

Toastmaster: Richard S. Rheem
Governor, International Science Foundation, and Director, Rheem Manufacturing Company

Making Brainpower Respectable
Dr. Henry David
Executive Director, National Manpower Council

2:30 p.m. Third Session, Spanagel Hall

Presiding: Merritt K. Ruddock

Panel on Brainpower Production
Moderator:
Dr. C. Mansel Keene, Chief, Standards Division, U.S. Civil Service Commission

Participants:

Dr. Remsen Bird, President Emeritus, Occidental College, and Trustee, Cooperative Research Institute

Raph M. Dorman, Manager of Industrial Relations, Bechtel Corporation

Reynold B. Johnson, Manager, International Business Machines Corporation Research Laboratory

Vernon Pick, Director, Pick Laboratories, and Governor, International Science Foundation

Dr. Austin R. Frey, Chairman, Department of Physics, U.S. Naval Postgraduate School

Panel on Brainpower Utilization

Moderator:

Robert F. Mello, Director of Civilian Personnel, U.S. Army Ordnance Missile Command, and Trustee, Cooperative Research Institute

Participants:

H. I. Gibson, General Manager, Guided Missile Division, The Firestone Tire & Rubber Company

Eugene M. Hicks, Branch Manager, Missile Operations, Chrysler Corporation

Laurence M. Limbach, Vice-President and General Manager, Rheem Manufacturing Company Aircraft Division

Dr. Gilford G. Quarles, Chief Scientist, U. S. Army Ordnance Missile Command

Dr. Russell H. Varian, Chairman of the Board, Varian Associates

Friday, August 8

8:00 a.m. Breakfast, Terrace Room

9:30 a. m. Closing Session, Spanagel Hall

Presiding: Jos. S. Thompson

Report on Brainpower Production Panel
Dr. C. Mansel Keene

Report on Brainpower Utilization Panel
Robert F. Mello

Report of Committee on Recommendations
Merritt K. Ruddock

Forum Action on Recommendations

12:00 noon Adjournment

OPENING SESSION

Mr. de Guigne: Having welcomed all of you at lunch, I don't want to repeat myself. Again, though, I would like to say how much we are indebted to the graciousness of the United States Navy for providing the charming surroundings for our meeting. I deeply regret that Admiral Yeomans is unable to be present because of a light case of the flu he unfortunately got up at the Grove. As a member of the Bohemian Club, I say "unfortunately." I don't know which Bohemian gave it to him, but please transmit those words. I am really very sorry.

It is my privilege now, gentlemen, to introduce Captain Foley, Executive Officer of the Postgraduate School, who will say a few words to us before the meeting starts.

Captain Foley: On behalf of the Superintendent, Admiral Yeomans, who, as you have been told, is unable to be present, and the staff and faculty of the Postgraduate School, I would like to welcome the members of the International Science Foundation to this School. Admiral Yeomans had looked forward to greeting you personally but is flat on his back after surviving the Bohemian Grove.

It gives me special pleasure today to welcome Admiral Stone back to the campus.

Although many of you are well acquainted with the Naval Postgraduate School and its academic achievements, I hope, Mr. Chairman, that you will permit me a few moments for a thumbnail sketch of the School for those of the group who are here today for the first time.

The major parts of the School, as you probably know, are located here on the grounds of what was once the well known Hotel Del Monte. We have another 300 acres on an adjacent hillside, used primarily for Wherry housing, and 100 acres adjacent to the Monterey Peninsula Airport which are now used for laboratories and recreational facilities.

The mission of our School is to conduct and direct the instruction of commissioned officers in order, by advanced education, to broaden their professional knowledge as required to meet the needs of the Naval Service.

We carry out this mission through three major component schools and a logistic and administrative command which supports them.

The first of the three component schools is the General Line and Naval Science School which is housed in a wing of the old hotel. In this school we provide graduate-type instruction for approximately 450 young Naval officers in professional subjects each year in what is known as the General Line course. Next Monday, for the first time, we are inducting a pilot group of fifty young officers in what we call the Bachelor of Science course. This particular course is intended to instruct these young officers in advanced professional subjects and at the same time to enable them to complete a more liberal education which will lead to an undesignated baccalaureate degree in science. This program will increase as time goes on.

The second component school I would like to mention is the Navy Management School. This school was started late in 1956 and is now well established and well accepted as an agency within the Navy for executive development in management techniques. I think it is evidence of the Navy's determination to adopt the most advanced industrial practices with respect to managerial and controller functions.

Finally, let me mention the Engineering School, in which the Forum is being held today. The Engineering School this year will provide advanced education in engineering subjects for about 600 U. S. officers and thirty foreign officers. The majority of the U. S. students are Naval officers, but we have approximately seventy from other services: Army, Air Force, Coast Guard, Marines, and Public Health Service. The courses in the Engineering School vary from one to three years in length and lead normally to a designated baccalaurate degree in and engineering subject and, in most cases, to a Master's degree. Some of the students go on for a third year at private universities such as MIT, Cal Tech, University of Washington, etc., to take their Master's degree in certain subjects when it is more economical to do so; a few go on, of course, to the Doctorate. The Superintendent here, then, supervises in addition to the Naval Postgraduate School proper the advanced education of some 300 officers scattered in private universities throughout the entire country.

The Naval Postgraduate School has a highly competent civilian staff, some of whom are present here today. The faculty numbers 122 at the present time and is headed by our distinguised Academic Dean, Roy Glasgow. The staff also includes an approximately equal number of U. S. Naval officers, some of whom conduct instruction in professional subjects, while others are what we call "officers in charge of curricula" and act in effect as coordinators of the academic courses and see to it that they remain responsive to the requirements of the Naval Service.

It might be of interest to you to know that this School was started in 1909 in Annapolis and has continued uninterruptedly since that date. It was moved to Monterey in 1951 and is accredited by the Western College Association and by the Engineers Council for Professional Development.

At the request of your President, the Engineering School has arranged for some very short tours of the immediately accessible facilities following this meeting. I think that perhaps they might be interesting to those of you who have not seen the facilities of this School. Guides will meet small parties outside the building at the end of this session. Please feel free to call on me or any member of the staff for any assistance we can give you. I am confident that your Forum today will be both interesting and profitable, and I assure you I am greatly honored to be included.

Mr. de Guigne: Thank you again, Captain Foley, for your gracious hospitality.

It is now my privilege to introduce Admiral Stone who is going to tell us a little about the first Brainpower Forum conference.

Admiral Stone: In 1956, it was my pleasure to welcome a similar group to the first Brainpower Forum here. I regret that Admiral Yeomans cannot be here today, but we surely appreciate what Captain Foley has said in his stead.

Today my assignment is to tell you briefly what happened at the first conference. Many months have passed since October, 1956 when that conference convened, and, of course, much has happened to change the

picture somewhat concerning scientific and technical manpower. We are all aware of the relatively recent advent of Sputnik which gave so much impetus to action looking toward long-range improvements in the scientific and technical manpower situation, especially through improvements in our secondary schools. But while there has been considerable action and certainly some progress, I feel--and I think you will agree--that much more can and should be done.

Early in 1956, it was the opinion of many of the members of the International Science Foundation that the so-called shortage of scientific manpower was not as critical as some believed and that the problem was partially one of discovering the hidden sources of manpower and bringing them into use.

I believe that most of you who are present today know that the International Science Foundation has a service organization for research known as the Cooperative Research Institute or CORE. Since our meeting in 1956, CORE has undertaken several very interesting and worth-while projects wherein some of the so-called hidden sources of manpower, including senior or retired professional personnel, have been utilized most effectively. I trust that some of the speakers who are to follow me will tell you more about the activities of CORE. The program of the International Science Foundation to establish additional international science centers such as the one which is now in operation in San Francisco also holds some interesting opportunities for senior scientists and engineers. These science centers can serve as the focal point for CORE operations which I think will expand in the future and will be most useful and worth-while.

The underlying thought that led up to the first conference has been expressed as follows: "The continuance of the upward trend of our economy is dependent upon increased development of our most important scientific resource--BRAINPOWER. We have been preoccupied for some time with the so-called shortage of scientific manpower. Yet, an immediate increase in the rate of production of engineers and scientists could not possibly ease the shortage for some time. Therefore, would not a re-examination of ideas

which might lead to hidden sources of brainpower be in order? It was this question which brought on the first conference here.

This question was broken down into several somewhat more specific ones, which were presented to the conference by Dr. Miller, who is here today. These were the specific questions that that conference tried to answer:

> What is the scientific manpower problem in the military services? In government? In industry? In research institutes, universities, and foundations?
>
> Why do we have this problem?
>
> Where can the additional required technical and scientific manpower be found?
>
> How can the productivity of our present supply of scientific manpower be increased?
>
> How can now unused manpower resources be marshalled?
>
> How can they be organized for effective use?
>
> How can they be motivated?

There were several very enlightening presentations at the first conference by extremely well qualified speakers who represented industry, educational activities, and the military services. As a result of these pertinent presentations, the stage was set for the informal panel discussions which followed.

Several of the speakers concurred in the belief that the root of the problem lay in our secondary schools where the seeds of scientific and technical interest are planted or at least nurtured. The motivation of students at this stage appeared to be the crux of the situation, as this (the secondary school level) is where the choice of a career in science or mathematics is usually made. The shortage of well qualified scientific and technical secondary school teachers was recognized as a vital weakness. Attention was directed to the situation in the U. S. S. R. where obvious

advances were being made in scientific endeavor.

Captain A. B. Metsger represented the Office of Naval Research at the conference. He pointed out that, in Russia, members of the Academy of Science have status and prestige at the top of the community. I would like to quote from some of his remarks:

> This is in deep contrast to what happens here. We read about the large number of scientific and technical engineering students who are graduated in Russia as contrasted with the relatively small number graduating here. And we have a strong impression that education in Europe in general is more serious, more intense by far, than it is in most American schools. It sometimes seems that we lack a certain stimulus. We look about and see a very fine economy surrounding us and we are delighted with it. There's every reason to be complacent about it, which is well enough for a few years. But complacency is the last stage before the fall. It's up to us to see to it that the seeds are sown today for the America of ten or twenty years hence. We have to take care not only of our immediate needs and keep our heads above water now, but we must be planning for the decade or two beyond.

So said Captain Metsger in 1956.

Another distinguished speaker at that conference was Dr. Wernher von Braun of the Army Ballistic Missile Agency. The subject of his talk was "Our Research and Development Program and its Manpower Needs." Dr. von Braun said many things which are worth rereading and considering. I would like to quote a few: "We must marshal public opinion to de-emphasize the hot-rodders among the youth and to encourage hot mathematicians.... We must attract more young people into scientific work. We must back youth with incentives rather than directives." He pointed out that we were neglecting the help that we might get in science and engineering from women, stating that science is impersonal and without gender. He gave the case of Madame Curie as an example of what women who are educated and qualified can be expected to do. He indicated that further help could certainly be obtained from many older persons who are scientifically trained and who are reluctant to be put out to pasture. Also, Dr. von Braun pointed out that there are many handicapped people who have been by-passed and forgotten and who could and would contribute something worth-while if given the opportunity.

Dr. von Braun particularly pointed out the shortage in mathematicians, stating that in 1956 the IBM Corporation estimated that 7, 500 mathematicians were needed to man computers that were then known to be on order. He said that there must be a general effort to increase the supply at the source by encouraging more able young people to go to college and by strengthening the material rewards to be derived from entering scientific pursuits in college, in industry, and in government. "Such professions," he said, "must be made attractive."

Dr. von Braun called attention to a four-point proposal, as follows:

1. Establish several thousand U. S. scholarships to help gifted but needy high school graduates to go to college;
2. Revitalize the teaching of science and mathematics in our secondary schools;
3. Convene a national forum to spotlight the ways whereby the nation can educate more and better scientists and engineers; and
4. Formulate the outlines of a grand strategy for maintaining our technical advances in the United States.

Finally, he said, "The teams of scientists and engineers of tomorrow are in the grammar schools of today."

Mr. Edward McCrensky of the Office of Naval Research, another speaker at the first Forum, also said some things which I think are worth repeating. He mentioned the importance of retaining science teachers in the nation's school systems and the need for improving the standing of science teachers. It appeared that the only direct solution in the secondary schools to this problem was to double or triple science teachers' salaries. These teachers are often in the paradoxical situation of having their students, upon leaving school, go directly to employment in a filling station or some other unskilled occupation at about the same salary the teacher receives after years of conscientious work. Mr. McCrensky also pointed out the need for getting more of the obviously capable young men and young women into college. He said that at least one-third of the high school graduates who had aptitude for college were not going to college because of their financial situation. He said that in England a very large number--I think he said almost 80%--of the

students who are needy are subsidized directly by the government. It is important to note that in the U. S. S. R. professional graduates, in addition to being educated by the government, are accorded relatively high social and cultural status.

Another speaker was Captain R. S. Mandelkorn, who was then attached to the U. S. Naval Radiological Defense Laboratory. Talking on the subject "A New Look at the Scientific Manpower Problem," he pointed out the desirability of using available scientists for generative thinking and of relieving them of mental drudgery and frustrating administrative tasks. He recommended that the scientist be assisted by adequate technical support personnel, both laboratory and clerical assistants. These assistants should be sub-professional personnel who could effectively carry out limited experimental work with minimum supervision and who could perform calculations and assist in report writing. All possible mechanical assistance that modern computer techniques can afford should be provided. He pointed out the possibility of using active and retired professors and qualified retired military personnel, possibly on a part-time basis. In this connection, I feel that it is interesting to note that some important research laboratories have already been established near scientific and technical schools, admittedly to take advantage of the professional talent that is often available on a part-time basis in those areas. Monterey is no exception, as there have been some laboratories established here because of the Naval Postgraduate School with its personnel available on a part-time basis for consulting work. Captain Mandelkorn also stressed the need for overhauling our secondary school curricula to include and stress the teaching of physics, chemistry, and mathematics.

On the improvement in utilization of our limited scientific and technical personnel, he pointed out that frequently teams rather than individuals are employed on research projects. When a team finishes a project, it is naturally often desired to keep that team intact until it can be given a new project. However, between assignments, there is a period when the whole team has little or nothing of value to do. This is a serious waste of valuable talent and

runs up the overhead cost of operations. But there appears to be no good solution to this costly situation since we cannot hope to have a clearinghouse to control the employment assignments of the valuable people concerned. Possibly something can be worked out to alleviate this situation within industry or within the military services.

Dr. Ernst Stuhlinger of the Army Ballistic Missile Agency gave a most interesting presentation on "Outlook to Space Travel." What he said in 1956 sounded utterly fantastic to many who heard him. However, since the advent of Sputnik and the publicity which his subject has since received, Dr. Stuhlinger's remarks do not seem quite so fantastic.

Dr. Richard L. Balch of Massachusetts Institute of Technology presented a very interesting paper entitled "Liberal Education or Liberation of the Individual--a Manpower Problem."

Dr. Claude Fawcett, representing the National Association of Manufacturers, spoke most interestingly on the subject "The Brainpower Shortage--a Threat to our Free Enterprise System."

Perhaps the greatest interest and enthusiasm at the first Forum were evoked by the panel discussions in which most of the conferees participated. I shall not attempt to summarize these discussions. However, I feel they are well reflected in the eleven-point program which resulted from this conference. These points are enumerated in your conference program, but I would like to take a few more minutes to read them to you:

1. Make use of the reservoir of retired scientists and engineers and other qualified personnel capable of assisting in research and development.

2. Government, industry, and educational institutions should join forces in preparing and maintaining a census of retired scientists, engineers, teachers, etc.

3. Teachers should be permitted to take periodic leaves of absence to work for or in industry and government; qualified personnel from industry and government should help to relieve the shortage of teachers by accepting teaching assignments.

4. Utilize more efficiently the services of existing scientific personnel by providing them with qualified administrative support.

5. Technicians should be employed in increasing numbers to relieve the scientist of detail in research projects.

6. Wide use of television, radio, and other media is needed to present to the American people, and particularly the younger generation, the importance of teaching, science, and engineering, and the rewarding satisfactions which come in the pursuit of these professions.

7. Government and industry should review their research programs, organization, and personnel with a view to making changes which will keep their personnel more effectively and continuously employed.

8. The educational system should be made flexible enough to provide opportunities for the exceptional student which will challenge him to the full extent of his abilities.

9. The teacher shortage should be relieved through the use of qualified retired personnel trained in subject matter fields.

10. Attention must be given to the problem of attracting and retaining the more capable teaching, engineering, and scientific personnel by provision for greater incentives and more recognition in the community.

11. Programs for financial assistance to promising students must be substantially increased and must include the development of projects to underwrite the careers of outstanding science researchers.

This ends my summary concerning the first Brainpower Forum, but, in concluding my remarks, I should like to quote a brief passage from Shakespeare's play The Tempest. In that play Antonio says, "What's past is prologue." This remark is inscribed in stone over the entrance to the National Archives Building in Washington, D.C. Perhaps some of you have not heard of a conversation which is supposed to have taken place in a taxicab between the driver and his passenger while crawling along with the traffic past the Archives Building. The passenger, who was on his way from the railroad station to the Capitol to attend a Senate hearing, read the inscription aloud, "What's Past is Prologue," and then he added the question, "What could that possibly mean?" Of course, this taxi driver, like all of them, knew the answer. He said, "Mister, I figure it means that you ain't heard nothing yet!"

So with that, and admitting that the past is prologue, I am sure that subsequent speakers will have much to say to you that is both current and pertinent.

Mr. de Guigne: Gentlemen, it is now my privilege to introduce Dr. Howard Bevis, Chairman of the President's Committee on Scientists and Engineers.

Dr. Bevis: Needless to say, I am very happy to have the opportunity to meet here with you this afternoon and to bring you the greetings of the President's Committee on Scientists and Engineers, particularly in view of the similarity of purpose that I discern between your organization and ours. Perhaps our methods are not exactly similar, but the objectives as I understand them and as they're expressed here in this little pamphlet in three short sentences are certainly very similar. You say here that the objectives of the International Science Foundation are the establishment and operation of science centers in metropolitan areas capable of supporting their programs, strengthening the mechanism of exchange between all scientists and engineers, and development of cooperative projects between members of the Foundation.

Perhaps I might just say a word about the President's Committee. It was established about two and a half years ago by the order of President Eisenhower. The Committee consists of the president or titular head of eighteen national organizations, several of the leading engineering societies, some representing the humanities, the Land Grant College Association, Association of American Colleges, etc., and also the American Federation of Labor-C.I.O., the National Association of Manufacturers, the Chamber of Commerce of the United States, the organization of State Governors, and the organization of City Mayors. I am happy to report that, on the subject we were brought together to deal with, we have, at least thus far, had very happy concurrence of opinion and a very great similarity of objective. So, I am glad, Mr. Chairman, to be here to join with you in what seems to me to be a purpose common to both your organization and ours.

My assignment, as you have already perhaps observed, is to undertake to relate for you something of what happened six months ago at a conference at Yale University.

It is almost six months to the day since the President's Committee, in cooperation with the William Benton Foundation, sponsored the conference

on what we called "America's Human Resources to Meet the Scientific Challenge" at Yale University. Six months is usually long enough for even the most newsworthy material to go stale, and I should have been most reluctant to come to speak to you about that conference if the intervening months had not proved so conclusively that the subject is more pertinent now than ever.

Marshalling America's human resources to meet the scientitic challenge is unquestionably our most important task. It is a task on which we have barely begun. And in this task every day of delay and every step taken halfheartedly represents an irrecoverable loss to our ability to meet and profit from that challenge.

The points brought out during the panel discussions at Yale are no less relevant today than they were in February. The questions raised still need answers; the suggestions made, for the most part, still need to be put into action. They have not lost in interest during these past six months; they have gained immeasurably in urgency.

In fact, the President's Committee is about to publish, in cooperation with the Public Affairs Press in Washington, a collection of papers based on the Yale discussions. It is directed to the general public and we hope that it will stimulate vigorous local discussions of these same questions in communities throughout the country.

In a democracy, such public airing of major national problems is the only sound basis on which policy decisions can be taken. The effort required of us is clearly one that demands not only widespread and enthusiastic public support but the active participation of each citizen--parents and taxpayers, voters and politicians, employers and workers, teachers and students.

I might interject here that the President's Committee as such was not set up to make a fact-finding report, nor was it set up for the purpose of trying directly to induce the Congress or the Federal Government to do something; its mission rather, in the President's language, was to address its activities to citizens and citizens' groups throughout the country in the hope that each group could manage, each in its own way, each in its own locality,

to tackle this problem of trying to increase the brainpower of our country; for clearly that is what we must do in order to survive in the face of the challenge presented to us by the other great world power, Russia.

We have passed the stage when we can be prosperous in this country by simply moving west and taking up more land. We have taken up most of the land that people want to take up. We have used up an overly large part of the natural resources with which we began. We have very much less to work with than when we started out fifty or one hundred years ago. In the meantime our population is increasing at a very rapid rate--there are now almost three times as many people in the United States as there were when I first began to know about population. Our standard of living has gone up and continues to rise. Now, obviously, if we are going to continue to maintain our standard of living with this rise in population and our diminishing store of natural resources, there is only one answer, and that is more and better trained brainpower. We have to be able to apply the resources to our technology if we are going to maintain our own economic position and our position in the world.

As a matter of fact, one of the principal purposes of the Yale Conference was to promote public understanding of the problems posed by the scientific challenge, the same problems which you will discuss in your panel sessions during the next two days. For this reason we invited to Yale not only 150 of America's leaders in science, education, and industry, but we also invited some fifty leaders in the public information media to attend as active participants. The decision to do so proved most rewarding. The editors, writers, radio and television executives, and commentators leavened the discussion with their non-academic, pragmatic approach to the subject, and the broader insight into the problem with which they apparently came away has since been directly reflected in the media they represented.

The presence of this journalistic "high brass" may also have had something to do with the quite startling turnout of the working press. Having made provision for approximately thirty correspondents, we were promptly swamped by 120 reporters and cameramen demanding briefing materials,

crowding into the panel sessions, and insisting on interviews and press conferences. I understand that a few of our scientist-participants were a little upset by these journalistic intrusions. If that is true, I hope they elected to attend the round table on "Public Understanding of the Scientist" where the view was freely expressed that the aloofness and indifference of some scientists are mainly responsible for creating the ludicrous stereotypes which the public has of them.

You will not be surprised that the Number One round table on the Conference program, under the chairmanship of Mr. Thomas K. Finletter, was entitled "Understanding the Nature of the Soviet Threat" and that the dinner address by Mr. Allen Dulles had as its title "The Soviet Challenge."

It is a hard fact that we cannot discuss the scientific challenge without immediately running into the military, political, and economic aspects of that challenge which the Kremlin is so vigorously exploiting. It is clearly the settled policy of the Soviet Union to take full advantage of the scientific revolution. The Russian leaders are determined that the age of atomic energy, of space flight, of transmuted elements, and of an end to our dependence on conventional natural resources will be a predominantly Russian age. Having failed in their plan to foment a world-wide social revolution, they are making every effort to achieve their goal of world domination by exploiting the scientific revolution.

Russia's new venture into economic warfare was pointed out not long ago by Mr. Douglas Dillon, the Deputy Under Secretary of State for Foreign Affairs, who spoke to the Senate Foreign Relations Committee, as follows:

> There is a new aspect of Soviet economic policy toward the free world which is becoming a matter of major concern to the United States. This is the economic offensive in the less developed countries..... Aid and trade have become part of an intensive diplomatic campaign which has concentrated heavily on points of weakness within the free world and which has been conducted with vigor, imagination, flexibility, and dispatch.

The way in which Russia's technological capabilities are being used as politico-economic tools was illustrated a few months ago by Soviet manipulation

of its aluminum production to push down the world price of aluminum in order to put pressure on the Canadian economy and American producers of aluminum, our second largest metal product.

Not only has Russia forced down aluminum prices on the world market, but the Soviet Union is now an important supplier of aluminum to Great Britain and West Germany. And we know that Russia is also exporting important amounts of coal, copper, oil, cotton, and manufactured products into Britain and Western Europe. Russia is obviously trying to make our allies in the free world more and more dependent on her for raw materials and many manufactured products. You may have seen a newspaper story, two or three weeks ago, reporting that Russia was preparing to extend its economic offensive to newsprint in order to undercut the principal free world producers--Canada and the Scandinavian countries.

This evidence, of course, was not available in February. I mention it only to illustrate how this particular aspect of the challenge has become more graphic and more urgent in the few months since we discussed it in New Haven.

The urgency of meeting the "Technological Requirements of the Free World and the Uncommitted Countries," which was the subject of a round table under Mr. Eric Johnston, has similarly been underlined by recent events in Indonesia and the Middle East and, perhaps, by the reception accorded some prominent American visitors in countries much nearer the United States.

Since I have already digressed into post-conference events, I should also like to quote from a talk which Dr. Lawrence G. Derthick, the United States Commissioner of Education, made to the Press Club in Washington just after he had returned from a tour of schools in the Soviet Union. Expressing astonishment at the accomplishments of Russia's "education-centered economy," Dr. Derthick declared:

> We were simply not prepared for the degree to which the U. S. S. R. as a nation is committed to education as a means of national advancement. Everywhere we went we saw indication after indication of what we could only conclude amounted to a total commitment to education.

The importance of science in Soviet education is unquestioned, Dr. Derthick reported. Biology, chemistry, physics, and astronomy are required of every pupil regardless of his individual interests or aspirations.

You will be interested in another comment by Dr. Derthick. "Low marks on examinations or lessons," he said, "are usually considered a reflection upon the teacher rather than the pupil."

What this signifies, of course, is that the Communist leaders, despite their ruthless disregard of the rights of the individual, recognize their country's human resources as its most valuable asset and respect intellectual achievements provided, of course, that they have a spotless political bill of health.

In only thirty years Russia has risen from the position of a backward agrarian country (what today we should call an underdeveloped country) to a position from which it challenges our claim to technological leadership. The secret of this remarkable "operation boot-strap" is an unstinting dedication to massive education and a firm faith in its value and efficacy.

We should be untrue to our traditions and disloyal to our heritage in the humanities and social sciences if we sought to copy the Russian educational system. I am sure none of us wants that. But I am equally sure that few of us can doubt that in some places there is something seriously wrong with our educational system.

Dr. Griswold, the President of Yale University, in his welcoming address to our Conference, laid it on the line. "We have neglected the welfare of our educational system for two or three decades at least," he said. He went on to point out that our ubiquitous elective system has proliferated the courses in our secondary schools from twenty-seven in the academic and eight in the non-academic categories in 1910 to fifty-nine in the academic but 215 in the non-academic categories forty years later. "This period," he said, "saw the combination of mathematics and foreign languages and the sciences declining. It saw English language and literature and rhetoric diluted. It saw physics and chemistry transformed into general science and algebra into general math.

It saw the proportion of high school students, for example, enrolled in algebra decline from 56% in 1910 to 26% in 1949."

The worst disease, Dr. Griswold believes, that American education has to contend with, is buck-passing, that hapless merry-go-round in which the university blames the high school, the high school blames the elementary school, the elementary school blames the parent, the parent blames the school board, the school board blames the local government, and the local government blames Washington, which of course everybody does.

Perhaps now is the time when each responsible citizen sincerely interested in his country might emulate one of our recent presidents and keep on his desk a sign which says, "The buck stops here."

As long as we insist--I believe that we are right to insist--that education is a local matter, we have an obligation, a patriotic duty, also to insist that the education we provide for our children be the best that tax money can buy. By insisting, I do not mean feckless grumbling; I mean taking the same vigorous action you would take if the sewer below your house was stopped up, or if a hump in the street scraped the bottom of your car when you backed out of your driveway, or if your house were suddenly assessed at double its market value. Are such dangers to health and property and such injustices more dangerous and more unjust than our continued failure to provide the nation's children with the best and most thorough education?

Needless to say, education was the primary concern of the conference on "America's Resources to Meet the Scientific Challenge." At New Haven education was the subject of Dr. DuBridge's enthusiastically applauded address. Education was also the topic of five of our ten round table sessions: "Educating Future Scientists in a Rounded Educational System" was chaired by Mr. Thomas Carskadon of the Twentieth Century Fund. "Conserving Our Rarest Resource--Creative Talent" was the charge of Dr. Eric Walker, President of Penn State and Vice-Chairman of the President's Committee. "The Quality of Elementary and Secondary Education" fell to Dr. Clarence Faust of the Ford Foundation. "The Coming Crisis on the Campus--Maintaining Standards with Increased Enrollments" (and this is one of the thorniest problems with which we will have

to deal) was the subject of a round table under Dr. Katharine McBride, President of Bryn Mawr. "Advanced Training for Superior Talent, the Problems of Graduate Education and Research" was discussed by a group under Dr. Paul Gross, Vice-President of Duke University.

Even if I had the time this afternoon, I should not have the reportorial skill to attempt to summarize the always thoughtful, but sometimes conflicting, views aired during these round table discussions. Some of the highlights will appear in the book which grew out of the Conference, and I shall seize this opportunity for a free commercial to refer you to it. It is scheduled to come off the press next month. I have recited the topics only to indicate the wide range of educational problems with which we must deal and to suggest to you that there are many areas in which you might do something now that the buck is passed to you. If you are in the right tax bracket, you might also remember that every buck needs some dough.

What we must cultivate in ourselves and in our fellow citizens is what Dr. Derthick describes as the Russian's "burning desire" for excellence. He reports that all over Russia he saw signs which said "Pass and Surpass the U. S. A." It is a good slogan and one which we might well adopt. We, too, need to pass and surpass the U. S. A. I don't think we are inferior to the Russians; I don't think we are behind them, yet. But they are certainly catching up to us awfully fast, and, if we don't redouble our own efforts and pass and surpass the U. S. A., the time might come when we won't be as well satisfied as we are now. We must surpass all our previous efforts not merely to match Russian effort (we shall grossly misinterpret the demands of the new age into which the world has moved if we set our sights no higher than that) but really to meet "the challenge and promise of the scientific revolution."

This more exhilarating challenge of the frontier of science and its rich promise of constructive awards underlay more of the discussions of the Conference than I have indicated here today. It was the special subject of a round table chaired by Dr. Harrison Brown of Cal Tech who has become something of an apostle of the scientific age. Another group, under Mr. Alfred Neal, President of the Committee on Economic Development, discussed "The Economic

Implications of an Adequate Science Program" to meet the demand of the scientific revolution. The opportunities offered by the scientific age were the basis for most of the suggested educational reforms discussed. The need for these reforms was seen at New Haven--and will, I hope, be seen in every county in America--not as preparation for a manpower race with Russia, but as a preparation for a perhaps soberer but more intellectually venturesome citizenry, a less complacent but more confident national attitude, and, above all, a more spirited and dedicated democracy.

I cannot do better than to close where the Yale Conference began, with excerpts from Dr. Killian's opening address:

> With all of the responsibilities and challenges it faces today, our nation must ask of us, its citizens, a certain height, and this height is increasing. The gathering obligations and challenges of our time place a mounting premium on excellence, on high performance, on better taste in all our work and living in the United States.....More than any other kind of society, democracy requires talent and leadership..... (But) it is not enough for the exceptional to act exceptionally. Throughout the entire spectrum of individual abilities, our goal should be to achieve the opportunity and incentive for the fullest possible exercise of each individual ability.....There is a need for more vigor and more emphasis on excellence in the secondary schools.....America's strength requires that the American people attach a higher value to the hard labor of rigorous thought.....Our goal should be to meet our own indigenous needs superbly well and...the achievement of a high degree of scientific literacy among the rank and file of Americans. A man cannot be really educated in a relevant way for modern living unless he has an adequate understanding of science. The defensiveness of those of us who used to attach ourselves to the humanities I think is unfortunate. One can't read science out of liberal education at the present time.

Such is Dr. Killian's prescription. Filling it will not be easy, but it is essential to the continued healthy growth of the nation.

We need not doubt that the American people can and will do what is required if the participants in such meetings as this one will carry the message of the need and its urgency into their own communities. That is one of the highest services we can render our country today.

Mr. de Guigne: Thank you very much, Dr. Bevis. I am sure everyone joins me in expressing our appreciation to Dr. Bevis for his efforts to hold open a spot in his busy schedule to permit him to come out here and participate in our conference.

Gentlemen, according to my agenda, that seems to be it. As you heard from Captain Foley, there will be a tour of the Naval Postgraduate School and I have been asked to suggest that those desiring to make the tour assemble in small groups at the left side of this room. The meeting stands adjourned.

DINNER

Mr. Thompson: It is an endorsement of the importance of the International Science Foundation's Brainpower Forum that the speaker I am about to present replied with such enthusiasm when our president, Mr. Champion, invited him to speak on "The Critical Element in our Brainpower Picture--Quality not Quantity."

Dr. Joel Hildebrand, Professor of Chemistry Emeritus at the University of California, is uniquely qualified to speak on this subject. He has had a varied and interesting career. An outstanding chemist, he received in 1952 the American Chemical Society's prize for contributions to chemical education and served as the Society's president in 1955.

I think that I can perhaps introduce him best by quoting to you the citation with which the University of California bestowed on him the LL.D. in 1954:

> Member of the faculty since 1913 and former Dean, both of the College of Chemistry and the College of Letters and Science. He and the modern University of California have grown up together, each contributing to the greatness of the other.
>
> A scientist, honored many times, nationally and internationally, for researches on solvents. A teacher of generations of students, who has made the study of chemistry and exciting intellectual adventure. An administrator conscious of the whole university--the humanities, the fine arts, the physical sciences, student life, and faculty government. Even in these days of his retirement he is the chief citizen of our academic community.

I have now the very pleasant function of presenting Dr. Hildebrand.

Dr. Hildebrand: I have been pleased by the topic assigned for this address because I have long been disturbed by the extent to which what is called "scientific manpower" has been discussed in terms chiefly of supply and demand. This indicates failure to understand the differences between explorers on the one hand, and practitioners, consultants, and technicians on the other. These differences are most clear in relation to the very question of supply and demand itself.

The latter categories are necessary in order to perform certain needed services. If the supply is unequal to the demand, society suffers;

if it is excessive, there is unemployment. The need for dentists, for example, is determined by the size of the population and the incidence of dental caries. A well-run society would seek to provide enough, but only enough, well trained dentists to supply its needs. The relation of explorers to society is very different. They do not advertise any services for sale in the yellow pages of the telephone directory. Society published no "want ads" for someone to discover America, or the laws of motion, or the Periodic System of the Elements, or the Quantum Theory, or the Uncertainty Principle, or to manufacture the trans-uranium elements. Only the explorer himself has the vision of what he may find. The editor of the Saturday Review asked me to predict some future advances in science. I replied that I could venture only tentative predictions of those I myself hoped to make.

Creative scientists differ from the others I have named also in that they do not compete for jobs. Instead, they make them. A large chemical company stated that 30% of its employees were engaged in producing products not known fifteen years earlier. Who created these jobs? The scientists who had made the discoveries upon which they were built.

These distinctions I do not intend to be invidious. Society needs experts and consultants as well as explorers; it needs persons who can make available to non-experts the knowledge, the "know-how," that has gradually accumulated with the advance of civilization; it needs people who know the best answers presently available. But civilization that does not grow dies. We need also persons who can get answers to many questions better than those we now have, and, furthermore, we need persons who can think up new and better questions. Such answers to infections as were furnished by iodine and phenol were not the best; the sulfa drugs were better, and antibiotics still better, though not, as yet, the final best.

The standing of a scientist is not measured by what he knows but by what he has done, not by knowing a vast store of answers to old questions but by having invented some good new questions and put them to nature in such ways as to obtain answers. His ingenuity has often been expressed by the invention of new instruments or greatly extending the range and precision of the old. The microscope,

the cyclotron, the radar telescope, the oscillograph, the cloud chamber, the bubble chamber, all have been vehicles for exploring new territory.

Some great discoveries have been made by men with eyes and minds more alert to the unexpected than are ordinary people. Examples include the discovery of X-rays by Roentgen and of penicillin by Fleming.

Persons who are able to deal with new scientific questions and new answers are always in short supply, as are highly creative people in the arts. Only a few are born with the peculiar combination of qualities necessary for the making of truly great poets, novelists, actors, violinists, scientists, and teachers. One has only to spend an evening before a television set to see how far the demand for that sort of talent exceeds the supply. Most of us look back to school and college days when just a few teachers towered far above the mass of good, mediocre, and poor.

I speak mainly about creative scientists because it is their discovery and training that I know most about from having spent my life at it. To be a productive scientist one should have several qualities in good measure, each of which is comparatively rare among the population, and which, in combination, are extremely rare. Their scarcity is a simple matter of probability.

In order to make the point clear, let us put it this way. If there are five recognizably different and unrelated qualities essential at a high level for success and one man in ten possesses one of them, the probability that all five qualities will be combined to the necessary degree in a single individual is 1 in 10^5, i.e., one in a hundred thousand. This illustrates, in principle, why great men in any important field are always and always will be in short supply. It should alert us to the fact that we should prize, foster, and utilize so slender a resource with the utmost solicitude. It differs from some other natural resources in that it is perishable. If a mine or oilfield is not exploited, it remains for future use; but a youth who may have potential creativity will be forever lost to society if he is never confronted with the necessary challenge and the opportunity to develop his talents. It is often asserted that a genius will develop willy-nilly. That is not so.

Potential scientists rarely develop in an unscientific environment.

There is much evidence that the early years are critical for developing scientific talents. I had this to say in an address in Chicago several years ago:

> The awakening of the scientific spirit may occur anywhere along the line, from early childhood to adulthood, and the determining influences are various, including books, parents, friends, and teachers. There are also adverse influences, such as poverty poor teaching, social distractions, a thirst for riches, and falling in love with the wrong girl. I wish to discuss some of these as they operate at various stages of development: in early childhood, in high school, in undergraduate and graduate years in college and university.
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> There are many scientists whose interest in science was awakened very early. I was not more than ten years old when I was introduced to physics and chemistry by a man who came once a month to the little private school I attended and performed experiments in elementary chemistry and physics. I was entranced and repeated at home every experiment for which I could assemble the necessary materials. I acquired a set of nature readers from which I learned about bees, ants, dragon flies, tadpoles, and frogs and discovered my pleasure in telling my playmates about them as we wandered in woods and fields. (I had already, you see, the makings of a professor.) Later, I was allowed to have a room in the attic as workshop and laboratory.
>
> I have sometimes wondered how I would be developing if I had been born in 1941 instead of in 1881. Would I be pretending to study with a radio blaring in the room? Would I be reading "comics" and "science fiction" instead of astronomy, geology, and chemistry? Would there be television in my home, turned on continuously and unselectively? Not necessarily, perhaps, but with all my friends talking about these things, and school trying chiefly to "socialize" me, I am not sure I would have had enough strength of character to go my own way. A little girl who lives near us lamented bitterly to her mother that, as they ride home in the school bus, her friends all talk about nothing but television, "and we don't have it and they simply ignore me!" I am glad, therefore, that I was born in 1881 instead of 1941 and could occupy my mind with science facts instead of opening it indiscriminately to science fiction and the pseudo-scientific frauds of advertising.
>
> There is much that a parent can do to develop the intellectual possibilities latent in his child. One of the most effective is to be interested in the subjects his child is studying. Too often the parent merely inquires into grades and rewards or punishes accordingly. But the goal of education is not marks but understanding, and, if a father treats his son's problem in algebra as at least as interesting as a problem in bridge, he may not only

> assist in a desirable motivation for his child but also jar his his own brain out of its quiescent state. My daughter studied anthropology under professors of distinction. Weekly, during her freshman year, she was my guest for lunch at the Faculty Club and gave me a summary of her intake for the week. This not only helped her to organize her knowledge but filled with fascinating material a gap in my own education.
>
> Some parents actually discourage a child's efforts at self education. My zoologist son, who from early youth was surrounded by specimens, bones, skins, and a menagerie awaiting death and dissection, was allowed by his indulgent mother even to keep carcasses in the family refrigerator. He once let a friend have several white rats from his colony. But, the next day, the lad brought them back, tearfully explaining that his mother would not let him keep them. Our boy remarked at supper, "I knew the minute I saw that woman that she would not let him keep them." His own mother's stock was boosted further by the comparison. She restrained more than one natural feminine impulse in the interest of her children's education. When, for example, another son sauntered into the living room one day with a live garter snake round his neck, she sat unmoved, although a lady caller nearly had hysterics.

If talent is to be developed it must be recognized as early as possible in order to provide the desirable opportunities and stimuli. The test most commonly relied upon is the "I.Q." I hear pupils characterized by their I.Q. scores, as a sprinter may be rated as, say, a "ten-second man." There have been proposals to spend huge sums of money on large-scale testing to discover talent.

I doubt whether that would be the best way to spend the money. Let me tell about my first experience with such a test. Soon after World War I, a professor of psychology in my university wanted data on the "Army Alpha" tests that had been introduced during the war. I got the students in my two quiz sections in freshman chemistry to volunteer as guinea pigs. One was the top section; the other, the bottom section in my huge class. The student who made the poorest score in the high section won the university medal for scholarship at graduation and later a Ph.D. in chemistry and then had a notable scientific career. A student in the low section got a higher score than all, including me. (I stuck out my neck by taking the test with the students.) That student, however, failed the course at the end of the term.

What was the matter? The test itself was somewhat defective in that it assumed that all truly alert young Americans would know such items as who are the "Red Sox" (I didn't); nevertheless it was not a poor test of intelligence. Where it utterly failed was as a test of other items just as essential as intelligence in a productive scientist: curiosity, drive, persistence, imagination, and judgment. The university medalist had these qualities in good measure; the "bright boy" did not.

There is another reason to mistrust "intelligence" tests. We have long given certain placement tests to students enrolling in our course in freshman chemistry in order to place them in laboratory and quiz sections with others of comparable ability. The final grades approximate rather well to the prognosis, but there are some students who do not perform nearly as well as they should on the basis of the tests, and there are others who purposely get mediocre scores in order to be placed in a section where competition will not be severe.

Words such as "intelligent" and "intellectual" are "bad" words. People who do not pass the tests maintain their self esteem by substituting supposed equivalents, such as "egghead," "square," "a brain." They swat the eggheads that thrust themselves up above the general level. And they are partly right, because supposed intellectuals have been known to say and do very stupid things. I have advised many a student, if he regards himself as an intellectual, to keep that fact to himself.

Although a scientist needs a good brain, there are many people with good brains who do not and could not become scientists. There is a report in the Scientific American for July of this year by Morris I. Stein of the University of Chicago of a five-year study of sixty-seven industrial chemists. He found no significant difference in intelligence between the non-creative and creative members of the group. The respects in which the latter excelled were the setting of more distant goals, better personal relationships, less conventional conduct, slower and more careful analysis of problems, longer work-hours, etc. These are not qualities measured very well by I. Q. tests or quiz programs. They are qualities of character.

The best way to try to predict success in any activity is to see how the individual performs in that activity, not in some other. The person best able to find out whether a lad is capable of becoming a mathematician is not an educator who has studied testing, but a teacher who understands mathematical reasoning and knows how to make that sort of activity seem exciting. The only good way to tell whether a college undergraduate has the makings of a research scientist is to give him a piece of research to do, not examinations for which to plug.

In our concern for high quality, we should not try to produce only scientists of the highest quality. We must subject the many to strong stimuli in all the basic subjects in order not to miss the few who are capable of responding in the highest degree. This is not wasteful because not only is there a need for many artisans and workmen to give effect to the visions of the designers, but there is need also for a general public sufficiently informed to understand its ultimate dependence upon brainpower.

Making science interesting to the many and affording each the fullest possible means to develop is the way to obtain the maximum number of scientists of the highest quality and at the same time the larger number of collaborators necessary for bringing to fruition the ideas that germinate in the highly fertile minds. The ranks of the latter are best recruited not by exhibits of ripe fruit, but by allowing the apprentices to participate in cultivating the trees. The best education is one that takes the form of an apprenticeship. The apprentice should be learning not primarily what the master knows but how he works. Even if it were possible for him to assimilate all that is known about the subject at the time, such knowledge would not equip him for very long in the future.

Let me consider now in more detail how the raw material of the potential scientist can be wisely discovered and developed. I shall here preach nothing that I have not endeavored to practice as a parent, as a teacher of some 40,000 university students fresh from high school, of many Ph.D. candidates, and, recently, in my own research assisted by young post-doctoral scientists supported by the Atomic Energy Commission and the

National Science Foundation.

I am not one of those who have sought the money and prestige to be found in administration. Three times I have had brief tours of duty as a dean and once in command of a military scientific establishment in France during World War I. Now, at 76, I teach and carry on an active research program for fun.

At the risk of being considered immodest, I give part of an introduction by one of my sons, now Associate Professor of Physics in the Fermi Institute of the University of Chicago. Men who produce goods are not reticent about their merits; I am not disposed to be reticent about my work directed to producing three male scientists and a daughter who is research assistant to a professor of sociology. Here is that son's account of what I tried to do for them. He said:

> In a few minutes my father will speak to you of pedagogic cookery: how to stir and season callow youths to turn out well done chemists. His words may bring new life to teachers and new hope to students, but those who really want the secrets of his culinary craft must see him at his work, since teaching is for him an art more than a science. The tens of thousands who have read his books have had a glimpse of how he teaches. Of these the freshmen chemists have had a better look; and, better still, his graduate students. But best of all is the view of those in his own kitchen. Let us examine how he teaches in the comfort of his home.
>
> Long ago, I well remember, I asked my father, "What do you do for a living?" He said, "I am a chemist." "A chemist?" I said, "What's that?" He answered, "Let me show you what a chemist does," and right then and there he put some galvanized nails into a bottle. He poured in some acid and put a balloon over the neck of the bottle. In a few minutes he handed the balloon to me full and floating. Then, with charcoal from the fireplace and saltpeter and sulfur from the garage (we had a well stocked garage), he made gunpowder, which he burned before my wondering eyes. By then I had forgiven him for being a chemist.
>
> I had two brothers and a sister to help me quiz the Medalist. We gave him no peace; yet whatever we asked he would listen to with interest and then show us the answer or tell us how to figure it out for ourselves.
>
> Nothing inspires such faith as a teacher who never asks that you accept a truth on faith. Here was a savant who welcomed being put to test. Nearly every evening after dinner he would read to us some poem or play or novel. He taught us to recognize the

> paintings of the great masters. He taught us to know all the trees in the Sierra forests, the flowers and rocks in the field, the constellations in the sky. He taught us how to swim and dive, how to sail a boat. He taught us much about getting along with people by telling us of the problems which confronted him and how he proposed to solve them. He said, "Never despair for lack of brains. You probably aren't using the ones you have at maximum efficiency. Judgment and perseverence go a long way to make up for lack of genius. Look at me," he said, "I am not brilliant; yet I have managed to do a number of things in my life."
>
> We were encouraged and instructed in any worth-while pursuit. The most confirmed blockhead could hardly have withstood the assault of intellectual enthusiasm which we enjoyed. Any flair for science, athletics, music, arts, or crafts on our part was noticed and the spark was fanned by a powerful hand. As a result, enough bonfires lit the sky to reduce any mother but mine to a cinder.

It is of the utmost importance to capitalize upon the natural curiosity of the very young child. He should have at least one parent or teacher, at every stage of his development, who can do for him what I tried to do for my children. Stimulating books should be lying about where he can see them because avid reading can often contribute more than formal schooling.

This sort of stimulus is more often than not woefully lacking in the critical years in elementary school, especially in the key subject of arithmetic. What is the evidence?

Well, let us inspect it. I deal with California, leaving it to my hearers to investigate the health of the patients in their own states. In The Arithmetic Teacher for February of this year, there is an article by Professor G. T. Buswell entitled "A Comparison of Achievement in Arithmetic in England and Central California." The same test was given to approximately 3,000 pupils between the ages of 10 years and 8 months and 11 years and 7 months in each area, to all pupils in attendance upon the day of the test. Here are several of the questions with the percentage of English and California pupils, respectively, who answered each correctly.

Questions	English	California
Multiply 7 lb. 4 oz. by 9	59%	4%
Divide 49 tons, 1,200 lbs. by 8	48%	0%
Subtract 47 gals., 5 pts. from 86 gals., 4 pts.	49%	3%
What is 1/2 of 7 1/2?	61%	15%
How many minutes are there between 9:30 a. m. and 10:45 a. m. the same morning?	51%	19%

70 was a perfect score; 1,077 pupils in England scored above 53; only 13, in California. Evidently something in California is far inferior to the same thing in England, and I don't think it is the children. I suspect, also, that arithmetic is not in a healthy condition elsewhere in the United States because one state university east of the Mississippi that I visited offers a course designated "Math Zero."

Few adults and few elementary teachers have had their eyes opened to the true nature of mathematics, to its beauty and its power. Their blindness is but the natural consequence of having had teachers like those mentioned in a certain survey of the schools of five states. Out of sixty classes observed, ten teachers were reported "adequate" and fifty were "confused" by their subject and barely able to keep ahead of their young students. Most of them disliked it and almost inevitably transmitted their attitude to their students. The report said:

> Future teachers pass through the elementary schools detesting mathematics. They drop it in high school as early as possible. They avoid it in teachers' college because it is not required. They return to the elementary schools to teach a new generation to detest it.

In some cases this hostility takes an aggressive form. A freshman told me that his high school counselor had tried her best to steer him away from mathematics, his intended major in college, because, she said, "it is too hard; you won't enjoy it." She had been certified as a counselor despite her utter ignorance of the vital role of mathematics in our complex civilization as well as

of the satisfaction that is to be had in mastering difficult, worth-while tasks. If she were in the pay of the Kremlin, she could not contrive a better way to serve its interests.

There is widespread ignorance of even the most elementary features of science. Otherwise well educated men have asked me what keeps the Sputniks going. There is more astrology than science in certain newspapers. $60 per annum per person is profitably spent by advertisers to "condition" people, like Pavlov's dogs, to react to words that convey no pertinent information. There is only one scientist on the Atomic Energy Commission. A cabinet member blocked funds for basic research on the ways of nature because, he said, "basic research is not knowing what you are doing." That wasn't in Russia.

I have seen a girl in school prepare a "project" about "hard" water. Under the guidance of the teacher, she had brought a carton of common salt to make the water hard and a package of baking soda to soften it. Now common salt is not the constituent of hard water that renders soap insoluble, and baking soda does not soften hard water. The poor child could learn nothing about hard water under the guidance of a teacher utterly ignorant of the chemistry involved. I could furnish case after case of this sort.

Such projects are embodied in what are today called "units of education." They used to be called "lessons" or "assignments," but educational progress consists partly of inventing new words: "work shop" for "conference," "unit" for "assignment." A retired teacher of my acquaintance calls them "eunuchs of education" because "they don't produce anything."

A candidate for a credential to teach science cannot learn what science is from a professor of "science education," such as one who declared in an outburst of enthusiasm over his own methods, "Where democratic interplay is permitted, and interchange of ideas and content information is fostered, our best teachers teach science in the midst of a glowing, vibrant, pulsing atmosphere of"--what do you think?--"social awareness." I have a beautiful granddaughter who has never needed lessons from a teacher to develop social awareness; the boys have taken care of that. What she has needed, but not

always had, is teachers who can make her more aware of the elements of our culture which should be transmitted to the oncoming generation.

The teaching of science cannot be improved by a school superintendent who cited as a model a "core curriculum" adopted under the direction of a school of education in which science consists of items such as "science in community living, science in personal living, consumer chemistry, landscape gardening, outdoor science, atomic energy." That brings it up to date! You see, they haven't a ghost of a notion of what science consists.

Nor are pupils learning English in a California school (and good training in English is even more important to our success in classroom chemistry than training in chemistry in the schools), which, as described by my colleague, James J. Lynch, Professor of Engligh, "is madly pursuing audio-visual aids" and where "every newly arrived or recently resurrected film strip must be shown in the classroom, no matter how irrelevant to the work at hand." Incidentally, some time ago I was present in a classroom where one of these ubiquitous and irrelevant films was being shown. The only thing of interest I could find going on was the 'group dynamics' in the back row, where the more physically mature boys and girls were taking advantage of the darkened room in ways entirely unrelated either to the film being shown or to the subject matter of the course.

How can competent teachers be provided for your children and grandchildren? Educationists say, "give us the money". But money alone will not do it. There are other even more serious deterrents that are seldom mentioned and are not being removed. One is lack of recognition for merit, because teachers do not trust administrators to recognize it. Another deterrent is the protective tariff that educationists in most states have had written into law.

Many gifted college students who have considered teaching have balked at the courses in education required. I offer in evidence a few extracts from a large file of unsolicited letters. A capable teacher in San Francisco wrote to me:

> The education courses which in this state are compulsory are more often superficial and of little value than any to which I have been subjected. Our administrators and younger teachers are strongly

> influenced by this superficiality and by the overemphasis of the social rather than the intellectual training of the pupil in the school. Schools of education need a searchlight turned on them so that the trash may be discovered and weeded out.

A man in another state wrote:

> Off and on since 1946 my wife had accumulated over three semesters of college credits. Her grade average was approximately 3.9 out of a possible 4.0, almost straight A. This fall she took her first education course, educational psychology. Within two weeks, on the basis of the unadulterated drivel contained in this course, she decided that she would change her major at the first opportunity.

An extraordinarily competent young woman of my acquaintance has rebelled at being required to take in-service courses in education and has been lost to teaching. She wrote:

> Five of my ten teaching years have been spent in the California elementary schools. My only qualification to teach is an M.A. in an academic subject. In a system where many certificated people were not retained, I was given consistent renewals and offered tenure if I would take certain education courses and become fully certified. The repetitive indoctrination sessions which these courses represent are so akin to brainwashing techniques that I find myself morally obligated not to take any more of them. Having no other choice, I have resigned from teaching.

My group at the White House Conference approved the following statement:

> There are many persons well qualified to teach, by virtue of intelligence, knowledge of specific subjects, facility in speech, personality, and sympathetic understanding of young people, who could be recruited to teach school if these natural qualifications were accepted for certification in place of course requirements in education.
>
> Many persons, otherwise well qualified, are repelled by courses in education that they regard as repetitive, doctrinaire, or inferior in intellectual quality.

A considerable portion of what is taught in schools of education may be not unfairly described as the preaching of doctrine, not the dissemination of knowledge. There is not nearly enough positive knowledge in existence to justify the hundreds of courses offered in most schools of education. (The

School of Education of the University of Texas offers 351 courses!.) In one university where the department of chemistry offers ten graduate courses, education offers fifty-seven. A subject that has arrived at some intellectual maturity, such as physics or chemistry, has a content of objective concepts, laws, and principles of such wide applicability as to make it unnecessary to deal in details and mere opinions.

Such observations have led me to propose as an academic law that the number of courses given by a department is inversely proportional to the product of scholarly eminence of the staff and the body of real knowledge in the field.

Another major deterrent to the recruitment and retention of able teachers is dictation by administrators and supervisors. One teacher expressed it as follows:

> The majority of administrators, department heads, and coordinators have been appointed to their positions precisely because they follow the "party line," and thus they in turn rate good those teachers who stress "life adjustment," not competence in the subject. Those teachers who stress competence in the subject are labeled "anti-progressive," "subject-centered."

A San Francisco lady wrote to me saying that she had visited the class where her eleven-year-old son was enrolled. The teacher complained because the boy "thought of himself as an individual and not as a member of the group." That would have been appropriate in Hitler's Germany, but hardly in a democratic country.

There is a statement by Dewey in his Democracy and Education (page 127) that should be hung over the desk of every counselor and school administrator. They all swear by John Dewey and quote him in support of their policies, but they never quote this statement:

> Too rarely is the individual teacher so free from the dictation of authoritative supervisor, textbook on methods, prescribed course of study, etc., that he can let his mind come to close quarters with the pupil's mind and the subject matter.

My Chicago son wrote in a family letter:

> A Soviet scientist (Professor Gol'dansky) who visited us recently made it clear that his countrymen are very proud of Sputnik. He made two interesting remarks. He said, "One reason we have surpassed you in developing satellites is that, for this work, we have adopted a capitalistic organization, while yours, from what I hear, is somewhat socialistic." He went on to say, "You Americans did us an incalculable service by your successful explosion of the atom bomb. It brought us to life! Now we are delighted to return the favor."

Have we awakened? As far as I can see, we are just yawning and stretching. There are intrenched as school administrators in many places men who have had no more liberal education than a major in physical education followed by indoctrination in a school of education. You can read about them, for example, in the April issue of the Atlantic Monthly in an article by Louise Short, wife of a University of Florida professor. These men neither wish nor are able to teach any basic subject but prefer to impose "life adjustment" upon real teachers. What are we doing about them? As far as I can see, little or nothing.

Not all are this sort. There are many, but not nearly enough, well educated, intelligent administrators. The only way to displace the incompetent by the competent is by electing intelligent, able persons to school boards. Where that has been done, the schools are good. Our only hope is to follow that course. We can expect little leadership from Uncle Sam. It is a case of "do it yourself."

Alfred North Whitehead wrote:

> The nation that does not value trained intelligence is doomed. Tomorrow, science will have moved forward yet another step, and there will be no appeal from the judgment that will be pronounced upon the uneducated.

Will that be our doom? We shall see, perhaps sooner than we should like to think.

SECOND SESSION

Mr. Ruddock: Greetings, Scientists, Brains, and Fellow Sinners. We have a very interesting program this morning; so I will be as brief as possible.

I take pleasure in introducing Dr. Edward N. Saveth, Project Director of the National Committee on the Aging, who is going to talk to us on "The Utilization of Older Scientists and Engineers."

Dr. Saveth: I noticed that in your previous Brainpower Forum you made two recommendations upon which I am going to touch today in my presentation. The first of these is "making use of the reservoir of retired scientists and engineers" and the second is"the easing of the teacher shortage by means of the utilization of qualified retired personnel." I will have something to say about these points in the course of my presentation.

In today's complex world, with its ever-increasing demand for specialization and brainpower, the trained professional worker exercises a key function in giving intelligent direction to the nation's manpower.

Under a grant from the Dorr Foundation to the National Committee on the Aging, I have been studying the older scientific and engineering worker whose problems are not unrelated to the professional group as a whole and to certain long-term trends in manpower utilization.

Professional, technical, and kindred workers, as the United States Census classified them, have increased very rapidly, more rapidly than any other census occupational category. In 1870, the professional group included less than one-half million workers, about 3% of the labor force. In 1950, there were about five million professionals representing 8% of the labor force. By 1950, professionals had increased three and one-half times faster than the nation's population and three times faster than the American labor force.

Within the professional, technical, and kindred worker group, scientists, engineers and technicians have increased more rapidly than any other classification. They were 3% of all professionals in 1870 and 20% in 1950. By 1960, with current emphasis upon scientific training reinforcing the long-term trend, trained scientific and engineering workers will constitute

an even greater percentage of the professional labor force than in the past.

The influx in recent decades into the professional, technical, and kindred worker group has had the effect of lowering the group's average age, compared to the rest of the labor force. The scientists and engineers are even younger than the professional group as a whole because science and engineering have proved more attractive than other professional categories to youth in search of careers.

What I have been saying can be expressed statistically as follows: the special reports of the United States Census of Population (1950) reveal that, whereas 5.6% of the total male labor force was 65 years and over, in the professional group only 4.6% was 65 years and over. Engineers 65 and over were 2.5% of the total number of engineers; natural scientists 65 years of age and over were 2.5% of their number; and the chemists 65 years of age and over were 2.2% of the chemists. In newer branches of engineering, such as aeronautical engineering, those 65 and over were only 0.3%, whereas in relatively older branches of engineering, like civil engineering, they were 4.3%. These figures are based on a 3-1/3% sample. (Occupational Characteristics, 1950 Population Census). References are to male workers only.

I have based these percentages of the distribution of professionals by age on the census table reporting "Age of the Experienced Civilian Labor Force" (1950), including both employed and unemployed professionals. I have used this table rather than the table reporting "Age of Employed Persons. . . ." because of the significance of self-employment in the survival of certain categories of professionals in the labor force, notably doctors, lawyers, clergymen, pharmacists, veterinarians, and dentists. These, for the most part, after the age of 65, can work on their own terms and at their own pace, and they tend to show up in large numbers in any count of employed professionals 65 and over. The table "Age of the Experienced Civilian Labor Force" reduces the factor of self-employment in estimating professional survival in the labor force.

It is apparent, therefore, that because of certain historic circumstances attendant upon development and growth of the scientific and engineering professions, scientists and engineers who are 65 years of age and over are relatively small percentages of the total professional groups.

This does not mean that the problem of the utilization of the older scientist and engineer can be dismissed lightly. Indeed, the actual number of older scientists and engineers is at this time not insignificant and will inevitably increase. Some gauge of their future proportion may be obtained by looking at age distribution in the older and traditional professions of law, clergy, medicine, pharmacy, optometry, dentistry, and veterinary medicine in which practitioners of 65 years of age and over are about 10% of the total number in the experienced labor force. In time, the distribution of scientists and engineers will approach that of the traditional professions. Finally, and I think you will agree, proper utilization of talent is beyond numbers and percentages.

It should be recognized that relatively few scientists are self-employed and that, before 65 and after, they are overwhelmingly wage and salary workers. As such, they are affected, more so than in the professions in which self-employment predominates, by mandatory retirement policies at a fixed age.

I cannot tell you quantitatively how many scientists and engineers are forced out of employment each year by the operation of compulsory retirement systems. In 1952, a survey conducted by the Institute of Industrial Relations of the University of California in cooperation with the Current Population Survey of the United States Bureau of the Census revealed that about 12% of all retirements in the category of professional worker were the result of the operation of compulsory retirement systems. Since 1952, the number of retirement systems has proliferated. It can be assumed that the number of professionals affected has increased and that the impact of compulsory retirement upon scientists and engineers has also increased.

The belief that compulsory retirement will be more of a problem in the future than it is at present was expressed frequently during a series of interviews I had with the industrial research directors of large corporations concerning the work and retirement problems of older scientists. (In a later stage of research, an effort will be made to express quantitatively certain of the data collected as a result of the interviews.) This again reflects an historical situation. Industrial research is a relatively new field in the United States. Except for a very small number of corporations which began

their scientific research laboratories relatively early in the twentieth century, industrial research in this country developed significantly in the 1920's, held its own in the 1930's, and made rapid strides in the 1940's and 1950's. Consequently, only a relatively small number of industrial scientists are retired or are approaching retirement. However, that retirement will mount in importance as a problem in a very few years no research director whom I have interviewed has denied.

How is retirement handled at this early stage of the evolution of the "problem"? All of the companies whose research directors I interviewed have some form of retirement and pension plan. None of these pension plans discriminates between the professional and non-professional employee. The retirement scheme that applies to a manual laborer in a plant applies, too, to that plant's top scientist.

Some plans provide for greater flexibility than others. In some companies, a scientist can be retained beyond retirement age (usually 65)--but not long beyond--at the discretion of his superior. In certain others, and this condition prevails in several of the largest industrial scientific laboratories in the country, no man regardless of his ability can be retained beyond the age of 65.

Industrial research directors have mixed feelings about compulsory retirement. They are aware that compulsory retirement fosters inequities insofar as the productive scientist is forced out along with the unproductive scientist, once the chronological age limit is reached. But they also feel that the policy of mandatory retirement presents fewer problems administratively. Any other policy, certain research directors have told me, would involve them in all sorts of difficult decisions of a personal character, involving the evaluation of the capacities of one man over that of another.

These research directors are rather vague as to why weeding out of an inefficient employee is more difficult at age 65 than at age 45 or 55. They mention that the older man has been around longer, that his ties to the company are that much closer. "One hates to offend an old-timer in his last years of service....."

Such a point of view on the part of research directors appears to be part of a broader personnel policy. Age-determined factors as seniority and length of service influence significantly the personnel policies of industrial laboratories. In most laboratories, the aim is to hire a man in his 20's or early 30's and train him to the needs of the company. To the man who "makes his career" with the company, the company feels a certain responsibility which may or may not transcend

the scientist's productivity as manifest, let us say, on the employee's fiftieth birthday. The scientist, too, feels himself a company man. Consequently, the reciprocal pattern of loyalty, employee to company and company to employee, prevails until age 65 when, owing to compulsory retirement, the company, without guilt but not without a sigh of relief, says good-bye to an employee who has the satisfaction of knowing that he made it to the end.

Thus, compulsory retirement enables the company to rid itself painlessly of a scientist who may not have been "pulling his full weight" for the past decade or more. But what of the efficient scientist who would like to stay on and whom the company would like to have stay, but who nevertheless must go because of mandatory retirement? The plight of the efficient scientist, age 65, forced to retire along with the "dead wood" is in part predetermined by failure of the personnel office to deal courageously with the inefficient scientist ten or fifteen years earlier.

A scientist, age 50, of average ability, finds difficulty in gaining a foothold in the company science hierarchy. To begin with, a scientist of 55 looking for a job is suspected of professional incompetence or personal maladjustment. Secondly, some research directors indicate that, because of pension systems and for other reasons, they would have to make a special pitch to the personnel office in order to hire a scientist of 50 or 55. The industrial scientific ranks--and this is particularly true in the large corporations--are pretty much closed at age 45 or earlier, with promotion coming from the ranks.

I am not attempting to depict the field of American industrial science as a battleground in which creativity struggles to be born against a deterrent hierarchy fortified by aging and tenure. No organization, certainly not a scientific organization, can survive without structure. But it is also true that the intelligent management of age and its concomitant of compulsory retirement is a determinant in the ultimate efficiency of an industrial laboratory. A study of the retirement policies of industrial scientific laboratories should not be isolated from an overall analysis of personnel policies in these laboratories and the role played by age in them.

I referred above to the "intelligent management" of the age factor. But management might well ask, "Where are the guides to such an approach?" These, admittedly, are very few. The conclusions of H. C. Lehman in Age and Achievement have not been tested in a laboratory situation except for the far-from-definitive researches of Dr. Donald C. Pelz and Professor Morris Stein. Dr. E. S. Hiscocks, writing in the British journal, Technology, on "Age and the Scientist" in June, 1957, has some interesting insights on the implications of Lehman's thesis for industrial research, but he has little to offer in the way of additional experimental data. Social science should endeavor to supply management with the data on which to base decisions.

Compulsory retirement is defended on the grounds that men in the lower echelons are able to move up into better jobs for which they have patiently waited these many years. In the course of interviews, the research directors return time and again to the theme that "new blood" is needed, that the younger men must be given both incentive and opportunity. Compulsory retirement, they argue, keeps careers open to talents.

At the same time, there is a feeling among some of the research directors that a scientist who is doing a competent job in his particular field should not be compelled to quit at age 65. They feel there is waste in forcing a bench scientist, skilled in a certain process, to retire. Separate this man from the job and his usefulness to society is at an end. This man knows his particular narrow field; he has not kept up with the advance of science in other areas. His skill is not transferrable to another aspect of science, and he cannot get a job somewhere else doing something else in the field of science. Owing to rapid developments in science, his skill has become obsolete except for that particular job. (It should be pointed out that occasionally, because of an industrial lag, an older man will find his place. Witness the recent employment of an older engineer who happened to be familiar with DC motors of 2,000 h.p.)

The research directors to whom I have spoken are very much aware of the obsolescence of their own skills. Having spent years in management, they are no longer abreast of latest scientific developments. Consequently, in retirement, they tend to look forward to selling their managerial rather than their scientific skills.

The research directors, while aware of inequities in particular instances of compulsory retirement, are not of the opinion that there is much talent loss because of compulsory retirement. Many of them feel that by age 65 a man has pretty much "had it," and so has the company. At the same time, the research directors acknowledge that both company and employee are "age-65-retirement-oriented," that the arbitrary age of 65 becomes a cut-off point which management and worker are conditioned to anticipate. The employee is expected to think of himself as "too old to work" and management learns to regard him as such. Were there no automatic cut-off point, these directors feel, a psychological hazard to continued usefulness might be eliminated.

Occasionally research directors and, less frequently, scientists of lesser company rank are retained as consultants. But there is much dissatisfaction with that status on the part of research directors who have difficulty adjusting to a consultant status in a company operation which they once directed. Besides, not all companies offer consultantships, and consultantships which are offered, by admission of the research directors, are insufficient to absorb even the small number of today's retirees.

What happens to retired scientists? In most instances, the research directors do not know. Almost nothing is being done in the field of pre-retirement counseling of industrial scientists, and still less is done by way of a follow-up of the scientist in retirement. Thereare, of course, the annual company affair to which all retired employes are invited and the mailing address to which pension checks are sent. A research director may, on a personal basis, keep up with the retired man and might even invite him back to do a special job. But no company pursues a policy of systematic follow-up of its scientist retirees.

Most research directors paint a picture of the happy retired scientist, relatively well-fixed financially, enjoying his leisure, having little or no interest in science, anxious to quit the job for the better pursuit of his hobbies--in brief, that of a well adjusted and happy man. And yet, not all of the research directors themselves want to retire. One man admitted to me that, when he first became research director, he planned to retire at 55. Now that he is 58, he contemplates distastefully the prospect of retirement at age 65.

Let me conclude this discussion of interviews with research directors by saying that the research directors are not unbiased people. As administrators of company policy, they are inclined to defend it. At the same time, most research directors express some uneasiness about compulsory retirement which, they feel, has been imposed by the exigencies of pension programs, union demands, and simplified administration. Off the record, and after a certain amount of rapport has been established with the interviewer, they are likely to express misgivings about compulsory retirement while asserting that they know of no alternative plan. It may be significant that the research directors who are most critical of compulsory retirement are those who had been themselves retired and want to return to work. These retired research directors are by no means examplary of the picture of the retired scientist, happy in his idleness, painted by many active research directors.

So much for management. Now let us turn to the older scientists themselves. It so happens that the older scientists I have interviewed are active people who, for one reason or another, are restless in retirement. Some are under financial pressure; others are looking for a kind of prestige and power they once had and lost on retirement day; others, at age 65 and more, feel a strong sense of career; others would like to be useful in their professions; others feel a need to belong, somewhere.

These men have taken steps, some quite ingenious, to help themselves. Mohawk Associates of Schenectady is made up of retired General Electric employees. Stavid Engineering Company in Plainfield, New Jersey, employs a number of retied scientists and engineers, chiefly from the Bell Telephone Company which has a hard and fast retirement rule at age 65. Stavid management has been most ingenious in utilizing the talents of highly skilled older men without allowing this practice to interfere with the advancement of younger scientists and engineers. Shortly before I left New York for California, I came in contact with a group of retired research directors who, under the auspices of the Industrial Research Institute, are discussing organization of a consulting firm in the field of industrial laboratory management. Other retired scientists are consultants for the firms they once worked for, and still others are government consultants. Some are teaching on the college level; a few, in high school.

These are most typical of the jobs which retired scientists take when they are available. The trouble is that there are too few openings for retired scientists. Or perhaps, not enough is being done to bring job and retired scientist together. There is a deep need for creative research in areas of job opportunity for retired scientists and an agency to bring together the job opening and the retired scientist. The establishment of such an agency and of pre-retirement counseling programs are essentials to maximum utilization of retired scientists and engineers.

It may be that I have overemphasized the desire of the retired scientist to return to work. It is possible that as an active researcher I have unearthed more active than passive older scientists. Unfortunately, statistical information has not advanced to a point where one can state precisely how many retired scientists are both able and willing to work and how many of those who are presently unwilling to work would again return to the laboratory under suitable employment conditions. Nor can I describe definitively the reasons why scientists who are well enough to work do not work and whether these reasons, in case of a critical manpower shortage, might be modified. Peter Steiner and Robert Dorfman in their study The Economic Status of the Aged have revealed a relatively large group of professionals, including an unknown number of scientists, who are well enough to work and do not work. This is an aspect of the older scientific manpower problem that requires further study before we can speak definitively of the manpower potential of the retired scientists.

In other areas, too, the quantitative information we have about scientists, retired and not retired, leaves much to be desired. On December 1, 1957, the President's Committee on Scientists and Engineers called the attention of the general public to the lack of data concerning numbers and distribution of scientists and engineers in the American population, regardless of age. The decennial census is particularly remiss with respect to the enumeration of retired scientists and, for that matter, all other workers who are retired. The census takes cognizance of only those workers who are in the labor force. A retired man is considered as not in the labor force and is not enumerated by the Census Bureau.

Fortunately, the National Science Foundation has established the National Register of Scientific and Technical Personnel whose task is to inventory the nation's scientific talent. From these records, it is possible to separate out the retired scientists. The Foundation has made available to the National Committee on the Aging records of all scientists in its files who were 65 and older. Taking the data at its face value, the following are the distinguishing features of 3,251 scientists who are 65 and over and who are listed in the National Register:

(1) Approximately 35% of the group is retired. That is, of 3,251 scientists who indicated whether they were employed or retired, 1,172 said they were retired. It is, at present, however, not possible to determine how many of the retired group are working. (I should like to digress a moment here to explain one of the difficulties we encounter in taking these data at face value. The difficulty focuses on the following question which is asked of the responding scientists: "PROFESSIONAL EMPLOYMENT: professionally employed_____; employed but not in a scientific field_____; retired_____; unemployed_____; full-time student____. POSITION: list only your present or last professional position _____." This question does not distinguish between a respondent who is retired and presently employed, and a respondent who is retired and gives his former employment. Thus, a scientist who checks "retired" and "professionally employed" may be referring in the latter case to his present position or he may be referring to his last position. Accordingly, there may be confusion between scientists who are retired and employed and retired scientists who indicate their previous occupation. In a communication to me, a representative of the Register attempts clarification of this point by saying, "Respondents were instructed to give information concerning either their present or last professional position. Thus, in the case of retired respondents, we would assume the information referred to the last position held by the respondent." In fairness to the National Science Foundation, it should be pointed out that the Register is primarily a means of locating scientists and was not designed to serve the purpose of sociological inquiry.)

(2) Whereas only 31.6% of all scientists are engaged in the field of education, 51.2% of the scientific retirees are from the education field. In addition, those scientists who are 65 and over and employed are concentrated most heavily (44.5%) in education.

(3) A relatively small number of scientists are retired from industry (35.2%) and an even smaller number (13.5%) are retired from government.

(4) Industry employs 50.8% of all scientists whereas, as we have pointed out above, only 35.2% of the retirees are from industry. This may be accounted for by the fact that industrial research was slow getting under way in the United States and, for a long period of time, educational institutions were the largest employers of scientists. There is an additional factor which may account for the over-representation of retired scientists from the field of education. Several interviews with former industrial scientists who are now teachers would seem to indicate that there is a tendency (how strong, it is impossible now to estimate) for certain industrial scientists to shift over in their middle 50's into the field of education. They advance as reasons the slower pace and the possibility of a longer career line in education than in industry. Moreover, certain of these men in recent years, in addition to teaching, have general supervision of a government-sponsored or industry-sponsored research project at the university.

(5) Whereas 31.6% of all scientists report their employer as being in the field of education, only 15.8% are actually engaged in teaching. The ratio of employed scientists 65 and over engaged in teaching is larger than that of all scientists, being 29.0% compared to 15.8% for the entire group. Finally, the percentage of scientists retired from teaching is larger still, 34.8%. Half of all employed scientists affiliated with educational institutions are teachers. The ratio of teachers to non-teachers affiliated with educational institutions is higher among employed scientists over 65 and higher still among the retired scientists.

(6) Statistics reveal research and development to be primarily the field of young scientists. That is, 49.4% of all scientists are engaged in research, development, and field exploration, whereas only 26.9% of the employed scientists over the age of 65 and 26.1% of the retired scientists over the age of 65 were engaged in these fields.

(7) Management or administration claims a slightly higher percentage of employed older scientists (20.3%) and of retired older scientists (19.8%)

than it does of all scientists (17.9%). These figures indicate that within the age framework of American science there has been taking place a process which parallels recommendations inherent in "Lehman's Law." It will be recalled that Harvey C. Lehman's Age and Achievement established that the peak age of creativity was in the early 30's and that, once this age was passed, a man's potential for creative endeavor--qualitative and quantitative--gradually declined. The fact that the older and retired scientists are present in more than the normal distribution in the fields of teaching, management, and administration and in less than the normal distribution in research and development indicates that the actual distribution of American scientists by age and function follows that which Lehman's treatise implies as most desirable.

(8) Educationally, older scientists compare favorably to the younger group. Of the retired scientists, 49.2% have a Ph.D. degree, compared with 41.3% of the total group. This might be explained, in part, by the fact that many of the older scientists are or were in academic life and that the Ph.D. traditionally is more esteemed, and incidentally more valuable, in terms of promotions and pay increases than in the industrial laboratory of yesterday.

(9) Of those 65 years of age and over who are not retired, 10.8% are engaged in non-scientific work. Of the retired group, 9.3% indicate that they have retired from non-scientific work.

(10) The greatest concentration of working older scientists and retired older scientists is in the fields of life science, chemistry and chemical engineering, and earth science--in that order and for both groups.

This analysis of the country's older and retired scientists is suggestive rather than definitive. I cannot tell you, for example, what proportion of the country's total of older scientists the 3,251 cards represent.

The National Register assumes that its total deck of scientists represents half of the natural and physical scientists in the United States. It is possible, therefore, that the 3,251 cards of scientists who are 65 and over represent half of the older scientists of whom there should be about 6,500. However, it is known that older professionals tend to discontinue their membership in professional societies. Also, there is evidence that the rate of response to questionnaires is

lower among older professionals than among younger professionals. Consequently, the number of older professionals included in the National Register of Scientific and Technical Personnel may be short on two counts: first, because the older people leave the professional societies and, secondly, because of their lower rate of response to questionnaires.

Plainly, the evidence is insufficient for me to give you a precise figure as to the number of older scientists, the extent to which they are being utilized, and the amount of under-utilized older talent. The best I can offer is informed guesses. I should say that there are certainly no fewer than 6,500 natural and physical scientists who are 65 years of age and older and that about 65%, or 4,225 are employed. Of the approximately 2,275 scientists who are not working, a little more than 10% are not well enough to work. My guess is that there is a pool of at least 2,000 natural and physical scientists who are not working and who are capable of working. How many of these want to return to work, and under what conditions, I cannot tell you.

I do not mean to suggest that full utilization of at least 2,000 older scientists will solve current shortages. Indeed, I hesitate to enter the lists in the debate over shortages because of the complexity and ramifications of the subject. Assuming that a shortage exists, a limited number of older scientists, concentrated mainly in fields like the life sciences where the shortages tend to be less acute, may be less of a solvent than is popularly believed. Full utilization of the older scientist will help meet the problem of shortages, but my tentative feeling is that there are too few of the older scientists to begin with, and far too few in the right fields, to make much of an impact upon the nation's manpower supply. At the same time, if a labor shortage may be defined as the lack of the right men to fill the right job, this is sufficient reason for inventorying, conserving, and utilizing skills of older scientific workers.

There are other reasons, too. (I am afraid that I have overwhelmed you this morning with statistics.) We should not lose sight of the fact that behind the statistics there are human beings. Many of these people are anxious, even eager, to be useful. The fact that they are not being utilized because of age barriers is as serious a problem to them as it is to the society they would serve.

COMPARISON OF DISTRIBUTION OF SCIENTISTS 65 AND OVER BY EMPLOYER, FUNCTION, AND EDUCATION WITH ALL SCIENTISTS IN THE NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL*

Type of Employer	No.	Percent	Industry No.	Industry Percent	Government No.	Government Percent	Education No.	Education Percent
All Scientists	86,453	100.00	43,949	50.8	15,204	17.6	27,300	31.6
Employed, 65 plus	2,050	100.00	799	39.0	338	16.5	913	44.5
Retired, 65 plus	827	100.00	291	35.2	112	13.5	424	51.2

Type of Function	No.	Percent	Research, Dev. or Field Exploration No.	Research, Dev. or Field Exploration Percent	Managmnt or Admnstrtn No.	Managmnt or Admnstrtn Percent	Teaching No.	Teaching Percent	Production No.	Production Percent	Other** No.	Other** Percent
All Scientists	74,177	100.00	36,671	49.4	13,249	17.9	11,706	15.8	2,589	3.5	9,962	13.4
Employed, 65 plus	2,079	100.00	526	26.9	399	20.3	569	29.0	41	2.0	421	21.5
Retired, 65 plus	1,172	100.00	194	26.1	147	19.8	258	34.8	13	1.8	130	17.5

Education	No.	Percent	Ph.D. degree No.	Ph.D. degree Percent	Master's degree No.	Master's degree Percent	Bachelor's & first prof. degree No.	Bachelor's & first prof. degree Percent	Less than a Bachelor's Degree No.	Less than a Bachelor's Degree Percent
All Scientists	85,986	100.00	35,513	41.3	21,600	25.1	27,373	31.8	1,500	1.8
Employed, 65 plus	2,040	100.00	996	47.3	418	24.9	566	27.4	60	2.1
Retired, 65 plus	1,156	100.00	570	49.2	216	18.6	335	28.9	35	3.2

*Figures for "all scientists" based on the 1954-55 deck of 94,000 scientists. Figures for older scientists are based on the current deck of 126,000 scientists. It is the percentages, therefore, which are significant for comparative purposes.

**Includes consulting, clinical practice, engineering economics or evaluation, technical writing and editing, patents, or library work; design, inspection, clinical analysis, testing or analytical and process control; technical sales and services or marketing and purchasing.

Mr. Ruddock: Thank you, Dr. Saveth, for that comprehensive and penetrating insight into an extremely critical problem. Are there any questions which any of the members of the group would like to put to Dr. Saveth at this time? If not, we will go to our next speaker.

But, before we do, I want to report to Dr. Saveth on a creative effort I came across the other day that has been achieved by a group of retired scientists. They felt that in this Sputnik age we needed a Sputnik martini. They devised one, and I will give you the formula as they finally worked it out: take a fifth of gin and/or vodka; put it in the deep freeze; leave it there until it reaches a temperature of 20° below zero; then take a four-ounce old-fashioned glass, drop a little vermouth into it, slosh it around, throw out any that doesn't cling to the sides; then pour in two ounces of the 20° below material; put in two ice cubes and leave them there for a matter of forty-five seconds; then remove the ice cubes and stand back, because you are in the presence of a 180-proof martini!

Our next speaker, Dr. J. Whitney Bunting, who is going to talk to you on senior industrial personnel for the colleges, was for a number of years the President of Oglethorpe University. He gave up this very important position in order to become Consultant for Educational and Corporate Support Research of the General Electric Company, in which position he has conducted a number of extremely interesting and important studies. And so I ask you all now to sit back, because you are in the presence of a 200-proof dedicated expert on the subject.

Dr. Bunting: Frankly, I should be very remiss if I failed to mention my pleasure in being with this group this morning. The facilities of this particular establishment, it seems to me, are ideal for the type of session that we are having today, not only because of the pleasurable activities we can find across the road, but for the very pleasure of being in this place of Naval establishment.

The general topic that we have is one in which I think every American should be definitely interested. I am honored at my selection as a speaker and as a participant. However, I look upon these meetings as an opportunity for me to gain valuable insight into the problems of scientific manpower development. Since I am not a scientist, I hope to take away far more material and information than I could possibly leave with you.

Let me state very clearly one or two facts in reference to my remarks for this morning session. First, this is a report on research undertaken by the Educational Relations and Corporate Support Service of the General Electric Company. As such, I am reporting only the findings that we have reached to date. We believe that we have more study to perform in order to get the most complete picture necessary for the development of a sound business program Second, nothing that I say today should be construed as meaning that a final course of action has been undertaken by the Company or that any specific program has as yet been adopted. Such a construction on my remarks would be definitely premature, to say the least. However, I can say quite truthfully, that we are encouraged in our interest by the warm response that our investigation has received from educators, other businessmen and our own professional and business managerial personnel.

A word or two here about the operation of the Educational Relations and Corporate Support Service of General Electric might be welcome. I believe that we have the only staff approach to educational relations in American industry. By this I mean that we have a fully manned and activated staff department with five components operating under the Manager of Educational Relations and Corporate Support Service. These components include research, educational program development, corporate support program development, administration, and communication. Thus, we are constantly alert to the development of new and challenging techniques that General Electric might employ to further its objectives in the field of educational relations. These objectives, briefly stated, are as follows: (1) the development of educated manpower; (2) the development of new knowledge through competent teaching and research; and (3) the maintenance of a social, political, and economic climate conducive to the continued growth and development of the American business and industrial system. Within the framework of these objectives, we are constantly evaluating new ideas that might further accentuate the job that we can do in the support of education at all levels.

Our interest in the use of retired industrial personnel for academic purposes has stemmed from many suggestions that have come to us from the educators themselves. In fact, if I might digress just a moment , one of the first things of importance to me when I left education and went with General Electric was the constant pressure that we have received from educators and

public and private universities to find ways and means of increasing the supply of talent for their faculty and business staffs.

Faced with the need for more faculty members with a growing enrollment bulge, many educators have looked rather hopefully at the American corporation as a potential talent supplier. In most instances, they have suggested that executives and professional men might move into academic life upon retirement. Better yet, they hope for some program of early retirement that might make such personnel available for a longer period of time. It is just this type of suggestion that promoted our series of research studies in this area.

You are all aware of the critical shortage of good faculty talent in many of the academic disciplines. Ever since the flight of the first Sputnik, our press has reported on the serious problems of education, with faculty development considered to be extremely serious. Moreover, in a recent study of our own, published under the title "Higher Education--A Twenty-Year Look Ahead," the views of over one hundred leading educators were tabulated: the results indicated that faculty development and retention was one of the greatest problems in college and university administration. The problem would be grave for many years to come, they informed us.

According to a report entitled "Teachers for Tomorrow," which was issued by the Fund for the Advancement of Education, I believe in 1955, about November, the total teaching force in our schools would have to expand more in the next ten years than it did in the past thirty-five. This would mean that, by 1965, we would need approximately 1,650,000 teachers as compared with the present figure of approximately 1,200,000. Moreover, at the college level, we would have to more than double our teaching force to about 400,000 persons by 1965. Neither of these figures considers the number of positions that will have to be filled as normal replacement for retirement, or death, or movement out of the teaching field. We know that it will be impossible to fulfill our academic needs by reliance upon past teacher-production techniques. It is this dilemma that occasioned our interest in the possible use of retired (or early retired) industrial personnel in the academic area.

The extension of the life expectancy of the modern individual is a well-known fact. The fact that many of our people live beyond 65 years of age has developed a growing and somewhat restive group of educated and talented people relcased by industry and yet having a vigor that should make them of extreme value to society if the proper post-retirement career could be found for them. In many cases, industries offer a permissible early retirement program at age 60 with a modest reduction in pension benefits. This group of persons, growing in number annually, has many of the experiences considered essential to the academic world both in the area of instruction and in business management and administration.

In the case of the General Electric Company, we know with a great degree of accuracy just what educational attributes our people possess. For example, out of an employed force of approximately 280,000 persons, we have over 30,000 with college degrees, many of which are master's degrees or above. Moreover, a large segment of these college-educated people are engaged in part-time teaching because of their fundamental interest in academic work and because their fields of specialization are in such short supply. Colleges, schools, and technical institutes that employ these individuals range from coast to coast, wherever there is a plant of the Company located. In fact, I personally am aware of cases where Company personnel will drive a hundred miles after work to engage in teaching where their services are needed. We believe that such people, as they near retirement, may make further contributions in the field of education.

As a practical method of evaluating the potential for an educational relations program to promote this flow of retired and early retired business and industrial personnel into all phases of academic life, two basic studies were undertaken and completed by our research component. The first undertook to survey the membership of the Elfun Society of the General Electric Company to determine, in this test group, the degree of interest that Company managerial and professional personnel had in a retirement career in education. Now this Elfun Society that I mention is an advanced professional managerial group composed of people who have reached a certain level or plateau of industrial advancement. It includes the bulk of the top managerial and professional talent of the Company.

The second survey was directed toward leading educators at the college level. They were requested to comment critically and specifically upon both the general idea of personnel shortage, the ability of retired business and industrial personnel to aid in overcoming the shortage, and the apparent qualifications of General Electric personnel to become educators as a secondary career. The degree of interest in the proposal was extremely high, and it seemed to us that the potential value of the idea was apparent. Let us summarize the results from both of these studies.

First, the results of our internal Company study: Since a survey of the entire group of General Electric's college-educated personnel (approximately 30,000 as I remarked a moment ago) appeared both too costly and impractical, the aid of the Elfun Society was enlisted to provide a test group.

The Elfun membership rolls contained a total of 7,700 names of which 6,800 were actively employed by the General Electric Company and 900 had been retired from the Company service. Since the views and opinions of retired personnel might have implications in the development of this type of program, they received questionnaires but their replies were segregated for further study and analysis. The response from both groups can be indicated by the following:

Age median for group - 44 years

Type of Company Work

(Some respondents indicated responsibility for both types of work)

Technical	63.9%
Non-technical	41.9%

Advanced Degrees

Master's	16.7%
Doctorate	11.5%

Teaching Experience

(Practically all respondents have had some experience in teaching either within or without the Company. However, much of this experience has not been under the formal control of an educational institution.)

Have had academic experience at college level	32.3%
Have had no formal academic teaching	62.3%

The majority of employees surveyed have made no plans for retirement at the present time. Only 6.9% have a definite program in mind and 27.9% indicated that they had a tentative program set up. The balance, almost two-thirds of the group surveyed, approach the retirement period with no program or policy in mind.

However, it is possible to develop some idea of interest in a retirement program from the following tabulation:

Present Retirement Thoughts	Percent Interested
Relax, travel, or loaf	14.7
Hobby or organizational membership	21.2
Some work for which personally fitted	63.6

Clearly then, Company personnel upon retirement plan to maintain a certain degree of activity and hope to develop a program before retirement takes place.

The field of education, either in teaching, administration, or research, might well serve as a basis for retirement planning according to the following analysis of replies:

After Retirement from General Electric	Percent
Definitely interested in academic work	33.4
Would consider academic work if they could get the type of job they would like	47.9
Would not consider academic work	18.3

Although most areas of teaching competence are in short supply at the present time, some are far more critical than others. It is interesting to note, therefore, how General Electric personnel might fare in this respect if they taught their specialties upon retirement. Of the more than 2,800 persons showing an interest in teaching upon retirement, this is the way their subject matter specialties would fit into the academic picture:

Subject	Number	Percent
Business Administration	896	31
Mathematics	747	25
Electrical Engineering	725	23
Physics	626	21
Mechanical Engineering	518	18
Economics	436	13

Of course, you can easily see that there are many reported competencies in two or more areas of instruction, such as physics and electrical engineering or business administration and economics. It is further of interest to note that most of the respondents felt that academic competence was increased by knowledge gained on the job. (I'll say more about that a little bit later.)

This same group showed both interest and competence in administrative and management opportunities in academic work. This avenue was pursued chiefly for the following reasons: (1) the business experience of retired industrial managerial personnel might aid the colleges in solving many of their management problems; (2) the use of retired business personnel in business functions might free other academically qualified personnel for teaching positions; and (3) whereas an industrial enterprise cannot evaluate a person's capacity to teach - and we believe should not evaluate that - it can evaluate his business experience and ability.

The interest in business and administrative functions at the academic level can be illustrated by the following breakdown of replies:

	Response	Percent of Total
Business Manager	1,025	35
Assistant to the President	742	25
Facilities Manager	648	22
Curriculum Consultant	510	18
Public Relations Director	381	13
Comptroller	267	9
Alumni Secretary	140	5
Fund Raiser	111	4

In this area, however, only a few indicated that they qualified for such tasks by virtue of academic training. Rather, they would call upon related business experience to aid in performing their chosen job duty.

Generally speaking, the participants in the survey assumed that some relocation would be necessary. However, this would not be a real stumbling block in the event that the right academic opportunity would be presented. Interest here was reported as follows:

Would desire to remain in present location	10.6%
Willing to move for right opportunity	73.2%
Location makes no difference	13.1%

So we have a rather mobile group, willing to go here, there, or anywhere for an academic opportunity.

Choice of Location	Percent
Far West Region	35.8
Northeast Region	31.9
South Region, including Florida	25.7
Southwest Region	18.9
Middile Atlantic Region	14.9
Midwest Region	13.2

An extremely interesting result of the survey was the relationship between retirement plans and the General Electric benefit program. Apparently, the thought that one might retain retirement and other benefits from the Company and yet retire early enough to make a satisfactory contribution in the field of education made a worthwhile future for many of the respondents. The following questions and tabulated responses illustrate this reaction:

Assuming a retirement opportunity should be afforded you by the Company, with retention of privileges in the various benefit programs, would you be interested in early retirement in order to enter academic life sooner?

Yes	54.0%
No	32.6%

Now, in that 32.6% were many of those who had already passed the 55 or 50 age mark; so there was very little choice for them. But it was interesting to note that many of those in the 30's and early 40's were very interested in an early retirement idea.

Appropriate age for early retirement under such a program:

50	7.6%
55	22.3%
60	31.2%

Assuming the above program to be in effect, would salary in an academic position play an important part in the decision?

Yes	27.9%
A Great Deal	8.2%
Some	50.7%
No	7.5%

Assuming no benefit plans from the Company, would you be willing to enter the academic field?

Yes	12.8%
No	23.6%
Possibly	48.4%

Now, let us turn to the second study undertaken, and only recently completed. This was our study of educator opinion.

In this investigation, a total of ninety-two leading college and university educators at the president-dean level were consulted with the results of our internal Company survey at hand. Replies were received from seventy-two administrators for a total response of 78.3%. (I should say that our response now is closer to 90% because of late replies just received.) The approximate classification of these respondents based upon institutional structure was:

Private Universities	(21)	29.2%
Public Universities	(24)	33.3%
Liberal Arts Colleges	(27)	37.5%

Sixty-eight of the respondents (94.4%) indicated positive interest in the use of such personnel to aid in the alleviation of the teacher shortage at both the college and the private secondary school level. Approximately the same number recommended continued study until such a program could be implemented by General Electric and other major employers of educated manpower in the critical faculty manpower shortage areas. Forty-five respondents indicated that they had had experience with retired personnel (principally military) and it had been very successful. In the majority of such cases, the interest is primarily in personnel for teaching rather than for administrative work, but it is indicated clearly that retirement before 65 is most essential for a program to have any real value.

Several suggested the development of a pilot program in which a limited number of institutions (preferably in Company plant communities) might participate in putting the program into operation. By this method the practicality of the idea might be proved before embarking on a large national project.

In spite of the wholehearted approval of the general idea, it would be wrong to assume that there would be no difficulties encountered in the implementation of such a program. Quite the contrary ! Most educators offered their considered opinions of the difficulties involved but felt that none of them were so serious as to be insurmountable. The major problems and the potential pitfalls raised were the following:

(1) The success of the proposal would be based upon the proper selection and screening of the candidates for transition to academic life, in other words, recognizing that everyone is not fitted to be a teacher.

(2) There should be no interference from the program in the normal upgrading of young academic career personnel. These people are not to come in at the top level and chop off the opportunities for advancement of the youngsters who are training for professorships, etc.

(3) Too much emphasis should not be placed upon the business experience of the retiree by the administration, thus causing a serious faculty morale problem. It was felt that in some cases the vice-president, let's say, of a large corporation might step into a college plant and be given a position of prominence by the president of the institution, who would rely upon him for advice and rule out the advice received from the regular faculty members.

(4) Industry personnel should expect some decline in living standards after the transition to campus life. Since we have undertaken this study we have had quite a few people in the Company who have come to us with the idea of getting one of these jobs, although we're not in the placement business. One of the more difficult things to do with these people is to convince them that there are psychic advantages in teaching that require, shall we say, a downgrading of their financial rewards. Some of them do not believe that.

(5) Industry personnel should expect a reduction in prestige and public recognition which they may have had from their business success.

(6) Colleges would have to be extremely selective, for it becomes more difficult to get full value from an individual as age increases.

(7) There is a reported danger in overweighting a faculty with older persons. This is particularly true in those institutions that pride themselves on the novelty of ideas and approaches to education. For example, one college president, of an institution that I shall not name back East, indicated that he felt that his students were so interested in the invigorating thoughts of young people that they would pay no attention to the more stable thoughts of the old.

(8) In most institutions, advanced degrees are necessity for teaching assignment, and many industrial people do not recognize that fact.

(9) Industry personnel must be educated to the realization that there is more breadth needed for the teacher than pure business experience alone.

(10) If a program of this sort is announced, a real danger lies in possible public reaction that teaching can be done by anyone regardless of past preparation and training.

I could provide you with more potential problems, but I believe these are sufficient to illustrate the fact that problems are inherent in this proposal However, if properly undertaken, most of the problems could be cured before the program begins.

The third phase of the study, now under way, cannot be reported upon at this time. This portion related to the implementation of the idea into the framework of the Company relations program. It is a slow job, for there are many problems to be solved, particularly in the pension and benefits area. However, we have the cooperation of the best minds in our compensation and benefits component, and, if a workable program can be evolved that will be equitable and helpful to all parties concerned, then I am sure you will hear more about this idea. The more I work with the idea, the more convinced I am that this project can be of real value to education, business, and society. And it can salvage so much of the talent that this nation loses when men retire to an unproductive life in their later years.

I believe that it's Alfred Hitchcock who delights in leaving a dramatic audience in the position of deciding the final outcome of a play he has presented. If I may borrow a leaf from his book, I'll leave you hanging by the same thin thread, because, as I say, we can report no further. But from our point of view, this is something that has interesting possibilities and we hope to develop it further.

Mr. Ruddock: At this point in the proceedings, I'm reminded of the story of the old New Bedford windjammer captain who tried to take his sailing vessel around the Horn but became becalmed in the Sargasso Sea. After about two months, when beriberi had broken out amongst the crew and they were

threatening mutiny and the water and food had run out, the captain was at his wits' end. He finally went down to his cabin, got down on his knees and said, "Dear God, you're going to have to help me. I'm a little out of practice because I don't recall having prayed to you since I was about six years old. You can see I'm in a hell of a fix and anything you can do to help me out would be very gratefully received. Thank you." So he went up on deck and, in a moment, saw a little black cloud on the horizon. This cloud multiplied by geometrical progression and, in the space of fifteen minutes, it covered the whole sky. And the winds came and the rains came, and the decks were awash, and the ship was about to founder. He went back down to his cabin and he got down on his knees and he said, "Dear God, this is ridiculous." And so that's the way I feel in introducing the next speaker who is well known to all of us. Dear God, it's ridiculous that I should have to introduce to you Dr. Robert C. Miller, Chairman of the Board of the Cooperative Research Institute.'

Dr. Miller: I am grateful to the chairman for the story told at the beginning of this meeting. Following two such distinguished and well informed speakers, it is rather obvious that I'll not make any points that have not already been made.

For various reasons, the paper that I am going to present to you this morning was largely written before I came here. When I was in my early 30's and at the peak of my creativity, I was able to extemporize and go on at considerable length without either script or notes. Now I am less able to do that, and I'm not sure whether it's because of lack of ideas or because I have become more critical of the output.

It's always somewhat hazardous to follow a manuscript. I think of the minister reading his sermon one Sunday morning who got into difficulty as he moved from one page to the next. At the bottom of the first page, he read "Adam and Eve in the garden," turned to the second page, then looked back to the first page, "Adam and Eve in the garden. Hmm, there seems to be a leaf missing."

Another hazard is that one is likely to repeat things that have already been said and to make some statements that he might not have made if he had heard the previous speakers before he wrote his script.

That the United States is suffering from a shortage of scientific manpower which threatens to become more acute with each passing year is too well known to require any comment from me. Less well known, or at least less emphasized, is the fact that this shortage of trained scientific personnel is acute throughout the entire Western World. Great Britain, for example, is just as badly off as we are. I quote from an editorial in the July, 1958 issue of the well known British journal Discovery:

> Material resources are valueless without human resources. If technical advance is to be fostered, we must have not only more scientists and science teachers to train them,but generally more skilled personnel at all levels. Already we are lagging behind our competitors in the supply of science and engineering graduates. Meanwhile it has been officially estimated that to maintain a modest 4% annual growth in industrial output will, over ten years, require an increase of 60% in the total number of scientists and engineers employed. Indeed, by 1970, we shall have to double our output of these graduates. This extra manpower will not be had for the asking. Children will have to be persuaded to stay on at school and to proceed to universities. A substantial switch from arts to science faculties will be imperative. Able children who are now lost to higher education via the secondary modern schools will have to be retrieved. (I was not previously aware that modern schools were the same problem in Britain that they are in this country.) Finally where are the teachers? Even according to our complacent official estimates, the teaching force, if it is to meet its commitments, must rise some six or seven thousand per year, at least a thousand of whom should be graduate science teachers for the grammar schools. Everyone, however, recognizes that, if educational standards are to be substantially improved, these estimates are certainly conservative. Science and school teaching are now immediately facing a shortage of trained manpower. This problem will extend throughout the labor force as the demands of a changing industry grow more exacting and as the burden of our relatively aging population grows.

Fortunately, widespread awareness of the situation is rapidly engendering steps to correct it. We have the Science Teaching Improvement Program (STIP) of the American Association for the Advancement of Science. Congress is giving earnest attention to a bill to provide scholarships in our universities for substantially everyone who is able to profit by such training. The National Science Foundation has been established, and, although it began with an extremely modest budget, that budget has been increased each year. I will state from my own observation and experience that the funds of the National Science Foundation have been more wisely and profitably spent than those of many private foundations with more vague and amorphous objectives.

Efforts to improve the quality of high school teaching will produce results faster than most people realize. As I stated at the past conference of our Brainpower Forum years ago, a high school sophomore who develops a real interest in science can complete his training and be a graduate engineer in seven years or have a Ph. D. in nuclear physics in ten. A well organized attack on the so-called long-range problems can considerably shorten the range.

Our immediate problem is not a shortage of scientific manpower seven or ten years hence, but the shortage right now. How are we going to cope with it today ? The obvious answer and, indeed, the only answer is to use the existing supply of scientific manpower more effectively. Dr. Saveth mentioned the fact that not enough is being done to bring job and retired scientists together. This is easier said than done, but there are in fact some practical approaches to the problem.

One of these is exemplified by the program of the Cooperative Research Institute (CORE) which was organized in 1950 for the express purpose of effectively utilizing what was believed to be an untapped reservoir of ideas, ability, experience, and knowledge.

CORE is based on two fundamental concepts relating to supply and demand for technical services. First, in industry, universities, research organizations, and in retirement, there is a vast reservoir of highly skilled professional personnel with time and ability to aid in the solution of the complex and diversified problems that face our civilization. This reservoir is composed of individuals who would welcome an opportunity to improve their professional usefulness and to supplement their income by engaging either in extracurricular research activity or in full time projects for which they might obtain leave from their regular duties. Second, there is a great need in industry, in government, and in other activities for the services of top quality, professional personnel as consultants and for the performance of team research projects.

At a time when our national well-being requires that we make the most efficient use of our existing research potential and, if possible, develop an expanded research establishment, there has been a singular lack of organized effort to solve this problem of supply and demand in a manner that would develop the full potential of the highly trained professions and in a manner which is efficient and economical., Capable as research institutes, universities, foundations, and consulting organizations are, their contributions must be made in the main by the personnel immediately at hand.

Any sort of clearing-house organization heretofore proposed has either suffered from excessive commercialism or has repelled the scientific group it proposed to aid by reason of outside administration and direction.

To use other terms, there ixists in the field of professional services a supply of a high-quality commodity possessing a large potential market but the necessary distribution system is almost wholly lacking. CORE represents an organized attempt to create such a distribution system. CORE's founders believed that the most efficient solution to the problem of bringing together the existing supply of technical and professional services and the potential demand and use for these services lay in a cooperative organization.

Viewed from the standpoint of its members this type of organization has as its primary objective the full exploitation of the various skills of the members through advisory consulting and research work which will be interesting to them, which will further their professional careers, and for which they will be paid. The working nucleus of CORE is drawn from a group of several hundred scientists, engineers, economists, and other professional personnel. They are on the staffs of universities, scientific institutions, and industrial organizations, both in the United States and abroad; some are self employed and some are retired. A recent index of CORE members' areas of competence lists over two hundred fields of sp;cialization. For projects of long duration, persons on institutional research staffs are often able to obtain leaves of absence from their regular employment. The change is stimulating and has some of the advantages of the well known university sabbatical. Many projects have been carried out by CORE utilizing members on a part-time or extracurricular basis.

From the viewpoint of the client, the cooperative plan offers the highest quality of talent to solve special problems with an absolute minimum' of overhead and with no burden for unused time. In general, the details of promotion, association, accounting, and research administration are handled by CORE's central organization. The creative and technical work on a CORE project is performed by CORE members best qualified for the particular project in question. The work may be done in the member's own laboratories and offices, in the plants or laboratories of the clients, in the field, or in facilities provided by the Institute as the needs may require.

In some instances, the fees for this work are paid directly to CORE members by the clients. In other cases, government research contracts for example, contracts are negotiated by CORE and tailor-made teams of the best qualified CORE members are formed as project organizations and provided with the facilities required for maximum efficiency in accomplishing the work desired. The objective in every case is to develop the working method and plan best suited to the particular set of circumstances, permitting the maximum efficiency and productivity of the member consultant and providing prompt, productive, low-cost service to the client.

An early CORE project performed under a contract awarded by the National Academy of Sciences-National Research Council involved fourteen members of CORE, each representing a different university and a different academic background. This group made a study of applied research in the United States and prepared a report which is used in technical assistance programs all over the world. Recent projects include a study of the vertical structure of wind for the U. S. Air Force, a port facilities study for the Department of the Army, a Marin County Master airport plan accomplished for the Marin Development Foundation, an evaluation of radiation damage to bone structure for the U. S. Naval Radiological Defense Laboratory, a study of cylinder fillers for the California Oxygen Company, and the development of a creative engineering group for the Rheem Manufacturing Company.'

Some comments from CORE members may be in order. Dr. Arnold Court of the University of California states:

> Originality in solving a problem is much more likely when the team that is working on it is made up of men with widely different backgrounds and experiences. In the CORE way of doing things, each team is made up anew and often the members have not seen each other before. In contracts, the unual research organization has standing groups which work together on the job after job, tending to handle each one in the same manner. Enthusiasm is the chief benefit of a cooperative arrangement for research. Competence is assured because CORE has no permanent staff which must be kept busy. Ideally CORE accepts only those contracts in which it can assign members who are particularly qualified and who therefore will be deeply interested in the work.

Dr. John H. Frederick of the University of Maryland writes:

> I have always regarded CORE as the clearing-house for scientific manpower, particularly manpower which has retired from more active work and which is centered in the universities where we have little opportunity to come into direct contact with those who need our services.

As a result of an idea developed at the first Brainpower Forum here two years ago, CORE has devoted increasing attention to the utilization of the large reservoir of ability and brains represented by our retired scientists and engineers. For a number of complex reasons, a tendency has developed in recent years to retire persons in business and industry and the Armed Forces at an increasingly early age. This trend is not likely to be reversed. It means that there are more and more people of the highest training and experience who are still in full physical and intellectual vigor (I use this description advisedly because I myself was born in the late nineteenth century) who have time on their hands. This is a situation I at the moment envy but may conceivably live to regret. Medical science is not only increasing the span of life but increasing the activity and the potentialities and the productivity of people in the upper age brackets. It is also a fact, which medical science should investigate, that people of superior ability often tend to be long-lived and retain their physical and mental vigor.

I call your attention to the late Bailey Willis and the late Andrew Lawson, professors of geology at Stanford University and the University of California, respectively, who quarreled with each other enthusiastically until they were both past 90. I call your attention to the late D'Arcy Wentworth Thompson, famed Scottish zoologist, of whom his daughter has recently written that, when he was well in his 80's, he could dance until the middle of the night and come downstairs the next morning refreshed and rested. I call your attention to Winston Churchill who was called out of retirement in Britain's hour of need, and I don't believe anyone complained that the job called for a younger man. To get closer to home, I call your attention to Admiral Spruance and Admiral Stone, Remsen Bird and Joel Hildebrand, and, last but not least, in this galaxy of national and international celebrities, Joseph Thompson, the senior young man in this group present today.

Now, having made my point, let me be more specific as to certain methods of organizing and utilizing senior brainpower. A few years ago, CORE, in co-operation with the California Academy of Sciences, established the San Francisco International Science Center to serve as a receiving station for visiting scientists and engineers from abraod, to help them make out their itineraries and programs, and, in general, promote cooperation between American scientists and engineers and those from other countries. This venture proved so successful that it led to the formation of the International Science Foundation, which then assumed the responsibility for the maintenance of this center and the establishment of other similar centers.

As a service both to visitors from abroad and to local institutions, the International Science Foundation sponsored the publication of a handbook of the scientific resources of the San Francisco Bay region which proved so useful that it has now gone through two editions. In organizing this handbook project, the Foundation negotiated a contract with CORE to handle data compilation and editing, and CORE, interestingly enough, found many senior engineers and scientists who were interested in participating in the project. The included a retired vice-president for research of CIBA and a retired secretary of the American Institute of Mining and Metallurgical Engineers. In other words, here is a definite example of channeling senior brainpower into an important and useful activity. Recently a Los Angeles International Science Center has been established at the California Museum of Science and Industry, whose Director, Don Muchmore, is present at this conference. The significant fact regarding this center--one significant fact--is that its recently chosen director is a member of CORE, Dr. Robert E. Vivian, recently retired as Dean of the School of Engineering of the University of Southern California.

It is the hope and expectation of the International Science Foundation, with CORE serving in effect, as its research arm, to establish similar centers throughout the United States to a total of perhaps ten. It is clear from precedent and example that these centers can serve as focal points for the organization and utilization of senior brainpower. California now has two such centers in its two largest cities. The establishment of similar centers elsewhere is recommended as a desirable objective. They should be adequately financed, by the Department of Defense, the National Science Foundation, by private foundations, or by business and industry.

Mr. Ruddock: Thank you very much, Dr. Miller, for that succinct report on CORE and its activities to create more interesting professional opportunities for our senior scientists and engineers.

This brings us to the end of what I know has been for all of us a very stimulating session. I should remind you that we will foregather at twelve noon when Richard Rheem will take over the "prayer meeting" and Dr. Henry David will tell us how to make brainpower respectable.

LUNCHEON

Mr. Rheem: Good afternoon, gentlemen. I have been talking to our speaker, a most stimulating gentleman, and I am looking forward to his talk today. He is a most distinguished, able, and learned speaker, as you all know.

Dr. Henry David, the Executive Director of the National Manpower Council, is also a professor of economics in the Graduate School of Business at Columbia University. He has worked primarily in the fields of American labor and economic history. Before coming to Columbia, he taught as a history professor at Queens College and City College in New York. During the war years, he was in charge of research and intelligence at the North American office of the British Broadcasting Corporation and, after the war, was the BBC's advisor on American affairs. He has served as a consultant for various organizations, among them the RAND Corporation.

Dr. David is the author of numerous books and articles and is editor of a nine-volume economic histroy of the United States, now in progress. The National Manpower Council was established in 1951 under a grant from the Ford Foundation. Since that time, when he assumed the post of its Executive Director, he has played a leading part in the preparation of the six volumes which the Council has published to date: "Student Deferment and National Manpower Policy," 1952; "Policy for Scientific and Professional Manpower," 1953; "The Utilization of Scientific and Professional Manpower," 1954; "Policy for Skilled Manpower," 1954; "Improving the Work Skills of the Nation," 1955; and the last, of which I approve heartily, "Woman Power," 1957.

It is a great pleasure, Dr. David, to present you to our distinguished group.

Dr. David: You have been told that I would address you on "how to make brainpower respectable." I hope you will feel no offense if I say this is not what I intend doing. Frankly, I believe that such efforts as have been devoted to this purpose represent a serious waste of manpower, time, and energy. "Making brainpower respectable" has no more to recommend it as an undertaking than such equally dubious ventures as "making brainpower happy" or "making brainpower loved."

I was quite willing to accept the assignment to speak to this theme, however, for several reasons. One is of trivial significance, namely, I was captivated by the possibility of representing something called "brainpower" as a fallen woman and setting out the details of a program by which she might achieve high respectability in a community which had obviously never appreciated her lowly life and proposed to make her pay penalties for her misdeeds and failures.

I should immediately confess that it strikes me as rather strange that people who are concerned with something called "brains" should also be concerned with the problem of making them respectable. I suppose it is safe to say that a fallen woman attains respectability by acquiring an impressive amount of money, influential friends, or by making restitution to society for her past misdeeds. The parable of rehabilitation which I merely suggest could easily be sketched in greater detail, and it might provide some illuminating insights into some of the problems which give rise to this conference. But, for a serious meeting such as this, it is becoming to use the title of my remarks as a springboard for commenting on some of the important questions with which those of us who are troubled by the state of the nation's manpower resources must deal.

If we are concerned with the production of brainpower, we must recognize that this, like other purposive efforts by society to increase the output of goods or services, raises questions about the allocation of scarce resources. It would be agreeable to believe that the resources required to produce more people of high ability who are capable of high performance are much greater than they are in fact. True, we are not making full use of the resources which are available for this purpose, but the first point of reference is, nevertheless, that we have to make do with relatively scarce resources. That is, the means of our disposal for attaining the goal of enhancing our resources of brainpower are always likely to be more limited than we would like them to be.

This notion of setting the problem in terms of the allocation of scarce resources is the first of several commonplaces on which I want to touch. A second commonplace is that the production of brainpower may be stated as a single goal, but that it can only be dealt with as an endless series of targets and that there are many ways to hit those targets. Moreover, not all the targets have to be hit dead center. Much can be done by way of indirection,

for what we want is a long-term outcome to which a great variety of developments can contribute. Perhaps the rule we should follow is to avoid stating the problem as if it were susceptible to direct, headon attack and solution. Unless we want to invite misdirection of our efforts and frustration, we must recognize that the exhortation "let us solve the problem of respectability" is as pointless as equivalent injunctions to "solve the problem of peace" or the "problem of unhappiness."

At this point it is useful to reflect for a moment upon the meanings of "respectable" and "respectability." The idea of being respectable means worthy of respect, deserving of esteem, of regard. But it also signified "good" or "fair" social standing or repute. Thus we speak of being respectable citizens and being respectable in our social relationships. When respectable is used in the sense of size or number, however, it signifies "considerable." On the other hand, when it is used with regard to performance or competence, it means "moderate." Thus, when we say, "He gave a respectable performance," we mean that the performance was competent but fell short of excellence. If we say of someone that he is wearing a respectable coat, we do not mean that the garment is in any way exceptional, but that it passes muster. Thus, the words "respectable" and "respectability" involve ideas of the exceptional and the excellent, of the ordinary and the mediocre, and, finally, even of comfort, that is, of comfort for the individual and for the social group.

This leads me to note my distress that anyone should set for himself as a worthwhile purpose having society at large feel comfortable with the man of brains, the scientist, the poet, the composer, or the artist--or, alternatively, wanting to make certain that individuals of unusual ability and great distinction are concerned with their acceptance by society on the score that they are really like everybody else, that they are not deviants.

You are perhaps familiar with a survey conducted by Du Pont which studied some 2, 400 of their technical, technological, and scientific personnel. Data were compiled on their age distribution, marital status, children, former residence, religious affiliation, social activities, and the like. (I might mention, incidentally, the comment in the report of the study to the effect

that at least two members of the group did not spend all of their time working for Du Pont because each had produced seven children!) The major finding of the survey was that this group of employees was not very different from other Americans. Perhaps they were even more like Americans than other Americans, for more of them went to church, engaged in civic activities, and had more schooling.

What is significant in all this is that there was apparently a felt need to demonstrate that scientists, technologists, and technicians are just like everybody else, that they are not "squares" or "hermits." The important point is they they are not like everybody else. To the degree that they matter as "brainpower," they are different. And to disguise the respects in which they differ and play up social and other characteristics which they share in common with many of their fellow citizens is to obscure their functions and the reasons why people of high ability and competence have to be thought about differently. One way not to think about them, it seems to me, is in terms of the loose notion of making them respectable.

I have already implied what I understand by the term "brainpower." This, like the terms "manpower" and "womanpower," is an abstraction which makes it easy to forget the reality with which we are concerned--human beings, men and women, possessing peculiar traits and qualities which are frequently not amenable to classification, who refuse to stay put in the neat categories into which we place them. It will help us, therefore, to think not of brainpower but of individuals who are differentiated from others by virtue of high abilities, unusual capacities or skills, high performance. They are individuals marked by greater or lesser degrees of creative power who occupy positions of strategic importance in the society by virtue of the functions they perform.

How large a group are we talking about? In a strict sense, we do not know. If it is the very top group in terms of the characteristics I mentioned, it must by definition be very limited in size. Thus, according to the Office of Education, the top 2% of the school-age youngsters in terms of ability represent a group of about three quarters of a million people. I think, however, that we are concerned with a much larger proportion of the population, the top 15% or 20% who, because of their ability, warrant the investment in education and

training necessary to prepare them for functions and activities which fall to a relatively small number of people in society and who are capable of high orders of performance.

It is not, I believe, naive to ask, in relation to one of the meanings of respectability, whether this group wants to be liked or has to be liked. In many of the gatherings in which I find myself, I hear murmers that teachers, scientists, scholars, and the like are not being properly understood, appreciated, or even loved. These complaints may be wholly justified. No one, I suppose, is every adequately loved or appreciated except by himself. My interest in the apparent need to be appreciated and liked is the light it casts on the yearning for prestige, status, and esteem and on the bearing of that upon the marks of success shaped by a market economy.

It is proper to ask to what extent the group about which we are speaking is in fact or could be successful in conventional terms and what the implications are of the self-conscious search for improved status on the part of professional interest groups. This second development suggests the emergence of a kind of guild society in which each specialized occupational group seeks the power to prescribe exceptional treatment which the group is to receive from society at large. The model I have in mind is the position already secured by medical doctors, who, through their professional society, in effect determine large areas of public policy. The question is whether it makes sense to multiply the number of equivalents to the American Medical Association.

Our concern with the individuals who are exceptional in their abilities, skills, and performance, that is, with brainpower, prompts me to comment on the relationship between them and the unhappy group labelled "intellectuals." If one wants to be uncharitable, one can simply define an intellectual as a person who makes a living by the manipulation of language. More seriously, an intellectual is one whose life--and perhaps also his living--turns on his ability to fashion or manipulate ideas. Ideas are his focus of interest and his currency. I would like to suggest that all intellectuals fall into the brainpower category but that not all the individuals in that category are intellectuals. I am arguing that,

in a highly specialized, technologically advanced culture such as ours, there are many individuals of high ability and exceptional skills and competence who seem not to be interested in ideas as such. The application of their skills to specific tasks involves the manipulation of ideas, but they appear to divorce themselves from the life of ideas. They are, so to speak, craftsmen, not artists, technicians, creative scientists.

I do not want for a moment to denigrate their significance, for I am persuaded that society must depend more and more heavily upon larger and larger numbers of people who fall into this highly skilled group of individuals who are essentially craftsmen, who work with great effectiveness with the tools of their metiers, but who are not necessarily engaged by theoretical problems in their field of work or by ideas in general. They have only a tenuous attachment to the life of the mind. As society comes to depend more decisively upon their skills, it becomes increasingly easier for them to win higher status, to win respect, while they remain free from what may be called moral responsibility for the purposes of their work and from a commitment to values of intellectual activity. It is painful to recall that about 65% of the professional, scientific, and academic population of Germany had little trouble in accepting the values of Nazism after 1933 and the tasks to which the new regime assigned them.

I have dealt sharply with the title of my remarks. But I do want to make it clear that the idea of "making brainpower respectable" is not without significance in connection with the part which the attitudes of individuals and groups and which motivation play in the development of highly trained manpower. I might remark, parenthetically, that many of us have found in the notion of motivation a most convenient explanation of why things go right or wrong with individuals. Paul Woodring tells a delightful little story in a footnote in his book, One Fourth of a Nation, which suggests what I have in mind. It is a story about an extremely bright college sophomore who managed to be a consistent "D" student and who was on the point of being flunked out of college. In his interview with Paul Woodring, the young man remarked with all seriousness: "I don't know what's wrong with this faculty. I've been consulting with the Dean of Men, the Director of Student Personnel, and now with you, but I still get D's, no one seems to be able to get me motivated."

It is a commonplace that attitudinal and motivational factors are crucial in the complicated process of occupational choice, although we still have a great deal to learn about their distinctive roles and the process itself. The idea of respectability has to do with systems of rewards and incentives and prestige and status, and, consequently, with attitudes and motivation. But if we argue that all of these items--rewards, incentives, prestige, status, attitudes, and motivation--are somehow not properly geared to produce the brainpower the nation needs, we should also recognize that we are deploring the values of society and the nature of its culture.

To induce a larger part of the available supply of able youngsters to enter fields of scientific endeavor constitutes a difficult problem. Nor is it easy to make certain that a larger proportion of able boys and girls complete high school and go on to college, that more women graduates go on to graduate study, or that individuals are effectively utilized in relation to their skills and capacities. Problems of this kind, I suspect, have no final or permanent solutions; they are susceptible only to a series of transformations. However difficult they are to cope with, they are all much smaller, neater, and more manageable problems than the problem of changing the whole culture so that they never appear in the first instance.

If there were not implicit in so many approaches to current manpower problems the naive and misleading assumption that manipulatory techniques of an advertising and promotional nature provide keys to their solution, I would not pause to emphasize this self-evident point. Obviously, no one should be impeded for a moment from saying: "I would like our culture to be different from what it is; I have values which society at large does not share, but which I wish it did; and I will try to persuade others of their merit." But it is something else again to believe that a Madison Avenue firm can or should be charged with the task of manipulating the culture or of solving problems of highly trained manpower, with the only question being the size of the budget available. I have seen proposals, as I imagine you have, which asserted, in effect, that problems of scientific manpower shortages can be solved by a public relations program or by an advertising and mass media informational campaign.

It is worthwhile to set the current concern with manpower in perspective. For practical purposes, it may be dated from the report of the President's Commission on Higher Education about a decade ago, which raised fundamental questions about the relationship of education to anticipated needs for highly trained manpower. The Korean hostilities stimulated interest in manpower demand and supply relationships and forcibly reminded people of some manpower lessons of World War II, particularly with respect to shortages of highly trained personnel and to the high rejection rates on educational, health, and other grounds. The preoccupation with manpower requirements and resources has grown tremendously since then and has pointed to the need for developing sound, long-range policies for enhancing the nation's manpower resources, both quantitatively and qualitatively. This need may be stated in another way: "How can a free, democratic society invest in its manpower resources so as to insure their more effective development and utilization?"

Historically, the earliest forms of investment contributing to this end took place in the fields of education and health, but by and large we in the United States long took it for granted that open immigration and population growth would satisfy the nation's manpower requirements. Interestingly enough, early in the twentieth century, at about the same time that there was a movement for the conservation of natural resources, there was a movement for the conservation of human resources which aimed at reducing the number of preventable deaths. Its primary targets were accidents, industrial illness, and epidemic and endemic disease. Only indirectly was it concerned with maximizing the nation's manpower resources in terms of more effective developmental processes and utilization practices.

Part of the American dream is the promise of self-development and self-fulfillment. Embedded in the reality of American experience has been the denial of that promise to millions of our citizens. We are now perhaps for the first time in a position to grasp the full import of the promise and to understand the means by which it can be translated into reality.

The social forces and institutions involved in manpower development and utilization alter in their nature and impact slowly, except in periods of great emergency. To understand this is to realize that there are no quick ways of securing great and striking gains in the numbers of able people capable of high

performance and that, in the short run, one has to play for relatively small gains which may, however, be quite significant. Dr. Saveth indicated how modest is the national reservoir of retired scientists and engineers upon which we might draw in times of acute need. Yet it is also true that the shortage of a particular firm or research lab might be effectively relieved if only one or two individuals could be recaptured from the reservoir of older personnel. I have heard Dr. Lee DuBridge emphasize how critical a shortage of one or two key people can be.

Beyond the short-run gains at the margins, of course, are the changes in manpower supply which can be brought about only over the long pull and which involve the major institutions of society and the operation of underlying social forces. Once we look at the problem of highly trained manpower in long-range terms, we are brought back to the bearing of the values attached to intellectual work and the intellectual tradition in the United States and of "respectability" upon increasing the "production of brainpower." Most serious European observers have, rightly or wrongly, generalized about the strength of the anti-intellectual tradition in American culture and have been able to cite evidence supporting this finding. It is true, of course, that Americans display some measure of indifference to, if not scorn of, the man whose achievements are not physically visible, quantitatively measurable, or do not take the form of enterprises designed to produce goods and services. But this is only part of the story, for at least as salient a feature of American life is the tremendous faith which our people have had and continue to have in something called education even when they are, as they seem to be today, less than content with its products.

In the American tradition, education provides the mechanism for secular salvation, economic and social, as well as political. But there are no educators in the galaxy of American folk heroes, just as there are no scientists, painters, musicians, or writers. The heroic figures include several generals, politicians, perhaps a technologist, a number of villains, and, of course, mythological figures distinguished by their great physical strength, the John Henry's and the Paul Bunyan's.

I do not find this shocking. Men of brains, of ideas, of creative aesthetic powers offer poor clay for fashioning folk heroes. Perhaps we ought to ask whether it is necessary for them to enjoy high prestige and status, to be accorded a respectable position, so to speak, in society at large. The criteria for appraising their achievements are not familiar to nor can they be applied by all of us. They are known to and comprehended by relatively small, highly specialized universes. Their prestige and worth are not determined by the population at large or even a numerically important part of it. If I were a young physicist, I should hate to think that I was competing for fame and attainment with a James Dean, for example. Even the posthumous appeal of that young movie actor is frightening, for it is reported that his grave has about three thousand visitors annually, that it is constantly covered with flowers, and that death masks of him sell easily at $30 a piece. For reasons which escape me, there is a James Dean cult. Can anyone imagine an Emerson, a Willard Gibbs, or a Horace Mann cult?

I do not want to be misunderstood. I am not for a moment suggesting that every one should genuflect before the life of the mind and the works of the mind. In a pluralistic culture there are competing values, tastes, and even hopes. We need not yearn for a situation in which our men and women of unique talents and exceptional attainments receive mass adulation. We do, however, need a series of literate universes in society which understand the functions they perform and mediate between them and society at large. We put a heavy premium on income, security, and deference in the United States. Harold Lasswell has pointed out, I might add, that over-preoccupation with these is one of the marks of neurotic behavior. Perhaps we still have to learn the particular meaning that these values and goals have for the individuals who are exceptional by virtue of their ability and performance in the realm of ideas. Patently, we should not ask them to make personal sacrifices for the privilege of doing what they want to do and what we need them to do, namely, to play a central role in the process of continuous change which characterizes our society and culture. A Nobel Laureate or a competent professor of mathematics does not have to be paid in the same coin as a vice president in charge of sales, but he need not be penalized for his devotion to a purpose which the few rather than the many appreciate.

In brief, my contention is that we have not yet found out what systems of incentives, rewards, status, and prestige make sense in relation to the nation's needs for brainpower; that when we do, we will discover that they are somewhat at odds with the dominant values of society; and that we will not find many clues to what they are in conventional notions of respectability. We need a new kind of literacy in the United States, a literacy that bridges the gulf between popular knowledge and specialized knowledge so that the functions, not necessarily the achievements, of those who are altering the world in which we live are sympathetically understood. Out of this kind of literacy, which must flourish in government, industry, and the armed services as well as in the academic world, there will hopefully emerge new meanings for "income," "security," and "deference." More important, there will also emerge a respect for the men and women whose work challenges old patterns of thought and knowledge, reshapes the world in which we live, tells us in effect that our "common sense" and our familiar reference points do not serve us well--in short, a respect for those who disturb us and make us uncomfortable.

PANEL

on

BRAINPOWER PRODUCTION

Mr. Ruddock: In opening, I wonder if I could tell you a little story about Washington that just came down from the Grove. There recently was a report of a harried bureaucrat there who was beginning to show signs of strain. Accordingly, he was sent to a psychiatrist for a checkup. The psychiatrist took a piece of paper and a pencil and drew a circle on it. He asked, "Now what does that remind you of?" The man said, "A naked woman." So then the psychiatrist drew an isosceles triangle, inverted, and asked, "Now, what does that remind you of?" The man said, "A woman without any clothes on." Then the psychiatrist drew a quadrangle and asked, "Now, what does that remind you of?" The man replied, "A nude female." "Well," said the psychiatrist, "I don't think we need to proceed any further. It's perfectly obvious what your problem is. You're over-sexed." The man said, "Me over-sexed? So who's drawing the dirty pictures?"

Now, none of these things, I don't have to assure you, are true of our next speaker. Dr. C. Mansel Keene, Chief of the Standards Division of the U. S. Civil Service Commission, made a mighty contribution to the first Forum held here two years ago, and, in view of his distinguished performance on the last occasion, we are all the more excited about the fact that he will be here today to lead, in a panel discussion on Brainpower Production, the minds of five very eminent men. I turn the meeting over to Dr. Keene.

Dr. Keene: I sort of resent the fact that sex has left my life and that it has become obvious!

We have a most distinguished panel, and we have been beset by the same problem that all panels have: we have gone through a period characterized by a certain degree of hysteria that we wouldn't be able to solve all these problems in the time available. You understand, however, that it isn't due to any lack of competence on the part of the panel but only to the short time available. We have to get off the boards here in a set time to let Mello and company complete the solution of the problem. Anything we don't do, Mello and his associates will do later. So we'll screw it up to start with, and he will unscrew the inscrutable a little later.

First, let's talk a bit about our panel so that you may know its members. Immediately to my left, we have Mr. Reynold Johnson, who is the Manager of the IBM Research Laboratory in San Jose. Next to him we have Mr. Vernon Pick, an ISF Governor whom all of you know. Next to him is Dr. Austin Frey, head of the Physics Department here at the Naval Postgraduate School. Then Mr. Dorman, who's the Manager of Industrial Relations of the Bechtel Corporation. And last, but far from least, we have Dr. Remsen Bird, President Emeritus of Occidental College, mainly occupied these days, I understand, with matters in the local community.

There are several facets of this problem which we could devote our attention. I think that the luncheon speaker showed us some of the larger dimensions, as have some of the other speakers. In its preliminary sessions, the panel has concerned itself with some of the marginal and fringe points as well as the problem at hand. I'd like to say, by way of starting, that, when we consider a perspective the question of education, the question of public attitudes, and the question of how we are going to produce more manpower, we must think in terms of the fact that we are starting from a social structure where we've already had a great deal of education and where one of the manifestations of society is that some of the worst friends of education are those who have been educated. We must start with that as a premise. I don't like to use personal anecdotes, but let me just give you one.

Many years ago the president of the university from which I graduated thought that it would be very fine to provide a better intellectual environment in the city where I was residing by having closer liaison between some of us "old grads" in that particular city and the college. All of us were very suspicious at first because we thought this was just a new way of touching us for funds. But it turned out that the president actually had a serious intellectual interest. (Perhaps he had a pecuniary one, too, but it wasn't manifest at first.) He suggested that we get together from time to time as an alumni group in this particular city and that we ask various campus authorities in to further our own consideration of a whole host and variety of problems. I undertook, as one of the committee, to arouse some

interest in the community. One of my friends, who was a school administrator, said, "You will find that there is no opportunity to get the Sons of the Stanford Red really interested in the kind of intellectual endeavor that you're talking about." I told him that he was negatively oriented and went off with bright and burnished shield to tilt with ignorance. It turned out to be more than I had a shield for. We had a meeting, a luncheon, with about eighty of the leaders in this particular city. We found no responsive note until a gentleman stood up, one whom we hadn't put in the audience. But he was the only one there who had something to offer. He said, "The thing that bothers me is why in hell more of our local high school graduates don't play on the Stanford football team." Now this struck an extremely responsive chord, and it seemed to me that the common denominator of the attitude of the group was pretty well demonstrated.

It seems to me that, as we think in terms of how we are going to improve the production of our intellectual manpower, we have to think in terms of the three types of education. First, that of the specialist, the researcher, the dreamer, the man who cannot be completely oriented to the goals of contemporary society, who must go beyond our current preoccupations; secondly, that of a development group, the interpreters, those individuals who are putting into effect in contemporary society the ideas which the men on the frontier have been spawning; and then thirdly, that of a large group of consumers who are preoccupied with day-to-day tasks just as ordinary citizens in a society.

I don't want to take issue with the dinner speaker last night, but he was concerning himself almost entirely with the first group and extrapolating to a total society things which would be true of a very atypical portion of that society. To the extent that--going back to my opening remarks--we as a society are beset by the less than mature attitudes of our college graduates, it will in large measure be because they themselves have not seen the relevance of some of the education that they themselves have received in terms of the on-going progress of this society. If we were starting with a group of Ubangis, I think we would be in much better condition because we wouldn't be laboring under the illusion that anybody was educated.

I am always reminded, when you start with problems of this sort, of Thurber's very trenchant observation showing the interrelationships of forces: thousands of people are kept busy cutting down elm trees to house people who are driven crazy by the cutting down of elm trees. There is a cyclical interrelationship here which makes it rather difficult to tease out the causal factors. But we shall try, within this overall framework.

I'm sure the panel accepts no responsibility for my remarks, nor I for theirs. In fact, we got together yesterday a couple of times to find out what we felt very strongly about--and there are some very strong feelings. My role as moderator from here on will only be to try to bring this to a conclusion an hour from now and to interrupt the panel members to the extent that they impose on each other's time.

Some of the areas that we consider worthy of consideration include what we naively identified this morning as motivation; after lunch now, we may want to use a better word. Let's call it "Element X," since motivation has been so broadly defined as covering a multitude of sins, as the term "personality" does. One of the things in which your panel found some interest was this whole area of how we motivate our resources. Another was how we get more teacher resources. Still another was how to separate education as a real and abiding thing from the "practitioners" of education, who sometimes think of education with a capital "E." Another has to do with the general area of how well we as a society are going to utilize the talents which come from our universities.

Mr. Johnson, how would you like to expatiate for a bit here on your theories of how we can get more and better teachers? All of us recognize that there aren't enough.

Mr. Johnson: I had more ammunition before Dr. David's speech than I have now. I may have to preface my point of view a bit.

I'm assuming, in this matter of the production of brainpower, the production of a very large amount of brainpower. I am assuming that we are not talking about the two or three people Dr. DuBridge speaks of. I couldn't agree with any remark more than that which points out that it takes two or three people to kick off anything that is worthwhile. However, things get done by quite a few

people solving small problems and people carrying banners in large numbers for important missions. Therefore I shall speak of the production of brain-power in the middle range of people, people in the 10% to 3%, in the upper bracket of competence, rather than the people at the very top. As was indicated this noon, this problem of manipulating 160 million people, including the 45 mission people in school, is such a very formidable job that it seems almost fruitless for a small group here and there to be talking about how we can get more effective engineers and scientists.

Consequently, I am rather inclined to go right smack to the point and say, "Let's pay more money." Let's start right out at the beginning and say, "What we want are better teachers so that they can motivate better scientists." And frankly, I don't know of a more direct way to get better teachers than to pay them more. Now, it is true that paying in itself, that money, doesn't particularly buy anything of value in the spiritual sense. But I find that the best preachers, the best religious leaders, the best missionaries, the best politicians, the best college presidents, and the best scientists get paid the most. We can extrapolate into the teacher bracket.

I think we ought to do something about it right here at the beginning. My suggestion of something that might be done, beginning at this conference, is simply to start preparing and publishing what we think are good salary ranges for people who are to teach the youth of tomorrow. Let's tell Tom, Dick, and Harry on the school board, the superintendent, and the politicians that good teachers should be paid, let's say, $10,000, and that good policy-makers on the school board and on the school superintendent's staff should be paid $20,000 in a community of reasonable size.

Now, this is not going to change things in the same sense that Sputnik did. There is no question but that Sputnik has a motivation power that no money can buy. But money can buy quality in the long run; the rewards count and are measured by the salary and income in a large measure. And, therefore, I think we ought to cope with this problem with directness and courage. We must try to find out how we can get those responsible for hiring and selecting teachers to pay them more.

This is my main thesis. There are some who don't agree with me on this point, but it is the point that I would like to make at this time. So, without further ado, I'll turn the discussion back to you, Dr. Keene.

Dr. Keene: Dr. Bird, you've been a consumer in this area. You've had teachers working for you. You know that they have a number of goals, a number of attitudes. What's your reaction to Mr. Johnson's idea?

Dr. Bird: I've just finished reading two books that have come to me from Lee DuBridge. One of them is The Next Hundred Years; the other one is The Challenge of Man's Future. They were done under the direction of Harrison Brown, a very distinguished scientist, by his associates at Cal Tech. These men who are research scientists have much to say about the need for the training of expert scientists. Much is said about the need for engineers. I was astounded, and I think especially pleased, to note that it was not the engineer or the scientist that Harrison Brown was emphasizing; it was creative imagination and creative intelligence.

I recall a conference at Pomona on the question of the humanities several years ago. There were two speakers. One of them was the president of the Chamber of Commerce in Los Angeles, and the other was an old mar of about 82 or 83 years of age, a man named Webb who was the Headmaster of Bell Buckle School in Tennessee and who had been appointed a Senator at the time there was a vacancy in the U.S. Senate. The president of the Chamber of Commerce became very enthusiastic about the fundamental need for practical education. "What we need in college is people who are practical," he said. "What I would like to have my son possess, if he goes to Pomona, is the ability to milk a cow." Senator Webb replied that he thought that the ability to milk a cow was very important, but that he would like to have his son be able to do something that a calf could not do better.

My wife has a cousin who works in The Sangamo in Springfield. He graduated from Springfield High School and had certain special qualities of patience and an interest in mechanisms. When he went into the Army, the Army used him in recovering the tanks that were smashed in Bastogne and other places. When he returned to Springfield after the war he was assigned to a "hush-hush" laboratory there. Around him stand the scientists, the very smart

boys who figure it out. Inside there is a circle of engineers, who apply what the scientists have learned. And Harold sits in the center, putting wires together. Not a one of these great men around him could do what Harold does.

We need scientists, we need engineers, and we need technicians. It's my impression, from what I read and hear, that one of the places where we are falling down in the U.S. is in training those who have the ability to put into operation the things that the smart boys have designed and the research scientists have brought into reality.

Now, taking up what Mr. Johnson says--of course, teachers need more money. But I don't think that's the governing need of teachers at all. One reason why we have an inadequate supply of talented ones if the lack of status and prestige of the teaching profession. I know a great many people who would be perfectly willing to teach for very little money if they had adequate laboratories, adequate libraries, adequate facilities, and if they felt the dignity of their office in the community. I think that there has been so much suspicion cast around, so much fear that the teacher is going to teach something that is going to hurt somebody and make him a "pink" that we have lost the feeling for the diginity of the teacher in the community. And, as important as it is that one should have bread and meat and the means of caring for one's family, I think it's relatively less important than the dignity of the office, adequate equipment to do the job, and the right to go where the truth leads.

Dr. Keene: We got talking this morning in our pre-panel session about some of the things which would inspire a teacher to communicate some of the things which Dr. Bird has been talking about. Dr. Frey, you have some ideas in this area. Would you like to carry on?

Dr. Frey: Well, in the first place, I might say that I heartily agree that we need the people who will put into operation the ideas others have developed. There is no question about that. The problem is how to find them.

It seems to me that we are wasting a lot of potential talent. We fail to discover this talent in the grammar school and the high school. And why haven't we discovered it? I think the primary reason is that we haven't adequate teaching staffs to inspire it. The teaching staff is very frequently, if

I may say so, overloaded with education and underloaded with knowledge in its own field. The poor teacher is not to blame.

I am reminded a little of the notice above the bar in the days of the 49'ers: "Please don't shoot the piano player. He's doing his best." And this is what the teachers are doing. They have been required to get some advanced education in order to get more money. I insist that this is important to them, and perhaps merely for the reason that, in this country, it is our principal measurement of achievement. Whom do you consider a "prominent" man? The man who has the money. If you continue to pay your teachers a starvation salary, they will never have an economic position which commands respect.

When I was at Lehigh University over fifteen years ago, we had a summer school session that was primarily for "flunkees" and secondly for teachers who wanted to get additional education. A teacher of physics would come in and say, "I would like to get a Master's degree in physics." We would reply, "Well, we have courses that will lead to a Master's degree in physics," and we would outline the sequence of courses. The teacher would say, "But this would take me five summers before I could possibly get anywhere near a Master's degree in physics. I can go to the Department of Education and get a Master's degree in education in two years." Where does he go? Obviously to the Department of Education. This isn't his fault; it's the fault of the system.

Now I'd like to speak of the scientific field, rather than teaching in general. In the field in general, you need a teacher who has patience, who has understanding of the teen age group and who has the ability to inspire them, to make them feel as if they were getting something out of the class. This requires quite a bit of good showmanship, and, although it is an art, some of it can be taught by the Department of Education. But, in addition to this, the mathematics or science teacher must know what he is talking about and much more than he is going to talk about; otherwise, he will never be able to answer the kind of question that comes up in class. A student asks about something which is a little aside from the book; this in turn leads to something else; and the teacher talks for five minutes about things that are not in the book at all. The class sits up and listens and thinks, "Well, now this might be something worth going on with; this looks like fun." And for those who have analytical

ability, which to my mind is the essence of being either a good scientist or a good engineer, it is fun. We need to find these people in the high school, get them started and convinced that mathematics is not really difficult for them. Mathematics and science were fun for me. I have a lousy memory, but I can do a reasonably good job on analysis. This being the case, I have been thoroughly enjoying scientific work.

Mr. Johnson: Let me ask a question, Dr. Frey. Do you think it's possible to get these people who will inspire the students into either high schools or colleges without making a very overt attempt to getting them paid better?

Dr. Frey: Not without helping a good bit. Every now and then you do find a $50,000 house for sale at $20,000. Similarly, you will every now and then find in the high schools and in the colleges the dedicated teacher who just loves it so much that he doesn't really care about money as long as he has enough to keep his family fairly comfortable. But, when the salary is so low that he has to go out and work in a garage or a filling station after classes are over in order to keep his family decently clothed and fed, this is rather pathetic.

Dr. Keene: One of the remarks that has been made is that we as a people haven't decided that we want subsidized education but that the educators are tired of subsidizing it with their lack of salary. This has perhaps been a problem.

Dr. Bird: I'd like to debate with the money fellow.

Mr. Johnson: I've presented the position I have because I felt that it could be a challenge to a discussion here. I don't want to be depicted as a "money man." But I rather think that, when it comes to matters of education or the spiritual values that we ascribe to teachers of an inspired variety, we tend to feel that money is "filthy lucre"; and we tend also as selfish people to say, "Now, what is this tax problem that I am proposing? Will the public really face this? Is there anybody strong enough to go up and tell them that they've got to pay twice as much on their taxes?" There are many "filthy lucre" aspects of money, but I'm trying to avoid this aspect and the emotional

feeling around money and actually get to the heart of the matter: the most constructive single thing that will attract the inspired physicist who would like to teach but who can't withstand the financial offers from industry.

Dr. Keene: Can we break in? Mr. Pick has been sitting up there by the Arctic Circle on his tundra, and he's had some ideas about how people might communicate enthusiasm to other people. Would you like to communicate some of that to this group?

Mr. Pick: I don't know why Dr. Keene brought in the Arctic Circle, but it is a good place to think. I gather from Mr. Johnson's opeining remarks that the more people who voice their opinions here, the harder it is to come up with something original. But I feel that enthusiasm in the teacher and the ability to arouse enthusiasm and liking for a subject in the student are of prime importance. Now I have a question: when you say we must hire better teachers, what is meant there? Do you mean teachers who just know more facts? Or do you mean teachers who are able to arouse enthusiasm in their students? The latter, I think, is of prime importance. I know that it's very true that money doesn't always get the best people. And I would think that would be particularly true in education. I have known people who have, as Dr. Bird suggested, turned down many times their salary as a teacher to remain in teaching, and I have always felt that it's not possible to buy with dollars the things that you need in teaching.

So, I would say that we must consider other aspects of the profession rather than just money. We must find some way of evaluating these people who are going to teach and determine whether they can arouse enthusiasm.

Dr. Keene: We might want to add at this point that we as a society sometimes demand such a dull color of our teachers that we wash out this very enthusiasm that Dr. Bird was talking about earlier.

With regard to the fact that we have a shortage, let me put in one point. Howard Meyerhoff of the Scientific Manpower Commission (he was to be on this panel and couldn't make the trip West; so I picked his brains at lunch the other day) told me that, in one of the top engineering schools in this country, sixty of their undergraduate units in engineering last year were given by graduate students or faculty wives. This would indicate a dimension of the

problem in terms of our manpower needs. Now it is true, of course, that, judging from some of the "profs" that I had, I would rather take the course from their wives. But other things being equal, it is probably true that this shows an eroding of the talent available to communicate, and this lack of talent has a geometric effect on the population.

I know that Mr. Dorman is concerned not only with the educational dimension of the problem but with what we should focus on in order to make the best possible use of the talent available. He's a representative of a large consumer organization. Mr. Dorman, would you like to give us some of your reactions in this particular area? What do you see coming out of our schools?

Mr. Dorman: The much discussed question of a shortage of engineers more importantly requires qualitative rather than quantitative evaluation. Whether there is an absolute shortage in the number of trained engineers for our current industrial economy is a controversial question. However, there is no question apparently as to the need for increasing the quality of our engineering manpower.

The qualitative evaluation commences with the assumption that the trained engineer possesses a technical degree from a recognized institution. Thereafter the requisite attributes may go in various directions, depending upon the personal views or inclinations of the evaluator.

An interesting hypothesis receiving considerable attention at present relates to the value of background training or experience in the aesthetic arts. At first examination this may seem far-fetched, but actually the relationship is well established. First, engineering in the broad and higher sense of the word requires imagination, perspective, and, indeed, intuitive capacities that by no means relate solely to the intellectual grasp of concrete dimensional problems. Second, communication of ideas into ultimate realities of engineering design requires keen awareness of total factors in the human personality. While no one disputes the fundamental requirement of exacting technical information, surely there must also be important emphasis on these other qualities.

The patterns of music, painting, theatre arts, and sculpture all have quite rigid techniques calling for precise and accurate technical, often mathematical, qualifications. We may lose sight of this fact because often the aesthetic overtones overshadow the basic formulae which can be as exacting and well defined as physical laws. More and more the industrial engineering enterprises are recognizing the influence of such exterior conditions on the ultimate capacity and competence of the technical man.

The challenge, therefore, seems to lie in how to create in the individual and intellectual curiosity that the emotional reach for greater knowledge in these areas. This may call for a gradual re-structuring of our cultural patterns so as to achieve general acceptance of the need for firm grounding in the logic and mathematical rigidity of the aesthetic arts as requisite to a so-called full engineering education. This is a problem for the educators. If they succeed, the industrial enterprises should be prepared to carry out further the training process by individual methods best suited to their own circumstances.

Dr. Keene: Dr. Bird.

Dr. Bird: There are areas in which everyone in this room can help. I've just been lunching with Colonel Walter Kraus who is the head of the Army Language School. He taught Spanish at West Point. He retires at the end of this year. He's young. Can he teach over here in the junior college? He cannot. Why not? Because he hasn't had California law; he hasn't had so many hours' experience in junior college teaching; he hasn't had so many courses in methodology. A great teacher is a man who loves to teach and who loves his subject and loves humanity. Whether he has had any methodology is of no importance, relatively.

One of the things that needs to be done is to enable the approximately 200 people in this community who have retired from the Army and Navy to teach where they are needed. A colonel going out into a high school and taking a department of Spanish or mathematics immediately has prestige. But he is not allowed to do it. The head of the local junior college resigned and went elsewhere. We had people in this community who were competent to succeed him. These people could be president of the University of California, but they couldn't be president of our junior college because they hadn't the courses in methodology that are required.

Dr. Frey: I would like the floor for one moment to point out that in my own personal case I have spent over thirty years teaching and yet I am not permitted to teach at Monterey Peninsula Junior College. And I really feel that, in the thirty years, I have acquired some aptitude in the technique of teaching.

There is also another matter to which reference was made earlier. It is something that keeps coming up all the time that I would like to defend. It is the statement that the engineer and the scientist are not being properly trained in the humanities. This is true. But, what about the other half of the story? The people who know the humanities--the lawyers, the economists, the politicians, the doctors, the businessmen--have no training in the engineering sciences. Why doesn't somebody jump up and down and scream because they haven't? All people do is blame the poor scientists and the engineers and say, "This is all your fault. You got us into this mess. Now get us out of it." But this is not their job. This is not their aptitude. This is not the ability that they have. They have a specialized type of ability which is quite different from that of the politician. They can do a particular kind of job, and, although I'll admit that it's desirable for them to have some other aptitudes, such as a reasonable command of English to permit them to communicate their ideas, I don't think it's necessary at all that they be able to play a piano. It's very nice if one can but you can always put a disc on the turntable and probably produce something better than you ever could the other way. And I think it would be very good if you could not only read some foreign languages, as most of us must in order to obtain our advanced degrees, but also communicate in them verbally. But, again, remember that the scientist has to have all of these other things that are piled on him, that people insist that he must be able to do. Now, on top of that they expect him to be a Superman and do everything. Let's turn the Superman around and turn some of these other people into engineers.

Dr. Keene: Mr. Dorman might want to move in on that. But I'd like to ask one question at this juncture.

There was a survey made by the Office of Education which showed that there is a tendency to push into the undergraduate engineering curriculum a lot of "how-to" courses. I have a list here: air conditioning and heating, air transportation, fire protection, food engineering, glass technology, humanities in engineering, meteorological engineering, paper and pulp engineering, process engineering, tool engineering, welding engineering, and a number of others, totaling, in enrollments in this country as of the fall of 1957, 4,110.

Now, I would ask Dr. Frey, and any of his associates who would like to react, if part of our problem in having too full a curriculum may be that we have too many courses in applications training.

Dr. Frey: Well, in the first place, I would like to point out that this is sometimes necessary because you have the wrong man there as your student. All he can do is learn the rules, the book. He can't analyze. You can give him a set of facts. Again I go back to my same premise that there are two kinds of people. There is the kind of person who will make an excellent technician--you can tell him what to do and he will do it. And you only have to tell him once or show him once. Then he can do what you have shown him and do it excellently, but he cannot go on from there to something else. He cannot take Fact A, which he knows is true, then Fact B, which he also knows is true, and deduce from it that Fact C must be true.

There are so many people who seem to have no aptitude for analytical thinking. I run across them in many places. Fortunately (and this is one of the reasons I love teaching here) I don't find nearly so many of them here as I did at Lehigh. There you find the freshmen coming in. Papa and Mama wanted their son to be an engineer. So they sent him to Lehigh University, and the Physics Department and the Math Department caught them in the freshman year. Between those two departments, they very rapidly found out that they did not have the capability of analysis. At the end of the first year they transferred to the School of Industrial Engineering, where they learned the facts. Fortunately, we don't need so very many of the ones who can do the analysis. But we do need some of them, and, for heaven's sake, let's look for the ones that can do it, catch them early, and inspire them. These are the ones that we are looking for. Let's find them.

Dr. Keene: Mr. Dorman, I think you probably have an inning here.

Mr. Dorman: Yes, I have a point to make. I wouldn't want my comments to be misunderstood. It seems to me that what we're talking about is the creative and, as you say, Dr. Frey, the analytical mind. My point in referring to the arts and humanities was not to make a person personable or give him a public relations view or anything of that kind. I thought we were talking about the mental processes and were somewhat in agreement that one of our basic problems today was not quantity but quality of the engineering mind. That means the creative, the imaginative, the mind that can do these things which you have so very clearly expressed.

My reason for referring to other fields was that the discipline the arts and the crafts create, complements and abets the processes and disciplines of the scientific training. The suggestion there was that they added to a colorful interpretation and a logical one as well, as in music--there is logic in that. It was directed toward the thought that this might be another way of emphasizing the quality of our scientific manpower as much as the quantity.

Dr. Bird: My job for some twenty-five years was trying to carry forward a college. The best part of the job was to take the dossiers of outstanding students to the graduate schools of the East. In conversation one day with the Dean of the School of Medicine of Northwestern University, I said, "We have a great many very fine boys who want to enter the medical profession. What would you like to have us give them as an introduction to their professional training? Biochemistry?" "Not a bit," the Deam replied, "Have them study Shelley!. What the doctor needs," he said, "and what we all need, is the enrichment of our imagination. And poetry and music and other areas are important. This doesn't mean that it is not important for him to get the specific courses in science for his profession. But that is our job. What is needed in college is the development of his quality of soul and his spiritual dynamic. And that's your job primarily."

I should like to recall, before I end this, what the poet Wordsworth said when he wrote his prelude: "While I was in Cambridge, my imagination went to sleep." It's a devil of a business if we do not stimulate in college

those creative forces that enable a man to be properly disciplined in the sciences so that he may be able to be analytical and, at the same time, may reach out to new patterns that have not hitherto been known.

Dr. Frey: Defending myself, I will say that a good and inspired teacher doesn't have to wander far from his own particular field, be it physics (which happens to be mine), or be it medicine (which happens to be somebody else's) before he can give the student the breadth that you are asking for. All he has to do is know a lot more about his own field than he's ever going to teach anyone but an occasional person here and there so that, when something comes up or somebody raises a question, something clicks back in his mind, and he goes off on a tangent and talks, as I've said, for five minutes about something that has no direct connection with the subject. Then you're getting somewhere. And the rest should come, not from the college, but outside, in a man's relaxation. One doesn't have to sit in front of a television receiver to pass the rest of his time.

Dr. Bird: I don't disagree with that. I think that you can learn the liberal arts from physics just as well as you can from poetry.

Dr. Frey: I am not so sure that you can learn physics from the liberal arts.

Dr. Keene: May I get another point in here now? Perhaps one of the problems which has been besetting us as a nation is that we've been trying to give everybody the same education. We have been moving from an era when few high school graduates went on to college to an era when plenty of the high school students are going to college. Some of the things we've talked about are offshoots of this.

I'd like to take another side of the problem for a moment now while we've got these brains assembled, and put their brainpower to work on this production problem. There is at present something very popular in all of our industrial operations and in government: the training of people and the concomitant upgrading of talent and bringing up-to-date of techniques by the introduction of contracts between universities and various corporations and governmental jurisdictions. It has become pretty popularly accepted theory that one must participate in these contracts in order to get ahead.

Apropos of all this, I'd like to air my own prejudice and see what our friends here think of it. We have a great shortage of teachers. Yet I suspect that we are decreasing the supply of manpower available to produce more brainpower by the fact that we are educating too many people on the job, perhaps for the wrong things. But it's become the popular thing to have an "institute," to have eight or ten weeks or eight months of training. Do you gentlemen have any comments on this?

Dr. Keene: Mr. Dorman, how do you feel at Bechtel? Do you feel that it's useful to continue the training of these people after they come to work for you?

Mr. Dorman: Oh, very definitely, although I think that there should be very different levels. In order to get different ideas and different approaches, you might want to bring people in at various levels of training.

May I make one comment in reference to the general question we're talking about here? A good many of you may be familiar with what Venezuela is attempting to do, and it may have some connection. Recognizing the problems they have in increasing the level of their society intellectually and otherwise, they are very ruthlessly selecting, for an experiment in education, only a small number of people--those who they feel will produce the best results and who will move ahead most rapidly. They have said: "We have limited funds (don't laugh, you people in the oil industry) and we must divert them to the most useful purpose. Therefore, starting in the lower grades and all the way through the educational system and even beyond that, we will weed out all except those persons who, physically and otherwise, have been determined by tests to be the most competent and put all of our money on those people as a realistic way of promoting their brainpower as quickly as possible." Now, I'm not proposing this for our country, but I think it is an interesting approach to the problem you mentioned.

Dr. Frey: It seems to me that we have been doing altogether too much teaching for mediocrity in our schools and even, I am afraid, in some of our colleges, although not to as serious an extent as in the schools. Public opinion has it that every American is entitled to a high school education and

to a junior college education. Very shortly it will be that every American is entitled to a college education.

What happens as a consequence? Well, obviously, some people have more capabilities than others. All men may be born with equal opportunity, but they are not born equal in spite of the Consititution of the United States. If you have to plan your teaching so as not to leave three-quarters of the people behind, what happens to the quality and level of teaching? Down it goes, and this is what has been happening. Actually it's not only that the curricula have been diluted with things like marriage relations, etc., etc. but even the quality of teaching in the old stand-by's such as physics and mathematics has been lowered.

Mr. Johnson: I'd like to add one more thought to the point about paying teachers better. I directed this recommendation at the wide base of our 45 million people in school. I do think that this may be a major step toward solution of the problem. I'm sure that Mr. Dorman may be touching upon a fundamental issue that we as a nation must face up to, namely, that there is some incongruity in trying to educate the mediocre and the brilliant mind in the same institution, with the same people and with the same curriculum. What this country needs, in order to survive, is much more basic knowledge. We need more engineers and technicians, and we need lots of them. But, when the chips are down, what we will really need is basic knowledge and basic theories and fundamental philosophies that will carry us for the next hundred years, not just through this competitive era that we are immediately facing with Russia. I would like to bring out this fact: Russia doesn't hesitate to advertise, nor do we hesitate to talk about the fact that in Russia the physicist makes five or six times what the business man does. I think it behooves us to take cognizance of the fact that financial rewards are the only real measuring rod with which we can equate the various gifted people.

Dr. Keene: I see you got back to that point again!

Dr. Bird: What is the relationship of the so-called humanities to the sciences? I think that science gives us clarity and precision and objective consideration of factual data, which is fundamental. But let me give two

arguments ad hominem. Myron Hunt, who was one of the great architects of the world asked: "Why is it that most of my class at M.I.T. work for those who have been in humanities? Why is it that executive positions are held by those whose fertility has come out of areas other than specific engineering?" That's the first point. The other point is: Robert Millikan was one of the first physicists to get the Nobel Prize in this country. He majored in Greek when he was in college.

Dr. Keene: Dr. David would like to say something. Can we activate the mike on this bank here?

Dr. David: I don't know whether the rules of the game allow me to....

Dr. Keene: You can go right ahead. All we want is to be sure that you have an open mike.

Dr. David: I thought you were going to say an open mouth!

Dr. Keene: It's your foot, sir, go right ahead.

Dr. David: I don't know whether you expect the other members of the conference to come in on this discussion. I have been moved to feelings of interest, anger, and also, I must submit, bewilderment, by some of the remarks of the panelists. I hope you will be patient with me for a moment, too, because I am profoundly distrubed by the acutely personal note which has colored almost every reference to something called "education." I submit, and without any offense intended, that the world of education doesn't begin and end with Lehigh, or even with Occidental.

Dr. Bird: Thank you, sir.

Dr. David: . . . .or with the range of your personal acquaintances. I submit further that even the most interesting and illustrious life of an individual having some bearing upon this does not enable us to come to grips with the thing that we are talking about.

About 80% of the remarks made about something called "education" have relatively little to do with the history of the United States or with the experience of society or with an understanding of the function given to

educational institutions in our land. I am not defending for a moment the evolutionary growth of education in the United States, but I am suggesting that it is extraordinarily difficult to do anything to improve the quality of education by making believe that these things have not happened, or by recalling that there was a golden, mythical age which, if we could only reverse time, we might produce again.

I should like to point out that, be they poor or indifferent, we have a great number of people in our schools. We're not going to keep them in schools less long than we do now (they may be there longer!). We are running a mass enterprise and we must think about running this mass enterprise with the resources at our disposal.

You are quite right in saying that there is the exceptional teacher who is so fired by his subject and his love of it that in some way the flame touches the students who encounter him. The number of students which even he or she can reach is very small. However, there are very many more teachers who have a very pale flame, indeed, and who are even afraid of being burned by it themselves. These are the people we have to worry about. One of the problems we face today is how do more people become inspired by these exceptional teachers.

We are all contemptuous of mediocrity. Our problem in this society, as in every other advanced society, is how to lift the level of mediocrity. The school world is a very confusing and paradoxical world. It has no one center of power; it is not manipulable from any one level of government. It is one in which everybody is an expert because everybody has gone to school and obviously knows as much as anybody who teaches! God save us from lay boards of education, but God prevent us from having any other kind!

There are other things to worry about in our school system: the quality and movement of school superintendents and the attraction and retention of teachers. I am not concerned with those in the first five years of their school career, but I would start to worry about those who have been teaching more than five years and are therefore likely to remain within the profession (the big losses come early). I would start to think of problems of retention. If you think the initial salaries are too low, you can move there.

But I think the key problem is where the ceiling sits and therefore what the competitive pulls are after five or ten years in the field. One also ought to consider, in this connection, the function performed and therefore the ways in which teachers can be utilized. If a teacher is crucial to relieving shortages of scientific and other kinds of manpower, then this is one profession which suffers from "mal-utilization"; it's the only profession I know in which you start and end with exactly the same title (I'm talking about elemetary and secondary schools), the same functions, the same responsibilities, the same powers. You're a teacher the day you're certificated, you're a teacher the day you die or retire, and nothing happens in between.

Now, that's another way of beginning to think of what can be done by differentiating levels of responsibility, titles, and rewards over time. The rewards, it seems to me, can be of two kinds. One, a reward just because you're there and you've lived long enough (since other organizations do it, I don't see why the schools shouldn't. Management has spent a lot of money to find better screening devices than seniority, and it's not clear that the devices have paid the tune). I would say that the same kind of investment should be made in in-service training in the armed services, in industry, and even, if you please, in government. This is a selective process; it seems to me you can pick horses that are likely to win, and, if you win in only one-third of the cases, you're doing damn well. That's a big return.

With regard to the salary story, I would say it's nice to talk about doubling salaries. I would be heartily in agreement with it; I would like nothing more than to have my salary doubled immediately. But you don't double salaries within a field without looking at a competitive wage structure elsewhere. This is a very crucial problem. Many of the solutions, it seems to me, are off base.

Dr. Keene: As moderator, I'm going to have to call time.

Dr. David: I'm very sorry.

Dr. Keene: I think Mr. Thompson, our senior statesman, wanted to say something here.

Mr. Thompson: I want to speak of just one thing Dr. David said.

I started a company in 1906 and made myself the president of it. I have been president of my company for 52 years. Some "gloomer" said to me, "What, 52 years working for a company and never a promotion?"

I do feel a little indignant, however, because Dr. David started to jump the panel here as though they had been airing personal grievances. I got no such reaction from any of the statements which were made. It seemed to me that they all adhered to the subject in very general terms. I'm going to be a little bit rude, too, and observe that Dr. David brought to my mind a phrase which I think I must have learned over fifty years ago: "intoxicated by the exuberance of his own verbosity." I am rude to say it, but damned if I don't think it!

Dr. David: I stand abused!

Dr. Keene: A moderator usually feels he's got to keep his panel apart, but this time we had our fun with the audience!

May I make one remark in closing? I am very grateful to these gentlemen. We had a rather large bear of woe by the tail, and we were holding on for what we could.

In order to give us common ground from which to talk, I put together some material which is stacked over yonder. I gave a set to each of the panel members, not to structure their thinking, but so that all of us would be concerned by some aspects of the problem. It's more or less a compilation of what's in the literature at the moment, and I thought that perhaps you might like a copy of it.

We gratefully relinquish the chair. I think we've run over five minutes.

Mr. Krotz: At the risk of being a bore, I would like to delay just another moment to ask Dr. Bird if he would like to be more specific in his recommendation as to what we can do about the qualification of teachers, because I think this is the key to something that is not clearly delineated at the present time.

Dr. Bird: According to the laws of this state, I think that we express our opinion through the State Board of Education and seek to discover what it is that creates the block.

Mr. Krotz: You say, "We." Are you speaking of a group? How is this to be effected: This is the question I asked.

Dr. Bird: We are the sovereigns of the land. We are residents of the state. As individuals we have access to our assemblymen and our senators and to our State Board of Education. We can bring pressure through our local situation. Our local situation is impotent except as it is strengthened in such a program through the State Board and through the laws of the state. I think we become overloaded with "methods" courses and they are standing in the way of content courses.

Mr. Ruddock: Gentlemen, I know you will want me to thank, on your behalf, the members of the panel and their able moderator for this stimulating and thought-provoking attack on the problem. We will now adjourn for coffee, which will be served here, thanks to our kind hosts.

PANEL
on
BRAINPOWER UTILIZATION

Mr. Ruddock: The meeting is called to order.

You may all recall a story that they used to tell about a Secretary of State just before the outbreak of the first World War, William Jennings Bryan. We, the United States, were being wooed by both the British and the Central Powers at that time. Mr. Bryan went abroad on his first European trip and he was given a state dinner by the Kaiser. And, at this state dinner, as so often happens in a large gathering, the noise suddenly subsided and the booming voice of Mr. Bryan was heard throughout the auditorium saying, "Your Majesty, I reckon I understand almost everything about Europe now except one thing, and that is why do they sometimes call it Budapest and sometimes Bucharest?"

Now, as you can see, that is not a problem which concerns any of our moderators, panelists, or speakers. And so it is with great pleasure that I introduce to you our second panel, which will be led by Mr. Robert F. Mello, Director of Civilian Personnel, U. S. Army Ordnance Missile Command, and a Trustee of the Cooperative Research Institute. We are very grateful to Mr. Mello, as to Mr. Keene and others, who are taking the time from their many great responsibilities to help us in thinking through some of these knotty problems. Mr. Mello.

Mr. Mello: I resent the use of the expression "brainpower," even "manpower" in a way, because it doesn't sound as though we're dealing with people. But we are. I feel that before we can say that we have too much scientific manpower or too little, we had better first find out what we're doing with what we have. As you all are aware, our research programs today are advanced or retarded by the people we have on the job. Admittedly, they are influenced by the lack of people that we have, but it's the people who are doing the work who make the greatest contribution. Therefore, I think that utilization obviously should concern each of us. So, before we decide that we need more, we first should consider what we are doing with what we have.

I'm afraid that there would be a strong odor of rubber burning if the panel spun its wheels on the broad topic of "utilization." We'd be rather like the sultan who first walked into his harem and looked around rather startled. He knew what was expected of him, but he didn't know quite where to start. So, to avoid having this problem of not knowing where to start, we have tried to break down our subject into manageable segments.

We have taken five rather broad topics, all of which concern utilization: environment; organization; professional development; creative thinking, that is, creative thinking on the part of the people who are doing the job; and, finally, administrative distractions, those things which take people away from the work for which they were hired. Now, you undoubtedly can think of many other topics that fit in here. However, time doesn't quite permit us to go much further.

The panel assembled here is composed of men who are all intimately concerned with scientific manpower in one way or other. Their experiences encompass scientific research from the idea stage to full production. I'm sure you know each one of them. You should by now, since I believe all of them have been connected with this Forum some way before. I'm not going to bother to introduce them as a group but will introduce them as each is to present his specific topic. We've also tried to get together before this session, as Dr. Keene and his panel did, to see what each felt strongly about. We found out that the thing we all felt the most strongly about was getting together. So we didn't. In spite of the fact that we did have breakfast together this morning, I'm not quite sure what each panelist is going to have to say. However, I think that this may be an advantage, since I can claim no credit or blame.

At the conclusion of the prepared comments we hope to have time for a few questions. Our objective is to present to you a few statements by the panel members that will stimulate your own mental digestion and give us a chance to have a little real food for thought before this meeting is over. So, I'm going to ask our panel members to keep this in mind when they are presenting their ideas and give you a chance to tear us apart if you want to. We would be most happy to have your comments on what we have to say.

Our first subject, environment, is going to be discussed by Mr. H. I. Gibson. Mr. Gibson is General Manager of the Guided Missile Division of The Firestone Tire & Rubber Company at Los Angeles. His Division has been responsible for producing, among other projects, the Corporal guided missile. Not long ago I had a chance of going through the plant and seeing the wonderful work they have done. Environment is a problem which has interested him very much. So, Mr. Gibson, will you give us your ideas?

Mr. Gibson: Over the past several years we have witnessed a tremendous increase in the use of scientific professional talent. This increase has been occasioned largely by the race for advanced weapons systems. Along with the increase in training and utilization of scientists newly entered upon their careers has also come a shifting of scientific manpower, a shifting from normal endeavors for the increased benefit of mankind to an endeavor for the preservation of civilization as we desire it. As a result, many scientists today find themselves in working environments that may be strange to them, even distasteful.

I would like to confine my observations upon my assigned topic, environmental problems affecting utilization of professional talent, to problems presented in defense activities and to speak as an individual in private industry who is charged with seeing that jobs get accomplished.

Assuming that a scientist has the ability, drive, and determination for individual accomplishment, perhaps the environment most conducive to his productivity is one which includes unrestricted freedom of action, broad opportunity to exchange ideas with fellow scientists, a technical library of ample scope, a well-equipped laboratory, and unlimited funds. Today, places of scientific endeavor that approach this ideal are probably in the minority.

In most fields of private enterprise, facilities and research budgets must be kept commensurate with the size and needs of the businesses that support them. Costs must be kept low enough to be competitive. Inherent in low costs are close control of operating expenses--operations against

budgets--and minimization of overhead expenses. Low overhead rates cannot be achieved if expensive equipment cannot be utilized with sufficient frequency to permit complete cost amortization and a return on the investment.

Another factor which may make for poor environment for some scientists is inherent in most projects for national defense: the projects must be accomplished on a time schedule and sometimes according to specifications in which the performing scientist had no hand and with which he may disagree. However, if you are under orders to shoot first a rabbit, you can't fire at the more succulent quail that springs simultaneously from the same clump of clover.

Compromise is necessary to attain the proper balance between scientific curiosity and perfectionism on the one hand and the harsh realities facing the free world today on the other. A government representative once expressed himself to me as follows: "Look. We'd rather take a Model T today and have it ready than risk waiting for a Cadillac two years from now."

So perhaps the ideal environment for scientific endeavor is achievable very infrequently, if at all, in today's race to design and field advanced weapons systems.

However, it is probably erroneous to believe that scientists differ basically from other people. Like all of us, they have varying attitudes as well as varying abilities. They share the human trait of preferring to do the things which they are capable of doing best. Of course, in the case of a scientist, this is to invent, to discover, and thereby achieve recognition and contribute to our society. They are distinguished from other people of comparable intellectual ability chiefly by the fact that they specialize in fields that afford challenges that can be so interesting as to be all-absorbing. In some instances this absorption may become so intense as to preclude desire to participate in any management or administrative functions. In other instances, scientists may desire to have, and may be stimulated by, knowledge of these phases of the organization for which they work.

Fortunately, environment consists of more than physical facilities and freedom of action. I believe that, with scientists as well as with other people, it includes also a friendly atmosphere, a sense of belonging, and a willingness on the part of both administrative management and scientists to achieve the balance that must prevail between the dictates of customers, economic necessities, and the desires of scientists. On the side of management, to help achieve this balance, I would recommend seven principles:

1. That especially careful attention be given to the aptitudes and individual inclinations of each of the members of a scientific staff and that, within limits of opportunity available to do so, assignments be made in accordance with inclinations as well as aptitudes.

2. That scientists should not be hired under any misapprehension as to the probable scope of endeavors that may be inherent in the operation or project upon which the employer is engaged.

3. That they should be given maximum freedom of action possible within the limitations of budgets and schedules and that they should have a voice in establishing budgets and schedules pertaining to their own work.

4. That they should be informed of reasons why, whenever their wishes cannot be fulfilled. (The universal feeling of frustration over lack of adequate information was voiced by the Pennsylvania Dutch mother who whipped her boy when "He wanted, I why'd him, and he wouldn't because me.")

5. That they should work under the direction of a scientist in whose ability they have confidence. (My acquaintance with scientists has led me to believe that, in most of their attributes, they are just like anybody else, only more so. They are "more so" undoubtedly because of above-average insight and a consequent heightened conscience. Therefore, in addition to his professional qualifications, the director

should have all the management training, breadth of understanding, and sympathetic interest in his associates that any other good supervisor should have, only more so.)

6. That they should be permitted freedom of contact with top administrative management as well as with their immediate director. (I doubt that a highly stratified organization in which "the Lodges speak only to Cabots and the Cabots speak only to God" is good for morale or individual development. The petty tale-carrying, time-wasting, and by-passing of direct-line authority that some organizations seem to fear are certainly very rare among intelligent people.)

7. That they should be supported, at least to the extent needed for their jobs, with physical facilities of the type they desire.

Mr. Mello: Thank you very much, Mr. Gibson. You've given us a lot of food for thought here. This matter of environment is something that we have to think about, because if you don't put things in the right context or in the right environmental situation, you can probably misunderstand what was meant.

I can probably best illustrate this by the story of the preacher who, having concluded his sermon, was standing by the exit greeting the congregation as they came out. One man, a stranger, went up to him and said, "By golly, that was a damn good sermon." The preacher was startled. The stranger repeated, "Yes sir, it was damn good!" The preacher, slightly indignant, said, "Well, I appreciate your compliment, but I resent your language." And the fellow said, "Yes sir, it was such a damn good sermon that I put $100 in the plate." The preacher said, "The hell you say!" I think that, after he evaluated the whole statement in its proper environment, it was a greater compliment than he had realized.

Our second subject concerns organization. We have, to present this topic to us, a man whom we all know and who needs really no introduction. Dr. Russell Varian I have known for some time through the International

Science Foundation. I'm sure you all have. You know of his intense personal interest in research. He has been active in research most of his life. He has been recognized for this, not only from the fact that he is Chairman of the Board of his company, Varian Associates, but he has received international recognition for his work in the field of microwaves. Not long ago he received the John Price Wetherall medal for distinguished service to science. His approach to this topic might be a little different than some of us anticipate from the standpoint of organizing because he's going to talk about organizing the fields of knowledge. Dr. Varian, I wonder if you would give us your ideas on this.

Dr. Varian: Yes, I'd be glad to.

The reason I've selected the subject I'm going to talk about is that it's one that is not talked about very much in this context. It's very often important to pick a certain important phase of a problem that is not being talked about and bring it to general attention. What I want to talk about might be referred to as the "Achilles' heel" of specialization.

Now, we are dealing with an age of specialization, and specialization is inevitable. We have long since passed the time when one man could encompass the whole field of human knowledge, and we've even passed the time when one man can even think intelligently, perhaps, in all fields of human knowledge. When we reached this point, specialization took over. But specialization grew up very often as an accident of history. Somebody discovered something and somebody else discovered something else which was related to it, and pretty soon you had a little sort of oasis in a desert of unknown. This grew and it became a field in which the knowledge all reinforced itself, that is, it was usable because it was all related. There were other things, like physics and chemistry, for example, which grew up separately and now are essentially just different aspects of the same science. But there still are boundaries.

What is bad about the present situation is not that these specialties have not developed in such a way as to make the information usable to the group specializing in it but that they became sort of standardized kits of

knowledge which were handed out to huge numbers of people. There was a boundary to this knowledge and, over on the other side of this boundary, was another specialty. Any boundary of this sort creates a barrier to communication. I think we would all agree that, if we put two perfectly specialized individuals down beside each other, they couldn't increase their field of knowledge except by use of their common knowledge. And if they didn't have any common knowledge, they couldn't communicate. Fortunately, there are no perfectly specialized individuals; so they all can communicate a little bit. But the boundaries between the specialties have become very serious barriers to communication. For instance, we have lawyers who do not understand anything about scientific matters. And we have various specialities within the sciences themselves that scarcely understand each other.

We come up against the problem of having to make overall decisions that cross many of these boundaries. And how do you do that? You might say that it is quite easy to do: all you have to do is take the experts, have them sit down together, and make a decision. But if you look at it a little more closely, you find this can't be done if they do not have an overlapping knowledge because the decision is not a matter of the summation of what each expert says. It is a matter of weighing the interaction of all of these things on each other and making a decision that is based on this interaction. Consequently, I think you could say quite definitely that you can't make any intelligent decision by having a lot of specialists sit down together with someone who is a specialist in, say, national administration. You've got to depend on the overlapping of knowledge.

Now, given the way the specialties have grown up and the fact that there are people with tendencies toward tidiness of mind who want to stick everything in pigeonholes anyway (a pigeonhole is in essence a space with boundaries around it to keep things from getting mixed up with each other in uncomfortable ways), you have a boundary between two standard kits of information involving a very large number of people. These are the things that really interfere with getting people together and getting sensible decisions in all these fields. I think it is very important to take this into consideration when we contemplate rearranging our curricula for the future. This factor is perhaps as important as the specialties themselves in determing what we as a people or as a society can do with them.

There's also a matter of who is a specialist and who is not. Many people consider that anyone who has a concentrated knowledge in a certain field has a very narrow outlook. I think you'll find that very often the person with a concentrated knowledge in a certain field has a broader outlook than the person who has not a concentrated knowledge because the person without a concentrated knowledge actually has a broader field of ignorance. Actually the breadth of view of a person is determined not by the concentration of his knowledge but by his ignorance, you might say.

There is one other thing I wanted to point out. There's another very important factor that is involved as soon as one of these boundaries is set up, and that is that there seems to be an age-old instinct in man to defend any boundary against aggression or encroachment. Once a boundary is set up, let us say between the Army and the Navy or the engineers and the research men, it becomes difficult to communicate; then you have cold wars and sometimes hot ones, and it becomes increasingly impossible to communicate across these boundaries.

In conclusion, I would like to give what might be a new definition of a liberal education. I think that the matter of cementing all these specialties together is one of the major problems that we have to face in the future. Consequently, perhaps the proper definition of a liberal education would be that a person is liberally educated if he is acquainted with the general pattern of human knowledge so that he can do this. He doesn't have to know detail in all of these fields, but he has to know enough to be able to talk meaningfully across boundaries. This definition isn't the conventional definition, but it's a definition that automatically keeps itself up-to-date.

Mr. Mello: Thank you, Dr. Varian.

Well, I got a new definition for an expert out of this. Dr. Varian applies it to a specialist, but this business of a "broader field of ignorance," is, I think, wonderful. When I have spoken before groups throughout the country, I have been introduced as an expert in some field of personnel administration. I'll always remember the definition given to me at one time: the definition of an expert is "X" equals the unknown and a "spurt" is a drip

under pressure. That definition usually calms me down. I think this description of a "broader knowledge of ignorance" is one I will use along with it.

A discussion of utilization wouldn't amount to very much without talking about the work and ideas put into the end-product, which brings us to our next topic, creative thinking. The panelist who will present this is Larry Limbach, whom I met for the first time last night. We had a chance to discuss his experience briefly. For the past two years he has been Vice-President and General Manager of the Rheem Manufacturing Company's Aircraft Division at Downey. Before that he was a Vice-President of Ryan Aeronautical Company for six years and for nineteen years a District Manager for Republic Steel. During all this time, Larry, I'm sure that creative thinking had a tremendous influence on your progress. Would you like to tell us about it?

Mr. Limbach: I want to start out by saying that some of the sessions to which I've listened here today did far more to stimulate creative thinking than I could ever do.

Taking one particular facet of this problem, I would like to talk about an industry application of creative thinking to a research and development department.

Too often, I think, when we talk about the problems of research and development, we are thinking of research and development in terms of a separate company having no relationship to the end-product derived from the research. So, from a practical standpoint, I want to direct my remarks entirely to accomplishing this where research and development is a part of a total production capability. Obviously, I am going to speak as a manager and not as a scientist or engineer.

It seems to me that, in industry, we don't lack for having ideas in research and development. The major part of our problem seems to be in evaluating these ideas and then in finding the specialist skills necessary to push selected projects through research and development. We hope that one out of ten ideas will finally get down to the hardware stage.

Going over this problem from our standpoint, I think we have tried to put into effect some of the things that you gentlemen have been talking about for the last two days. We have embarked on a program where we have gone outside the company to try to get specialized help as we need it. Our program was partially inspired by your 1956 conference.

Specifically, we have formed an alliance with the Cooperative Research Institute and have selected a team of research associates from CORE's membership. Under the guidance of CORE's project chairman, we are in the process of learning how to work with each other. Certainly this approach has many attractions as far as industry is concerned. We have at our beck and call a large reservoir of specialists and skilled talent which we can get into our organization on short call. Several of the CORE members serving on our team are senior engineers and scientists who have retired after outstanding academic and military careers.

Another problem that I think industry constantly faces is the fact that many of us do not have in our research and development groups every skill that's needed. And certainly, most important of all, some of the skills that are needed are needed for only a short period of time. From an operating standpoint you can't afford to have on your staff specialists whose skills are used only occasionally and who spend the rest of the time waiting for an assignment. So we feel that there is a real potential in this alliance that we're working on.

We also feel that, in working this out, we will expose our research and development people to a great number of ideas which came from these people from the outside. We are hopeful that, in so doing, they will pick up ideas that will help them along with their problems. I can't give you the results yet, but I am certain that it will produce results and that, if we are to gain something tangible out of this sort of meeting, it behooves some of us at least to put some of the recommendations into effect. Certainly this particular effort that we're working on is a tangible result of the sort of decisions that come out of a meeting such as we have had in the past two days.

There are two other interesting factors in this project of ours with CORE. From the standpoint of cost, it is very attractive. We can have a well-rounded

staff from the Cooperative Research Institute working on a part-time basis for us for a year for about the price of four or five engineers. The other interesting aspect is the fact that we only have to pay for these specialized skills as we use them.

A point that seems important to me from the management standpoint is that, in working this out, instead of trying to cram this arrangement down the throats of the people in the research and development organization, we have let them work with the group from the outside. It has now reached the point where they are anxious to work with these people. This is always a good way to start it rather than to tell them, "Well, now, this is it!"

I hope that I can report some of the results on this particular project the next time we have a meeting such as this.

Mr. Mello: Thanks very much, Larry. Well, there's a practical man's approach to creative thinking.

In a way, it reminds me of something that happened with an aircraft concern--I'll leave it nameless for our purpose, but some of you may have heard this story. The aircraft concern was building a new jet plane. They had been working on it quite a while and were having a bit of trouble. The Air Force, to whom the concern was under contract, was insisting that they hurry up and get this thing solved because the plane kept losing a wing in a dive. None of the pilots would have anything to do with it, as they had lost a few test pilots. They had about given up but had one more plane they were going to build. All of the engineers were together trying to figure out what they could do to correct this deficiency. As the chief engineer came in one morning, there was a note on his table that said, "Why don't you drill holes in the wing where it breaks?" He looked at it and thought, "What a stupid idea!" He started to throw it away. "Well, wait a minute," he thought. "What have we got to lose? One more plane. We've got the money for it." So they took the risk. They drilled holes on the wing, and the plane took off with the pilot cautioned to be ready to jump. The plane went into the test dives, and it performed beautifully. They tried to find out who the engineer was who had come up with this creative idea and this tremendous departure

in wing design. But they couldn't find him. One day when they had about given up, the janitor stopped at the chief's desk and said, "Say, you looking for the guy who wrote that note?" The chief said, "Yes." "Well, I wrote it." "You did?" he said, "Are you an engineer?" The janitor replied, "No, I only went through the sixth grade." The chief asked, "Well, where in the world did you get this idea?" "Well," he said, "any janitor could tell you. Don't you know that toilet paper never rips where it's perforated?"

Now perhaps that isn't what you mean, Larry, but you get ideas from many sources. Perhaps you'll get some the same way. We'll be interested in hearing what happened next year.

Our fourth topic is one with which our speaker is intimately concerned, professional development. Eugene M. Hicks is going to talk about it today. Gene is Branch Manager for Personnel and Administration for the Chrysler Corporation Missile Division at Detroit. This Division is of course something in which I'm quite interested because it is the organization that is producing the Jupiter and the Redstone. Gene has under him the department concerned with the professional development of the staff after they get on the job. He himself is a product of this school. He is a graduate of the Chrysler Institute of Engineering, and he also had a tour at Wayne University in Detroit, As a matter of fact, he was born in Detroit. Why don't you tell us, Gene, what you're doing at Chrysler?

Mr. Hicks: I believe that most managers and personnel administrators recognize that there's really no set rule for the installation of a successful professional development program. Perhaps the most useful way to approach it is to describe what we are attempting to do at Chrysler Missile Division.

The Chrysler Missile Division, like other organizations, recognizes that in a broad sense development of one kind or another goes on throughout a man's working career. As long as he is making progress, he certainly needs special instruction and experience to enable him to carry out his changing duties and responsibilities. We at the Chrysler Missile Division look at professional development from three major points of view: technical growth, managerial growth, professional career growth. To present a brief

overall picture of the various things we do at our company to encourage and further technical and managerial growth, I should like to start at the time of hiring a young engineer or scientist.

We have had a graduate engineers' training program in operation for the past two years. Those who elect to go into this year's training program have an excellent opportunity to discover first-hand the different factors that go into the performance of jobs in various organizational activities. Experience gained by these young engineers includes assignments in our research and development department, laboratories, and field operations. We go on from there to give the engineer a better appreciation of the other aspect of the missile business with assignments in manufacturing and quality control, and, to help round out his career orientation, further assignments in personnel administration, contract control, program control, and purchasing.

During the year's rotation of assignments other development action is necessarily going on. Our trainees attend two-hour classes each week during which time they are exposed to materials both of a technical and an administrative nature. For example, the technical material might include such things as missile check-out and specialized courses on power plant, guidance systems, electrical systems, etc.

On the administrative side of the picture, the trainees attend courses in plant organization, company procedures and policies, public speaking, and, most important, a forty-hour pre-supervisory training course. The trainee's performance is evaluated upon completion of each assignment and, at the end of the year, he is given a permanent assignment. This is done by an analysis of psychological tests, performance evaluation of job assignments, and his classroom record. Naturally, all of this information is weighed against his job preference and the needs of our company. Because of the excellent training they have received, these young professional people certainly stand a better than average chance to win a promotion to management ranks when the opportunity presents itself.

We have just seen how the graduate engineer is given an opportunity to acquire technical experience. Now let's talk about programs designed to

further the technical development of all our professional people.

Obviously, when our company increases its work force to accomplish increased tasks, the staff must be informed as quickly as possible about the engineering and manufacturing aspects of the new products--in our case, the Redstone and Jupiter missile systems, which include extensive ground support equipment. Our newly hired professional personnel are given technical courses covering these missile systems. Then, depending upon the area of specialization, they are offered an opportunity to attend a great variety of specialized courses, such as optics, pneumatics, power plant, etc. These are in-plant training courses. Many of our professional people are selected to attend local universities or seminars for special training. It is extremely important that our people be kept well informed on missile development. To help accomplish this, we have a special service whereby a weekly technical document bulletin is circulated throughout the plant. This bulletin highlights the latest technical and scientific information received by our library.

As a young engineer or scientist grows in stature, he participates more and more in advanced technical meetings between the customer, Chrysler Missile Division, and our major sub-contractors. Such meetings provide the young professional person with an opportunity to work with leading engineers and scientists in solving broad-gauge problems. With respect to managerial growth, progress up the ladder of success must come from demonstrated managerial ability, with only a few exceptions. Exceptions are isolated cases of scientists who have unique skills and other personnel in that general category, such as inventors, or, as some companies prefer to call them, "individual c ontributors."

To assist the professional man to assume his managerial role, the Chrysler Corporation established a management development program in 1954, which works something like this. All management personnel are appraised at least once a year by their supervisors. The appraisal is coordinated. By this I mean that the supervisor fills in the appraisal form, and the management appraisal coordinator counsels on making the appraisal and checks it for completeness and accuracy. Next the appraisal is reviewed by the superior's superior. Then the management appraisal coordinator consults with the superior making

the appraisal to determine the type of developmental action needed. Usually developmental action takes the following form: special coaching by the supervisor, special in-plant training courses, or special out-plant training courses. After this is done, the supervisor conducts a feed-back interview with the man he appraised. However, supervisors themselves frequently need training and guidance on how to counsel and coach their subordinates. This training is given by the management development department, and the people in this department are competent and well versed in training techniques.

Where there is a need for in-plant training courses affecting quite a few groups, special courses are devised and administered. Such courses might include report writing, public speaking, counseling employees, procedures, labor contracts, grievance procedures, etc. Out-of-plant training is usually arranged with the local universities. In addition to special technical courses on engineering, complete programs can be arranged which lead to a Master's degree.

In general, the management development appraisal reveals four important things: (1) a factor breakdown of a man's performance, (2) an overall rating of his performance, (3) an estimate of his potential, and (4) description of strengths and weaknesses and the type of developmental action needed to correct these. In addition to supervising coaching and training designed to improve weaknesses in management personnel, the management development program plays another very significant role in the managerial growth program. Each department has a manpower inventory, prepared for it by the management development department. This inventory shows an evaluation of the performance and potential of all the management personnel in the department. By using this inventory, the department head can efficiently plan his manpower forecast, his losses, and possible replacements.

Now, outside of promotional opportunities within the same department, the management development program operates a plant and corporation-wide selection and promotion system. Whenever an opening occurs in any one of our divisions, potential candidates are screened and selected to be referred for interview.

With respect to professional career growth, we recognize that, if we're going to keep the good engineers we have and help attract others, we must take very firm action. Some of the things that we do in this particular area may be of interest to you here. For instance, we have sponsored memberships in the American Rocket Society. Each year our Division offers a group of paid memberships for one year to young engineers and scientists. From these associations the young professional begins to gain experience and insight into his chosen profession. Secondly, opportunity is given to our management personnel to participate in professional societies by contributing articles to their journals, serving on panels, and presenting technical papers. Thirdly, the Missile Division provides counseling and training for state examinations for registered professional engineers. These refresher courses, designed to aid our engineers in preparing for these examinations, are composed essentially of two parts, engineering fundamentals and engineering law and ethics.

We feel that the program I have outlined represents a rather practical approach to professional development.

Mr. Mello: Thank you very much, Gene.

We come to the final topic in the group of five we have selected. Though it is the last, it is not the least. The problem of insulating a skilled man--an engineer or a scientist or any other skilled individual--from administrative distraction is something we are all faced with at one time or another.

To discuss this with you we have Dr. Gilford G. Quarles who has been with the Army Ballistic Missile Agency as Scientific and Technical Consultant and is now Chief Scientist for the Army Ordnance Missile Command. As General Medaris' adviser on scientific matters, he is concerned with the many scientific programs within the Missile Command. The amount of time an engineer or a scientist can spend directly upon the work for which he was hired is one of the problems encountered in all these programs. So, Gil, will you expound on this for a moment?

Dr. Quarles: Yes, I will.

We can't go very far into the question of utilization of technical manpower before we come face to face with two conflicting needs: the need for creative scientific or technical effort and the need for administrative, managerial, or executive work or effort. You've heard Gene Hicks refer to the "need to win promotion up the ladder of success along managerial channels."

Now, despite some of the implications of Lehman's thesis, as discussed this morning, I think that we have a real need to retain technical personnel, the creative technical personnel, in creative endeavor if they can be used for creative purposes in which they are most highly skilled. This means that we need to be able to recognize technical competence or creative competence without diverting a man into administrative or managerial channels.

Technical competence per se is not an indication of leadership ability or managerial ability. It is true that, for technical leadership or technical management, we do need technical ability. But I think we need a different line of advancement for technical personnel, one in which the technical, creative man, engineer or scientist, can continue to do creative work and nothing else and yet receive all of the recognition, all of the material rewards, the remuneration, the prestige, and the privileges that go along with managerial position or responsibility. This isn't often done. Gene mentioned the fact that in Chrysler, on rare occasions, it is. In other cases, you have the situation of the man being put into what is called a "consultant's" position so that he can be paid a little bit more money and still continue his creative work.

But, even if we have this sort of dual channel, one creative and strictly technical and one managerial, we still have the problem of the required technical ability for certain types of supervisory jobs. The immediate supervisor of the technical group must be a technical man. There are a number of reasons for this: he must know the technical work in order to be able to evaluate it; he must be able to speak the language in order to talk properly (partially the problem Dr. Varian was talking about a while ago); he also needs--and this has been emphasized--the technical respect of the

people he is supervising. And this is true right on all the way up to the top. It is necessary that the supervisor be able to fulfill these obligations; therefore he must be a technical man.

But there are many distracting, non-creative duties that go along with this managerial responsibility. These are apparent even at the lowest levels, and they become much more serious as we go on up to the top. At best, these provide a dilution of the creativity of the man who has been diverted into the managerial channel, and, at worst, they provide a very serious frustration because so often the very good scientist is a poor manager or supervisor simply because his heart isn't in it. He's gone into a managerial position because he was faced with a choice, as Dr. Hildebrand mentioned last night, the choice between going into management in order to get the material rewards or sticking with something that he really loves but which doesn't carry the material rewards. That should not be the choice.

At the Army Ballistic Missile Agency a couple of years ago, in an effort to achieve maximum utilization of technical manpower, a survey was made of the people who had, for various reasons, gone into supervisory jobs at various levels. They were asked: "What jobs do you do? What work do you do that is not utilizing your technical capabilities? What are the non-creative jobs that you do? How much of your time do you put on them?" The results of this survey are summarized in a beautifully written paper by Mr. Mello here; he just incidentally has 500 copies of it in his briefcase, in case anybody's interested. Broadly speaking, this is what was discovered: the engineers as a whole felt that about 50% of their effort was spent on non-creative, strictly non-engineering work. It was also found that this non-creative work fell into two categories. There were certain tasks that the engineer had to do which weren't creative but were part of his management responsibility. They were technical in nature, such as programming and scheduling the work requiring a technical understanding, planning for determining the need for materials, equipment, facilities, etc., problems of contract liaison, problems of budget determination, and, above all, budget justification. These are non-creative, but they do require a technical know-how, a technical ability. The second category of responsibility

which went along with these supervisory or managerial positions was strictly non-technical, what we would call an administrative type: the problems of handling the money, budget administration after the funds were allocated, the problems of personnel administration, liaison with the personnel office to get and keep good manpower, problems of security, maintaining the security checks that are necessary to protect the information that is generated on critical programs, and the whole overall problems of organization, methods, procedures, etc.

These two types--the technical on the one hand, the non-technical on the other--of distractive influences were decried by the engineers. Once the problem was laid out in these terms and was recognized, at least one solution was immediately apparent, as is so often true when you define a problem. This was to assign to these engineers assistants who were qualified to do these non-creative tasks but not qualified to do the creative work. This was done by setting up two new types of position. One is called a Technical Program Co-ordinator, who handles the technical programs that are non-creative, and the other an administrative officer, who handles the non-technical, administrative problems. And these two were assigned at the various managerial levels in the organization in each one of the major divisions and at the top executive office. And of course the necessary clerical and leg-man staff were assigned along with them.

This system has been found to be rather effective. It has some defects, but for the most part it's quite effective. The engineers, in the usual "open-minded fashion" of engineers, viewed it with some scepticism. But they were willing to be shown and went along with it. They thought that it would relieve them of, or take away from them, some of their responsibilities, some of their authority. They thought that they would have imposed on them still another level of supervision. But this did not prove to be the case.

The following question might be raised: "Well, doesn't this simply assign three men to do a job that one man was capable of doing before?" And the answer is simple: "No, it does not, not any more than when you assign a secretary, a machinist, a draftsman, and a technician to an engineer, you are assigning four or five people to do the work that one man did before." What

you wind up with is three men to do a job three times as big and better than one man would have been able to do it. The system works, it's liked, and it has many collateral benefits. I won't go into those. But it has proved itself by salvaging a major portion of the creative ability of the engineering and scientific staff of this Agency, ability that would otherwise have been lost simply because the staff was shuffling papers or doing non-creative albeit technical work.

To summarize, we found that there are really three types of responsibilities that go along with the managerial position. One is the creative part, the injection of the technical creativity into the program; the second is the non-creative technical; and the third is the non-technical administrative. By assigning a specialist to each of these responsibilities we found that maximum advantage was taken of the talent available.

Mr. Mello: Thank you, Gil. Well, we've covered a lot of ground here. We're really not on a soapbox trying to sell anything or convince anybody of anything. I think we're sometimes at a disadvantage in presenting ideas on utilization. We've talked about insulating from admimistrative distraction. We've also talked about professional development and the advantage of creative thinking in the effective utilization of personnel. Now, in the few minutes that remain we would like to have questions.

Mr. Krotz: I would like to ask Gene Hicks if he would give his definition of management personnel. I'll amplify my question. It seemed to me that you included professional people as management. Is this true?

Mr. Hicks: Well, in some cases, as Dr. Quarles mentioned, we do have a system of dual hierarchy where the management people and professional people can move up the ladder at the same pace and rate. Many of the things that we do to try to help them get to the top are exactly the same for the line manager as for the professional person. Does that answer your question?

Mr. Krotz: Do they carry management titles as they go up that ladder?

Mr. Hicks: We find that titles are very important, especially to our engineers and scientific group. We have a title that we use. We don't use it freely however; it's not passed out indiscriminately. For instance, an engineer or a scientist who is working alone or with a small group would probably be known as a "managing engineer." These people enjoy all the privileges that go with the line supervisor. They are recognized in management discussions, they are invited to participate in corporate as well as division problems, and we find that they contribute and do a great deal toward achieving the success that we're shooting for.

Mr. Krotz: Don't you have some problem left there, as indicated by Gil, in actually referring to it as professional development? You're still saying that they have to go the management route.

Mr. Hicks: No, not necessarily. We find that we cannot insulate the professional person from management problems. The professional people who may, day in and day out, have very little to do with running the plant and the division feel that they must participate in these management problems. Although they may not be decision-making guys, if I may use the expression, they do contribute. It's not a requirement that they attend some of our management development courses, but we find we can't keep them away. They like it, they participate.

Mr. Mello: Another question?

Mr. LaCauza: My questions's for Dr. Varian with reference to these boundaries. After all, in engineering schools throughout the country, everybody has to take courses in the various fields of science and, from their point of view, those boundaries should not exist. Apparently, from what you say, they do exist. With reference to the suggestion given by Dr. Quarles of having, say, the non-creative technical man, would not he be the man to open the door to those boundaries? Would that not solve it?

Dr. Varian: No, I don't think so. I think these boundaries go deeper than that. For instance, the mere fact that you have lawyers who know nothing about any scientific subjects introduces a whole lot of problems. Of course, the boundaries between physics and chemistry have been steadily disappearing for a

long time, although there's still a certain amount of it, a historical accident. But there are so many of these things. I'm not talking merely about the sciences. I'm talking about all the specialization, all the specialists. One of our basic problems is that, when you have decisions to make for national or world safety and our future that involve all these things, the people you have to convince have a totally erroneous idea about what science is. That's your basic problem.

Mr. Mello: Dr. Varian, and gentlemen, I believe that our time is up. We're going to have a chance to summarize this tomorrow and we'll try to tie all of it together at that time. Thank you very much for your attention.

Mr. Ruddock: Thank you, sir, and the members of the panel for this comprehensive report. I believe Mr. de Guigne has an announcement he would like to make.

Mr. de Guigne: May I second the motion of thanking the moderators and the panels for a very inspiring afternoon.

As those who were here before probably know, we have a Brainpower Forum Committee on Recommendations. I wish that the following gentlemen, under Admiral Spruance as Chairman, would remain here (having had a little touch of the military life, I'm going to drop titles and just read last names): Ruddock, Bunting, Champion, Keene, Mello, Pick, Quarles, Thompson, Miller, and Chown. Thank you, gentlemen.

CLOSING SESSION

Mr. Thompson: Mr. de Guigne has been stricken with something that would have been death to a Thompson--he's lost his voice; so I have been asked to move in as the chair. That is always a pleasant thing for two reasons: one is that you can quit the minute you want to; and the other is that, if you sit down and think of something clever that you might have said, you can use it the next time you are on your feet.

So, representing the Chairman of our Board of Governors, Mr. de Guigne, I want to open this morning's session by asking Dr. Keene to sum up the deliberations of his Brainpower Production panel.

Dr. Keene: Well, I would like to report that there was startling unanimity of opinion on the panel and complete complacence on the part of the audience. But this wasn't our panel; so I'll have to report on the one we had rather than on the mythical panel that I would like to have had.

To the extent that I can express the consensus of the panel, I believe that emphasis was placed on the following items. Underlying the presentation of virtually every panel member, with one possible exception, was a plea for a very broad based education, what I think most of us would consider a liberal education; that this education be broad and comprehensive and that it capture as early as possible in the life cycle of individuals their fascination and interest in the learning process and in its applications. Once having captured the fancy, interest, and intellectual concern of youngsters with the continued encouragement of these individuals, particularly those of high competence, there was agreement that they should be urged to continue on a career leading to scientific endeavor. There was emphasis, as a part of this process, on the identification and encouragement of individuals of high competence in subject matter areas, who can communicate to youth their enthusiasm in the intellectual processes, to be used as master teachers. There was a very important point made in conjunction with this: where preparation in educational methodology may be lacking but an individual has demonstrated clearly and abundantly his capacity to teach, he not be required to re-prove the point that he's a teacher by going through training in methodology. I think there's a feeling on the part of the panel that there's considerable talent available to be drawn from many people in our population who do not have training in methodology.

A very important matter which was emphasized a number of times by the panel was the need for a thorough-going consideration by our citizens of the need for better salaries for teachers, particularly as this affects the retention of teachers and their being rewarded for long, faithful, and effective service, for enhancing their prestige, and -- perhaps we should say -- "other rewards" less tangible than money in terns of the environment and the attitude framework within which teachers go about their work, since these seem to be some very fundamental and motivating forces compelling the interest and the dedication of the kind of people that we want in the teaching area.

I believe it was the consensus of the panel that these are some of the matters meriting attention to help us produce better brainpower not only for the future needs but also for the very desperate present needs of this country in the contemporary world situation.

Mr. Thompson: Thank you, Dr. Keene. I think your mention of "inspiration" and the encouragement of those who can inspire is immensely important.

The toastmaster is supposed to be like the plaster in a brick wall--no thicker than will just stick the bricks to each other and just thick enough to keep them apart. I sometimes have a tendency to spread a little thick now and then. So I am going immediately to introduce Bob Mello who will give you a report on the discussions of his panel on Brainpower Utilization.

Mr. Mello: This panel which I moderated--and I am now supposed to digest in just a few minutes what five men took years to figure out--discussed utilization. The objective of the panel was to bring out that, if we are going to consider what brainpower we need, we must first consider what we're doing with the brainpower we have.

Now, there was one very significant thing about this panel. They are well aware of the old saying that statistics are like a Bikini bathing suit: what they reveal is very interesting, but what they conceal is vital. So the panel gave no statistics. They discussed the subject strictly from the standpoint of men who are used to working with people. We broke it down into five areas: environment, organization, creative thinking, professional development, and administrative distraction. Each area had something to do with the way we use people.

Dr. Varian, in his discussion on organization, brought out the fact of over-specialization. This is the "Achilles' heel" of specialization. In science particularly, we seem to over-specialize, like the E. E. N. T. specialist, who got so specialized he only dealt with the left nostril. That's about the way we get sometimes in science, and this presents a problem in communication. In other words, the left hand doesn't know what the right hand is doing, and they are unable to communicate this to each other so that they can organize properly to conduct scientific research. Dr. Varian's point was that perhaps we should consider in our educational institutions that a broader knowledge be given to all people.

In discussing environment, Mr. Gibson, who is with the Guided Missile Division of Firestone, talked about a problem that the scientist in industry has to face because of the environment in which he is forced to work, where budgets and cost systems and things like that are a constant frustration. He is asked to budget something that actually can't be handled in that manner. You can't predict always where you're going; you just know that you're on your way.

He listed seven points of which he feels every industrial concern should be aware. One of them was to assign work in keeping with the aptitudes and inclinations of the staff. This is the proper environment in which they should work. Don't oversell to the scientist what he is to do. Be sure that he knows just what he is faced with at the time he starts. Give him his boundaries and limitations so that he is not misled by what you want. He should have a vote in budgets and the controls placed over his work. Mr. Gibson brought up the matter of supervision--that the scientist or engineer, the professional man, must have a supervisor whom he respects; therefore, this supervisor should have proper training in the management phases of his job. The scientist should be able to exchange ideas freely with other people who have the same skills. And then, lastly, he should have good facilities. All of these things are reflected by the environment in which the man works.

Larry Limbach presented a rather interesting approach to the next topic, creative thinking. Speaking as the operating manager, he said that

his company's idea was to go outside to obtain the talent needed to support their programs. They were obtaining this talent through the Cooperative Research Institute. Through this method, they got fresh ideas from outside, from people who were not influenced by the local problems. This creative thinking actually gave the staff a shot in the arm. It was an interesting approach to creative thinking within an organization, that is, to bring it in from the outside but not necessarily hire it on a permanent basis.

Mr. Hicks of Chrysler talked about what Chrysler is doing in professional development. If you are going to utilize a man properly, you've got to give him training and assistance within the organization so that he can develop professionally, technically, and from a management viewpoint. Mr. Hicks explained their training program in some detail.

Dr. Quarles concluded our discussion on brainpower utilization by talking about freeing the engineer and the scientist from administrative distraction. He discussed the system the Army Ballistic Missile Agency had instituted whereby a technical program coordinator and an administrative officer were provided to support the engineer so that the non-creative side of his work could be handled by someone else and he could go on with the more creative work.

All this ties down to the fact that there are many ways to increase the utilization of brainpower, but we shouldn't always decide that the best way to increase it is to add more to it. We should look at what we have available.

Following the summary reports of the panel discussions, Mr. Thompson announced that the Recommendations Committee which Mr. de Guigne had appointed had prepared a list of items for consideration by the Board of Governors of the International Science Foundation. He then asked the secretary of Admiral Spruance's Committee, Merritt Ruddock, to present the items which had been developed.

The conference participants discussed these items, which were submitted to the Board of Governors of the International Science Foundation at the close of the meeting. The following recommendations were approved by the Governors on August 12, 1958:

In order to achieve the objectives of the International Science Foundation's Brainpower Forum and aid in the solution of problems brought to the Forum by Foundation members, the 1958 conference committee on recommendations suggested that the International Science Foundation lend its support to programs being carried out by appropriate existing agencies which will ensure action on the following recommendations:

1. In the interest of maximum utilization of our available scientific manpower and of helping to relieve the shortage of teachers in our public schools, the use of qualified retired personnel from industry, universities, and the military services should be expedited in every way possible. As it is assumed that these potential teachers will have above average training in the subject-matter fields but will lack the courses in education required to obtain a teaching certificate, a reappraisal of our present policies with regard to the certification of teachers should be made. Additionally, in order to attract men and women of the highest competence to the teaching profession, it is vital that standards be raised and, as selection improves, that teachers be given the material rewards, privileges, dignity, and prestige commensurate with their high responsibilities to society.

2. Immediate support should be given to programs which will better define our resources in the field of senior manpower in order that we may avoid making policy decisions based upon the extremely limited data presently available. Attention should be given to the development of more effective techniques for maintaining comprehensive inventories of available senior manpower.

3. More attention should be given to studies of research organization and administrative procedures as related to the utilization of senior scientists and engineers.

4. The International Science Foundation should encourage its corporate members to investigate the availability of their retired personnel for service in our educational institutions and, if necessary, help them to pool their interests and develop cooperative programs to inventory

and evaluate their senior scientific manpower resources. The project of this type which has been sponsored by the General Electric Company might be of interest to all members of the International Science Foundation, as pre-retirement planning for a post-retirement career is much needed if we are to achieve effective utilization of senior scientists and engineers.

5. The ISF program of establishing science centers in major U. S. metropolitan areas and developing at these centers activities of interest to retired scientists and engineers should be accelerated and given all possible support by U. S. industry, U. S. foundations, and U. S. government agencies.

6. Research projects which provide part-time opportunities for retired scientists and engineers should be encouraged by government and industry. Projects sponsored by the Cooperative Research Institute at the ISF centers are cited as an example of this type of activity.

7. The International Science Foundation should obtain support for a pilot project to develop an experimental science center which would create the living and working environment needed to ensure that scientists and engineers might continue their professional work after retirement if they so desire. The Monterey area might provide an excellent site for such an experimental center because of its unique combination of cultural resources and available senior manpower.

PRESS RELEASE

INTERNATIONAL SCIENCE FOUNDATION ADOPTS SPRUANCE COMMITTEE PROGRAM TO DEVELOP OPPORTUNITIES FOR SENIOR SCIENTISTS

San Francisco, August 12. The Board of Governors of the International Science Foundation today announced adoption of a seven-point program which evolved during the Foundation's conference on senior scientists and engineers held last week at the U.S. Naval Postgraduate School in Monterey. The conference, one of a series initiated in 1956, was sponsored by the following members of the Foundation: U.S. Naval Postgraduate School, Army Ordnance Missile Command, Stauffer Chemical Company, General Electric Company, Cooperative Research Institute, Federal Pacific Electric Company, Rheem Manufacturing Company, Northrop Aircraft, Inc., Standard Oil Company of California, Firestone Tire & Rubber Company, Varian Associates, Ford Motor Company, and Tidewater Oil Company.

At the conclusion of the conference, Christian de Guigne, Chairman of the Board of Governors of the Foundation, requested that Admiral Raymond A. Spruance, USN (ret.), serve as chairman of a committee on recommendations composed of the following conference participants: Robert F. Mello, Director of Civilian Personnel, U. S. Army Ordnance Missile Command; Dr. J. Whitney Bunting, Consultant for Educational and Corporate Support Research, General Electric Company; Dr. C. Mansel Keene, Chief, Standards Division, U. S. Civil Service Commission; Dr. Robert C. Miller, Chairman of the Board of Trustees of the Cooperative Research Institute; Jos. S. Thompson, President of the Federal Pacific Electric Company; Dr. Gilford Quarles, Chief Scientist, Army Ordnance Missile Command; Jim R. Chown, Assistant to the Vice-President, Customer Relations, Northrop Aircraft, Inc.; Dr. Remsen Bird, President Emeritus, Occidental College; and Merritt K. Ruddock.

After an evaluation of the conference papers and discussions, the committee developed a seven-point program which was then submitted to the Foundation's Board of Governors for approval.

The seven-point committee report read in part:

In achieving the objectives of the International Science Foundation's Brainpower Forum and aiding in the solution of problems of the Foundation members who have pooled their interests and operated the Forum, the 1958 conference committee on recommendations suggests that the International Science Foundation take steps to lend its support to programs being carried out by appropriate existing agencies which will ensure action on the following recommendations:

1. In the interest of maximum utilization of our available scientific manpower and of helping to relieve the shortage of teachers in our public schools, the use of qualified retired personnel from industry, universities, and the military services should be expedited in every way possible. As it is

assumed that these potential teachers will have above average training in the subject-matter fields but will lack the courses in education required to obtain a teaching certificate, a reappraisal of our present policies with regard to the certification of teachers should be made. Additionally, in order to attract men and women of the highest competence to the teaching profession, it is vital that standards be raised and, as selection improves, that teachers be given the material rewards, privileges, dignity, and prestige commensurate with their high responsibilities to society.

2. Immediate support should be given to programs which will better define our resources in the field of senior manpower in order that we may avoid making policy decisions based upon the extremely limited data presently available. Attention should be given to the development of more effective techniques for maintaining comprehensive inventories of available senior manpower.

3. More attention should be given to studies of research organization and administrative procedures as related to the utilization of senior scientists and engineers.

4. The International Science Foundation should encourage its corporate members to investigate the availability of their retired personnel for service in our educational institutions, and if necessary, help them to pool their interests and develop cooperative programs to inventory and evaluate their senior scientific manpower resources. The project of this type which has been sponsored by the General Electric Company might be of interest to all members of the International Science Foundation as pre-retirement planning for a post-retirement career is much needed if we are to achieve effective utilization of senior scientists and engineers.

5. The ISF program of establishing science centers in major U.S. metropolitan areas and developing at these centers activities of interest to retired scientists and engineers should be accelerated and given all possible support by U.S. industry, U.S. foundations, and U.S. government agencies.

6. Research projects which provide part-time opportunities for retired scientists and engineers should be encouraged by government and industry. Projects sponsored by the Cooperative Research Institute at the ISF centers are cited as an example of this type of activity.

7. The International Science Foundation should obtain support for a pilot project to develop an experimental science center which would create the living and working environment needed to ensure that scientists and engineers might continue their professional work after retirement if they so desire. The Monterey area might provide an excellent site for such an experimental center because of its unique combination of cultural resources and available senior manpower.

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OBJECTIVES OF THE INTERNATIONAL SCIENCE FOUNDATION

In 1953, with the assistance of the California Academy of Sciences and the endorsement of the National Academy of Sciences-National Research Council, the Cooperative Research Foundation established an experimental international science center in Golden Gate Park which initiated projects designed to aid in the development of our own scientific resources and those of our colleagues overseas. The center became a focal point for engineers and scientists visiting the Bay Area and developed activities which have given local professional personnel increased opportunities for exchanging ideas with scientists from other countries.

In 1954, when the work of the experimental San Francisco Bay Area International Science Center had begun to receive the recognition of organizations in other parts of the United States and abroad, it was proposed that a new foundation be organized for the purpose of sponsoring not only the operation of the San Francisco Center but also for undertaking the establishment and operation of similar centers in other metropolitan areas. In order to provide an effective method for stimulating the development of the scientific resources of these areas, it was recommended that the new foundation's corporate and membership structure be carefully tailored to integrate the cooperative efforts of academies of science, research councils, scientific and engineering societies, colleges and universities, government agencies, museums, foundations, research institutes, industrial laboratories, banks, corporations, associations, and individuals. Accordingly, a group of members of the Cooperative Research Foundation established the International Science Foundation as a non-profit corporation with national headquarters in San Francisco.

The program of the International Science Foundation depends upon three types of activity for its effectiveness:

1. Establishment and operation of science centers in metropolitan areas capable of supporting their programs. It is expected that, as additional centers are established, they will begin operating in temporary quarters and, like the San Francisco Center, they will at first function as clearinghouses to aid visiting scientists and engineers in exchanging ideas and developing

professional cooperation with their colleagues in local sections of scientific societies and in local industrial laboratories, universities, research institutes, and other organizations. Each center will develop a program to meet local needs. ISF's ultimate objective is to have each center housed in its own buildings, providing facilities which may be used by ISF members and especially by engineering and scientific societies for offices, meetings, and other activities. These centers will also furnish housing and other accommodations for scientists.

2. Strengthening the mechanism of exchange between all scientists and engineers. The International Science Foundation believes that emphasis should be placed on improving the quality of scientific and engineering manpower and on increasing the productivity of our existing manpower resources. Visiting engineers and scientists bring new ideas into laboratories and stimulate our research staffs. ISF promotes world trade in ideas through its center programs, through travel grants, exchange of publications and information, and by special projects such as the publication of handbooks of the scientific resources of the areas served by ISF centers.

3. Development of cooperative projects between members of the Foundation. The team research projects that are now being developed are projects in which each ISF member provides personnel and a portion of the required funds or material for the work. The International Science Foundation also plans to work with its participating members on the organization of international symposia.

The program of the International Science Foundation takes on new importance in view of the recent cold war developments which are ushering in an era of world-wide, open competition between democratic and communist systems. The Foundation depends upon corporate support for its effectiveness and, in turn, gives American business and industrial interests an opportunity to make direct contact with ISF members institutions in other countries and participate in cooperative projects which are mutually beneficial. ISF's corporate members are in a strategic position to demonstrate some of the advantages of our free enterprise system to scientists representing these overseas scientific groups when they are visiting the U. S.

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MEMORANDUM TO MEMBERS OF THE INTERNATIONAL SCIENCE FOUNDATION and
PARTICIPANTS IN THE 1958 CONFERENCE OF THE BRAINPOWER FORUM

The Proceedings of the 1958 conference of our Brainpower Forum have been printed by the Firestone Tire and Rubber Company as a part of its participation as a conference sponsor. I am enclosing your complimentary copy of these Proceedings. An order blank is attached for your convenience if you wish to obtain additional copies of these or earlier Proceedings for friends or colleagues.

In connection with the 1958 conference, we must report that the most unpleasant duty that befell our editor was that of eliminating the wonderful collection of stories that Joe Thompson and his fellow Bohemians brought along to liven our meeting. We have re-recorded the stories from the meeting tapes and would be happy to hear from any of ISF's members who would like to borrow this scholarly collection from the ISF tape library.

I believe that you will be especially interested in the presentation of our dinner speaker, Dr. Hildebrand (pp. 21-35), in the material prepared by Dr. Bunting and Dr. Miller (pp. 53-71), and in the panel discussions on brainpower production and utilization (pp. 89-137). You may also be interested in the fact that, since last August, we have been able to initiate action on points 5, 6 and 7 (p. 150) of the Spruance Committee recommendations. The enclosed ISF Newsletter will give you additional information on this action.

Several conference participants have suggested that the Brainpower Forum Committee prepare a resolution which could be endorsed by those members of the International Science Foundation who wish to take a stand on major Forum issues. A resolution of this kind has been prepared, and, if you desire to be listed among those members endorsing the resolution, you may sign the consent blank at the top of the resolution and return it to us at your earliest convenience.

On behalf of the Board of Governors of the International Science Foundation, I want to thank all members who participated in the August conference and express our appreciation to the sponsors who made it possible. We hope to hold a Forum conference on research administration as soon as Forum fund batteries can be charged.

June 22, 1959

Robert L. Champion
President

MEMORANDUM TO THE BOARD OF GOVERNORS OF THE INTERNATIONAL SCIENCE FOUNDATION:

I herewith give consent for the use of the name of_____

_____ in connection with the following
(individual or organization)

resolution.

_____ _____
Date Signature

- -

In order to achieve the objectives of the International Science Foundation's Brainpower Forum and aid in the solution of problems brought to the Forum by the Foundation's members, the 1958 conference committee on recommendations suggested that the Foundation lend its support to programs being carried out by appropriate existing agencies which will ensure action along the following lines:

RESOLVED, THAT, in the interest of maximum utilization of our available scientific manpower and of helping to relieve the shortage of teachers in our public schools, the use of qualified retired personnel from industry, universities, and the military services be expedited in every way possible.

THAT, as it is assumed that these potential teachers will have above average training in the subject-matter fields but will lack the courses in education required to obtain a teaching certificate, a reappraisal of our present policies with regard to the certification of teachers be made.

THAT, in order to attract men and women of the highest competence to the teaching profession, standards of teaching be raised and, as selection improves, teachers be given the material rewards, privileges, dignity, and prestige commensurate with their high responsibilities to society.

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BRAINPOWER FORUM PROCEEDINGS

International Science Foundation
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Senior Scientific Manpower Conference Planned

of the recommendations of the group attending ISF's Brainpower Forum he U. S. Naval Postgraduate School was that the Foundation sponsor a con- nce on senior manpower in late 1957. Plans are now being made to hold meeting in Monterey. Discussing conference objectives during last October's um were, left to right, Dr. Wernher von Braun, Director of Development rations, Army Ballistic Missile Agency; Captain A. B. Metsger, Deputy Chief Naval Research; Christian de Guigné, Chairman of the Board, Stauffer Chemi- Company; Richard S. Rheem, Chairman of the Board, Rheem Manufacturing npany; and Brigadier General John Barclay, Deputy Commander of the ıy Ballistic Missile Agency.

INTERNATIONAL COOPERATION IN SCIENCE

Quarterly Newsletter of the International Science Foundation

San Francisco **Summer 1959**

Christian de Guigné, Chairman of the Board of Governors of the International Science Foundation, presides at a Sunnyvale Chamber of Commerce ceremony symbolizing the transition of the D'Arrigo land from agricultural to industrial use.

Science Center Now Under Construction

On May 15, 1959, the International Science Foundation initiated development of its first major international science center on a 130-acre site in Sunnyvale, California.

This new type of industrial park will offer many advantages to the industrial firms establishing facilities there, as the site, near the Bayshore Freeway and Lawrence Station Road, is located in the center of the Bay Area's rapidly expanding concentration of industrial activity. It is conveniently situated with respect to airport facilities and the area's educational institutions.

The zoning approved for ISF's unique planned community for industry will make sites available for research laboratories, manufacturing plants, office buildings, a clinic, banks, shops, a motel, restaurants, auditorium, garden apartments, and a number of other activities.

Approximately thirty acres will be developed as the Center headquarters area to provide University extension and a wide range of services to the research and development interests locating in the Center. One of the features of the headquarters area will be a club for scientists and engineers. This club, to be modeled on the facilities of one of ISF's members in England, the Society for Visiting Scientists, Ltd., will provide housing and other accommodations for visiting scientists representing ISF member organizations throughout the world. The 100 acres surrounding the headquarters area are being made available for sale to corporations and organizations who plan to build their own offices, laboratories, or light industrial facilities.

Objectives of the Center Program

In 1954, the founders of the International Science Foundation initiated a two-phase program to strengthen the cooperative scientific activities of the academies of science, research councils, scientific societies, universities, institutes, foundations, and the corporate and individual scientific interests that make up the Foundation's membership.

The first phase of this program has as its objective the establishment and operation of a number of reception centers in major metropolitan areas of the United States which will function as "clearing houses" to expedite an exchange of ideas between scientists and engineers working in these communities and visiting scientists from other parts of the U.S. and overseas. It is anticipated that each center, during its initial operating period, will be housed in a local scientific institution as has been the case with the Foundation's San Francisco Center at the California Academy of Sciences and its Los Angeles Center at the California Museum of Science and Industry. These first "Phase One" centers have become effective focal points for activities facilitating an exchange of information between professional personnel.

The role of the International Science Foundation in Phase Two of the center program was foreseen as that of a catalyst sponsoring the development of scientific communities by bringing together groups of ISF members who wished to develop their own laboratories or plants in close proximity to service facilities of various kinds. The "Phase Two" centers would thus provide sites for office buildings, research laboratories, and facilities for light manufacturing. In addition to accommodations for ISF members with rather sizable research and development requirements, it was felt that each center should offer a variety of services which would enable small research or engineering groups to operate more effectively.

The participating membership of ISF includes many governmental agencies, foundations, and scientific organizations which could facilitate their local programs by locating area liaison offices in ISF centers. Local sections of national scientific and engineering societies, by establishing offices in an ISF center, could take advantage of the center's services, its library, and its facilities for meetings and conferences. Thus the engineering and scientific activities which would develop around each ISF center would complement and strengthen the programs of the ISF members located in the center.

Some facilities at each center will be operated by ISF or one of its service organizations on behalf of a group of its members. One example of a facility of this type which has been suggested by a number of Bay Area ISF mem-

bers is a cooperative environmental test facility which could be utilized by industry, government agencies, and independent research groups for qualification of components for aircraft and missile programs.

In connection with its program for better utilization of senior scientific manpower which was initiated at the U.S. Naval Postgraduate School in October, 1956, the International Science Foundation is interested in establishing a pilot project at one of its science centers which would provide an attractive residential development conveniently located with regard to the research facilities of the center. The residential area would include homes, apartments, and services for retired scientists and engineers as well as other professional personnel who would be participating in the research projects of the center. The National Committee for the Emeriti has proposed that such a pilot project be jointly sponsored by the International Science Foundation and the Committee. This would create a community where retired scientists and engineers from universities and from industry could find convenient opportunities for consulting work or for part or full-time employment.

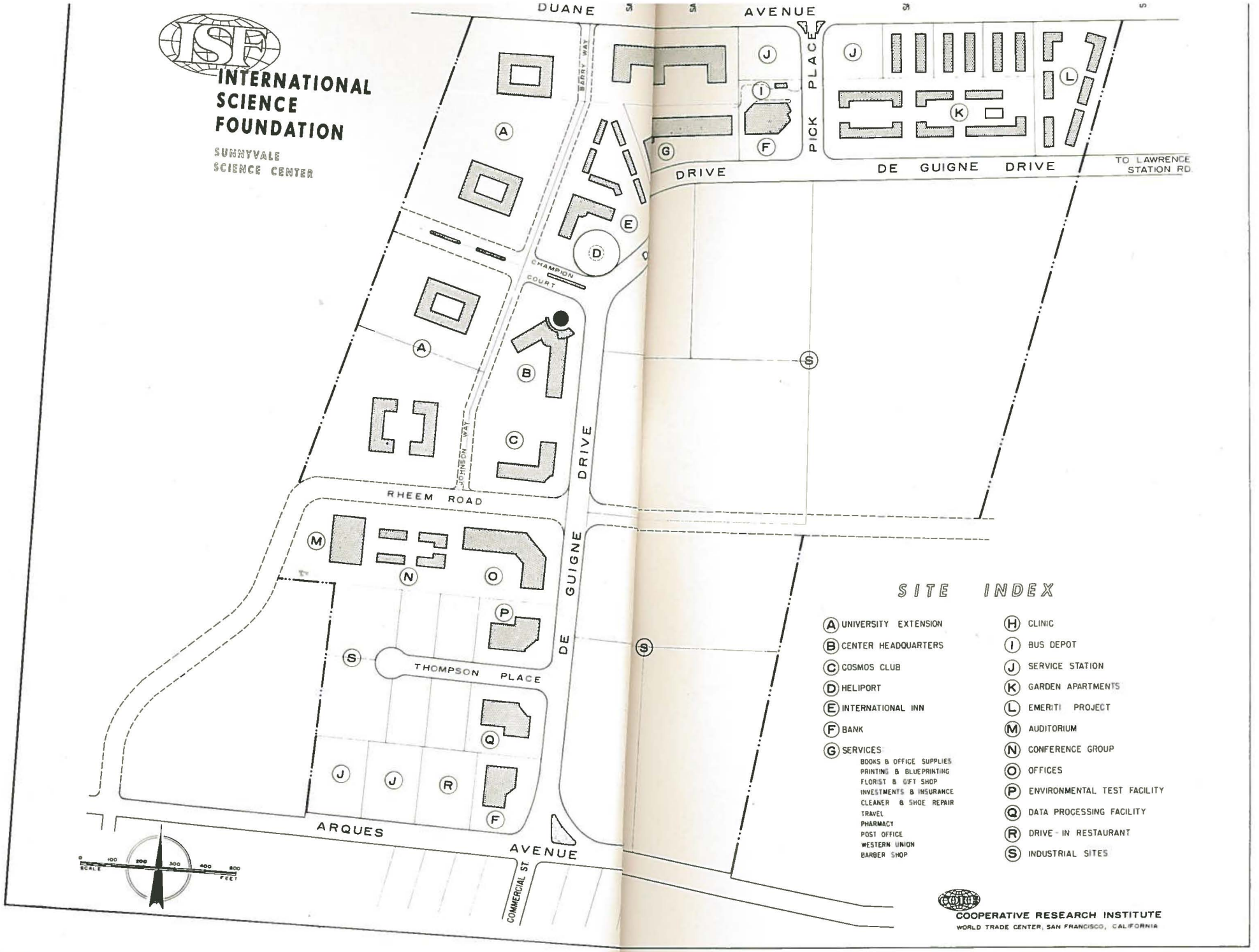
The International Science Foundation's long-range plan for facilities in the San Francisco Bay Area envisions seven centers which will include three basic types: research, engineering, and industrial.

Los Angeles Handbook Planned

The staff of ISF's newest reception center for visiting scientists, headed by Director Robert E. Vivian, Dean Emeritus of the University of Southern California School of Engineering, will begin work this fall on an inventory of the scientific resources of the Los Angeles metropolitan area. The Southern California Center plans to release this new biennial publication in 1960.

The program of the Center at the California Museum of Science and Industry has been developed jointly by Dean Vivian; ISF Vice President Don M. Muchmore, who is Director of the Museum; Richard S. Rheem, the member of the ISF Board of Governors who serves as chairman of the Foundation's Committee on New Centers; and Robert L. Champion, ISF's President.

Members of the Advisory Board of the Southern California International Science Center include John Stauffer, Senior Vice President of Stauffer Chemical Company; Dr. Rufus B. von KleinSmid, Chancellor of the University of Southern California; J. Howard Edgerton, President of the California Federal Savings and Loan Association; Dr. Raymond B. Allen, Chancellor of the University of California at Los Angeles; Courtlandt S. Gross, President of Lockheed Aircraft Corporation; Lloyd L. Austin, President of the Security First National Bank; Randolph A. Hearst, President of the Hearst Publishing Company; Earle M. Jorgensen, President of the Earle M. Jorgensen Company; Preston Hotchkis of Founders Insurance Company; John S. Griffith of Buena Park; L. M. Limbach, Vice President, Rheem Manufacturing Company; H. I. Gibson, General Manager of the Guided Missile Division, Firestone Tire and Rubber Company; A. E. England, President of A. E. England, Inc.; William Clayton of the Clayton Manufacturing Company; and Jack G. Kuhrts of Miller, Kuhrts & Cox. Ch. de Guigne, Robert L. Champion, Richard S. Rheem, Don M. Muchmore, and Robert E. Vivian of ISF's Board of Governors are *ex officio* members.


INTERNATIONAL SCIENCE FOUNDATION
SUNNYVALE SCIENCE CENTER
DUANE AVENUE
PICK PLACE
BARRY WAY
CHAMPION COURT
JOHNSON WAY
DE GUIGNE DRIVE
RHEEM ROAD
THOMPSON PLACE
ARQUES AVENUE
COMMERCIAL ST.
DRIVE
DE GUIGNE DRIVE
TO LAWRENCE STATION RD.
SCALE 0 100 200 300 400 800 FEET
SITE INDEX
(A) UNIVERSITY EXTENSION
(B) CENTER HEADQUARTERS
(C) COSMOS CLUB
(D) HELIPORT
(E) INTERNATIONAL INN
(F) BANK
(G) SERVICES
BOOKS & OFFICE SUPPLIES
PRINTING & BLUEPRINTING
FLORIST & GIFT SHOP
INVESTMENTS & INSURANCE
CLEANER & SHOE REPAIR
TRAVEL
PHARMACY
POST OFFICE
WESTERN UNION
BARBER SHOP
(H) CLINIC
(I) BUS DEPOT
(J) SERVICE STATION
(K) GARDEN APARTMENTS
(L) EMERITI PROJECT
(M) AUDITORIUM
(N) CONFERENCE GROUP
(O) OFFICES
(P) ENVIRONMENTAL TEST FACILITY
(Q) DATA PROCESSING FACILITY
(R) DRIVE-IN RESTAURANT
(S) INDUSTRIAL SITES
COOPERATIVE RESEARCH INSTITUTE
WORLD TRADE CENTER, SAN FRANCISCO, CALIFORNIA

Proceedings of August, 1958 Conference of Brainpower Forum Now Available

The Firestone Tire and Rubber Company has recently completed printing the Proceedings of ISF's 1958 Brainpower Forum conference as part of the Firestone conference contribution. Other sponsors of this latest conference were the Stauffer Chemical Company, the General Electric Company, the U. S. Army Ordnance Missile Command, the U. S. Naval Postgraduate School, Federal Pacific Electric Company, Rheem Manufacturing Company, Northrop Aircraft, Inc., Standard Oil Company of California, Varian Associates, Ford Motor Company, and Tidewater Oil Company.

Our August, 1958 conference, held at the U. S. Naval Postgraduate School, gave Forum participants an opportunity to report on projects initiated after the 1956 conference to provide better utilization of senior scientific manpower.

The conference highlight was an address by Dr. Joel H. Hildebrand, Professor of Chemistry Emeritus of the University of California, on "The Critical Element in our Brainpower Picture—Quality not Quantity." Dr. J. Whitney Bunting, Consultant for Educational and Corporate Support Research of the General Electric Company, reported on studies undertaken by General Electric to evaluate the potential for an educational relations program to promote the flow of retired business and industrial personnel into academic life.

Dr. Robert C. Miller, Chairman of the Board of Trustees of the Cooperative Research Institute, discussed the results of an experiment initiated as the result of the platform adopted at the Brainpower Forum's 1956 conference and designed to create new opportunities for retired scientists and engineers. Another speaker, Dr. Howard L. Bevis, Chairman of the President's Committee on Scientists and Engineers, reported on the Yale conference of February, 1958. Representatives of industry, education, and government participated in the conference's two panels—one on brainpower production and the other on brainpower utilization.

The conference's committee on recommendations, under the chairmanship of Admiral Raymond A. Spruance, developed a seven-point program which was submitted to ISF's Board of Governors. The program covered teacher certification policies, inventories of available senior manpower, research organization and administrative procedures with regard to the utilization of senior scientists and engineers, the development of projects of interest to retired scientists and engineers at ISF science centers, and the development of an experimental science center which would create the living and working environment needed to provide opportunities which would enable scientists and engineers to continue some professional work after retirement.

Copies of all Brainpower Forum conference proceedings may be ordered from the International Science Foundation.

Cooperative Research Institute Now Offering Unique Services to ISF Members

Following the first conference of ISF's Brainpower Forum several years ago, the recommendations committee reported that our shortage of scientific manpower would be much less critical if more attention were paid to better utilization of presently existing brainpower resources. Accordingly, the Foundation requested that its service organization for research, the Cooperative Research Institute, initiate a program to test a number of the Forum's recommendations.

Pilot projects were initiated for several ISF members to evaluate different methods of organizing research teams made up of personnel from a wide variety of sources including universities, research institutes, industry, and retired groups. These pilot projects included development of a Marin County master airport plan for the Marin Development Foundation, an economic study of the proposed Marin County airport for the Board of Supervisors, development of a mathematical model of the vertical structure of wind for the Air Research and Development Command, a tuna marketing study for the Japan Trade Center, an evaluation of radiation damage to bone structure for the U. S. Naval Radiological Defense Laboratory, development of a new type of acetylene cylinder filler for the California Oxygen Company, hospital site evaluations for the Kaiser Foundation, and the organization of a research advisory council and group of fifty consultants for the Rheem Manufacturing Company.

The experimental projects proved to be unusually productive, and the International Science Foundation has now suggested that the Cooperative Research Institute (CORE) make similar services available to all ISF members who might wish to utilize the manpower resources that have been mobilized. CORE's working nucleus is drawn from a group of several hundred scientists, engineers, economists, and other professional personnel on the staffs of universities, reseach institutes, scientific institutions, and industrial organizations both in the United States and overseas. For projects of some magnitude and duration, these CORE members can be given leaves of absence from their permanent staff positions in order that they may join a CORE project organization. Projects of short duration have been carried out utilizing CORE members on a part-time basis.

The methods of operation that have been evolved by the Cooperative Research Institute as a result of the Brainpower Forum conferences are designed to provide high-quality research teams and ensure maximum project flexibility at low overhead cost to ISF members. The most interesting type of project developed for ISF members has been the organization of stand-by technical staffs made up of CORE members in widely varying areas of specialization. Members of these stand-by staffs are on call and are utilized by ISF members to supplement their own research staffs when uniquely qualified scientific manpower is needed for consultation.

CORE is now prepared to organize and staff projects for ISF members and will welcome inquiries from those who wish to discuss project requirements.

ISF Completes Downtown San Francisco Facility

One of the most interesting features of ISF's new Ferry Building facility for visiting scientists is the use of members' trade marks, seals, and insignia as an integral part of the center design.

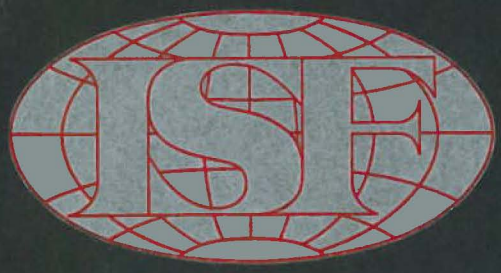
The display of members' insignia has attracted much attention and is becoming more colorful as new plaques are received. Those members of ISF who have not yet designed their insignia plaques are urged to do so as soon as possible. Most of the insignia received to date have been painted on ¾-inch plywood, but several have been executed in leather, lucite, bronze, or stainless steel. The size must be uniform in order to fit the display; hence the restriction that they must not measure more than six inches on the longest axis.

***Center,* Christian de Guigné receives the membership plaque of the Consiglio Nazionale delle Ricerche from Pierluigi Alvera, Consul General of Italy. *Lower right,* Toshihiko Nishiwaki, Vice-Consul of Japan, after presenting the insignia of the Japan Trade Center, looks on as Paulo Monteiro Lima, Vice-Consul of Brasil, receives the membership certificate of the Instituto Nacional de Pesquisas da Amazonia from R. L. Champion, ISF's President.**

Another feature of our World Trade Center facility is its library containing conference proceedings, reports, periodicals, and other publications of the Foundation's members.

Among the more important collections are the monthly reviews of the National Research Council of Italy, bulletins of the National Research Council of the Philippines, and reports on scientific and technical developments by the South African Council for Scientific and Industrial Research. The Foundation also receives regularly scientific reports published by the Royal Danish Academy of Sciences and Letters, the Swiss National Science Foundation, the Austrian Academy of Sciences, the Belgian National Research Council, the Central National Council for Applied Scientific Research in the Netherlands, the Chemical Institute of Canada, Det Norske Videnskaps-Akademi i Oslo, and the Consejo Superior de Investigaciones Cientificas in Madrid.

The proceedings of symposia and colloquia sponsored by the CIBA Foundation and of symposia held by the Josiah Macy, Jr. Foundation also form an important part of ISF's library, along with the *Book of ASTM Standards* of the American Society for Testing Materials, the proceedings and transactions of the American Society of Civil Engineers, and reports and other publications of many of the other scientific and engineering societies that make up ISF's membership.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