NOMINATIONS

HEARINGS

BEFORE THE

COMMITTEE ON LABOR AND PUBLIC WELFARE UNITED STATES SENATE

NINETY-THIRD CONGRESS

SECOND SESSION

ON

JEWEL P. COBB, NORMAN HACKERMAN, WILLIAM NEILL HUBBARD, JR., SAUNDERS MAC LANE, GROVER E. MURRAY, DONALD B. RICE, JR., L. DONALD SHIELDS, AND JAMES H. ZUMBERGE TO BE MEMBERS OF THE NATIONAL SCIENCE BOARD, NATIONAL SCIENCE FOUNDATION

SEPTEMBER 11 AND OCTOBER 3, 1974

Printed for the use of the Committee on Labor and Public Welfare

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NOMINATIONS

WEDNESDAY, SEPTEMBER 11, 1974

U.S. SENATE,
COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The committee met, pursuant to notice, at 3 p.m., in room 4232, Senate Office Building, Hon. Harrison A. Williams, chairman, presiding.

Present: Senators Williams, Kennedy, and Cranston.

Also present: Senators Weicker and Tower.

The CHAIRMAN. The committee will come to order to consider the nominations referred to the committee for the National Science Board, National Science Foundation.

I have a letter here from the White House that I order inserted in the record at this point.

[The letter referred to follows:]

THE WHITE HOUSE

WASHINGTON

August 30, 1974

Dear Mr. Chairman:

President Ford supports the nominations of William Hubbard, Donald Rice, Norman Hackerman, Grover Murray, James Zumberge, L. Donald Shields, Saunders MacLane, and Jewel P. Cobb for the National Science Board. Since these appointments have been in process a long time, anything you could do to expedite their hearings would be appreciated.

Thank you for your patience in this matter. Please call if you have any questions.

Sincerely yours,

David J. Wimer
Special Assistant to the President

Honorable Harrison A. Williams, Jr.
Chairman
Labor and Public Welfare Committee
United States Senate
Washington, D.C. 20510

The CHAIRMAN. The distinguished senior Senator from the State of New York, my good friend and ranking minority member of the committee, Mr. Javits, could not attend this hearing because of a prior commitment but I am happy to order his statement printed in the hearing record as if he were present.

PREPARED STATEMENT OF HON. JACOB K. JAVITS, A U.S. SENATOR FROM THE STATE OF NEW YORK

Senator JAVITS. Mr. Chairman, I regret that I will be unable to be present at the hearings this afternoon due to scheduling conflicts. This is the first time the committee has held hearings on nominees to the National Science Board. In this regard I would like to point out that this hearing has been requested and held with the full concurrence of the minority members of the committee.

The importance of the National Science Board to the contribution which science can make to alleviate the many problems which lie before this Nation is great. With each day the significance of the task of the men who sit upon this Board grows both with respect to the welfare of this Nation, as well as that of the international community. We, in the Congress, do not take their duty lightly and wish to express to them our awareness of the importance of the contributions they must make.

The CHAIRMAN. Senator Weicker, we are honored to have you here to introduce one of the nominees.

STATEMENT OF HON. LOWELL P. WEICKER, JR., A U.S. SENATOR FROM THE STATE OF CONNECTICUT

Senator WEICKER. Thank you very much.

I just want to say a few words on behalf of Dr. Jewel Plummer Cobb who is here with us today.

She is a member of the faculty at the Connecticut College, New London, Conn. That is the college my wife attended, and I always remember it as the Connecticut College for Women.

Dr. Cobb also is dean of the college and is someone highly thought of not just in academic circles but indeed in civic circles in Connecticut and, more specifically, in the town of New London.

I think her presence will be a great addition to the Foundation. She has a great warmth about her. She is a true scientist, but I suppose first very much a human being. She is interested in other human beings, and I am very proud to have her as the Connecticut representative on the Board.

The CHAIRMAN. Thank you very much, Senator Weicker.

Senator Tower, we would like to have your statement at this time. If you do not have time to stay and would like to introduce the nominees from Texas, please proceed.

Senator TOWER. Thank you, Mr. Chairman.

It is good to be back in my old committee environs without having any other responsibility.

The CHAIRMAN. We greatly miss you.

STATEMENT OF HON. JOHN TOWER, A U.S. SENATOR FROM THE STATE OF TEXAS

Senator TOWER. It is a pleasure for me to appear today to urge the favorable action of the committee on two fellow Texans, Dr. Hackerman, who is the president of Rice University, and Dr. Murray, who is the president of Texas Tech.

Both of these men are not only distinguished educators but distinguished scientists. Dr. Hackerman is a renowned chemist. Dr. Murray is a renowned geologist. Both have made substantial and significant contributions in their respective fields.

The value of their services on the Science Board of the National Science Foundation is manifest in the fact that they have been renominated for second terms. I should just like to express my unqualified endorsement and urge the favorable consideration of the committee.

In order not to detain the committee longer, I ask that by unanimous consent my letter to you on the matter be included in the record at this point.

The CHAIRMAN. It will be included.

[The letter of Senator Tower referred to follows:]

JOHN TOWER
TEXAS

COMMITTEES:
ARMED SERVICES
BANKING, HOUSING AND URBAN AFFAIRS
JOINT COMMITTEE ON DEFENSE PRODUCTION

United States Senate
WASHINGTON, D.C. 20510

September 10, 1974

The Honorable Harrison A. Williams
Chairman
Committee on Labor and Public Welfare
United States Senate
Washington, D. C. 20510

Dear Mr. Chairman:

I am most pleased to have the opportunity to urge that your Committee report favorably to the Senate the nominations of Doctor Norman Hackerman and Doctor Grover E. Murray for additional terms of service on the National Science Board, National Science Foundation.

We Texans are often accused of excessive boasting when we speak of the many attributes of our State. Our boasting is accurate and not subject to rebuttal, however, when we speak of the outstanding institutions of higher learning--both public and private--located within Texas. My friends before your Committee today, Presidents of two of our finest and most respected universities, are exceedingly well qualified for continued service on the National Science Board, having proven their worth through their outstanding contributions to the Foundation over the past six years. Not only are they eminent administrators and academicians, but moreover they are highly respected natural scientists within their individual realms of experience and training.

Dr. Hackerman fills a dual role at Rice University in Houston where he serves not only as President but in addition as Professor of Chemistry. A transplanted Texan, having been reared in the Eastern United States and educated at Johns Hopkins University, Dr. Hackerman has distinguished himself as an outstanding chemist. For twenty-five years he served the University of Texas, first as an Assistant Professor of Chemistry, and then progressing through the ranks to the Chairmanship of the Department and eventually Presidency of the University. Widely published, he has long held membership and participated in the professional societies of the scientific community of which he is such an important member.

Dr. Murray became a Texan in 1966 when he moved to Lubbock to assume the Presidency of Texas Tech University. A North Carolinian by birth, Dr. Murray received his advanced degrees from Louisiana State University, where he later joined the faculty and rose to Chairmanship of the Department of Geology prior to being named Vice-President for Academic Affairs. Publisher of a textbook concerning the geology of the Gulf Coast, Dr. Murray's expertise and abilities have benefited numerous educational and geological professional associations and commissions.

I thus commend, Mr. Chairman, each of these men to you and to the members of the Committee and urge your favorable consideration of their nomination to the National Science Board.

Warm regards,

Very truly yours,

John Tower

John Tower

JGT:Sb

The CHAIRMAN. We are very grateful for your appearance and your statement. It will be very helpful to the committee.

We will now receive for the record a statement from Senator Bentsen.

STATEMENT OF HON. LLOYD BENTSEN, A U.S. SENATOR FROM THE STATE OF TEXAS

Senator BENTSEN. Mr. Chairman, I am pleased today to join those endorsing the renominations of Dr. Norman Hackerman and Dr. Grover Murray to the National Science Board. Both have served on that body for the last 6 years, and their nominations for reappointment attest to the merit and distinction of their service.

Both Dr. Hackerman and Dr. Murray have demonstrated a continuing excellence within their chosen professions, academic disciplines, universities, and larger communities. Both have spent long years acquiring their expertise, but they also bring to all of their endeavors a breadth of vision and perspective absolutely essential for distinguishing the immediate from the lasting.

Dr. Norman Hackerman currently serves as the president of Rice University in Houston. Educated as a chemist at Johns Hopkins, Dr. Hackerman came to Texas shortly after the Second World War and taught with distinction at the University of Texas from 1945 to 1970 while pursuing his special interest of colloid research. He chaired that university's chemistry department, served as dean of research and sponsored programs, and was vice chancellor for academic affairs. He climaxed his career in Austin by being named president of the University in 1967 and held that post until leaving for the presidency of Rice.

Dr. Hackerman has received the National Association of Corrosive Engineers' Whitney Award and currently is a fellow of the New York Academy of Sciences and the American Chemical Society.

Since his appointment to the National Science Board, Dr. Hackerman has chaired its programs committee and its ad hoc committee on the Fifth National Science Board's Report to the Congress which published its findings, "Science Indicators," in August 1973. He also is a member of the Board's Committee on Graduate Education.

Dr. Grover Murray has served as president of the rapidly growing Texas Tech University in Lubbock since 1966. Educated in geology at the University of North Carolina and Louisiana State University, Dr. Murray chaired L.S.U.'s geology department and served as vice president and dean of academic affairs before coming to Tech and adopting Texas as his home. Since 1969, Dr. Murray has also been president of the Texas Tech School of Medicine.

Dr. Murray has chaired the U.S. National Committee on Geology, directed a National Science Foundation project on geologic studies in northeastern Mexico, served on the Interior Department's Marine Resources Advance Committee, and been a delegate to the 1967 meeting of the International Committee on the History of Geological Sciences in the Soviet Union. He has served with the World Health Organization and been a member of the board of directors with the Southwest Center for Advanced Studies.

Dr. Murray received the University of North Carolina's Distinguished Alumni Award in 1971 and is a fellow of the Geological Society of America. As the National Science Foundation proceeds with its coordination of our Nation's energy research and development, Dr. Murray's association with the Society of Exploration Geophysicists, the American Society of Oceanography, and the Gulf Universities' Research Corp. will be invaluable.

Dr. Murray has served on the National Science Board's long-range planning committee and has chaired its Budget Management Subcommittee.

Mr. Chairman, John Fitzgerald Kennedy once thoughtfully observed that "Science contributes to our culture in many ways, as a creative intellectual activity in its own right, as the light which has served to illuminate man's place in the universe, and as the source of understanding of man's own nature." Man's inquisitive nature is perhaps his greatest resource. It has led him on an endless pursuit to the far horizons of knowledge, and it is that force which must be harnessed and directed in solving the problems that pose a never-ending challenge to him.

If man's inquisitiveness knows no bounds, most of his resources are, unfortunately, not without limit. During the past year, we have painfully learned that the materials needed to feed, to clothe, to house, and to transport man are not always sufficient, nor are the resources needed to increase quickly their supply. Critical choices will have to be made in the decade ahead—and are, indeed, already being made—which will drastically affect the quality of life on Earth during the last third of this century.

Both of the gentlemen I endorse have proven their ability to make those hard choices, to balance the many demands with the growing but nevertheless limited resources of their fine universities. Their decisionmaking ability and management experience have already been utilized by the National Science Board, and both will certainly be drawn upon heavily in the years ahead.

More than sheer intelligence, inquisitiveness, professional skill, and management ability is, however, needed if the fruits of science and technology are to be harvested for man. Science has profoundly enlarged our capability to sustain and improve life, but within our own lifetimes, we have also witnessed the profoundly destructive forces that the discipline has unleashed. Man's survival will continue more than ever to depend upon the rational, civilized and truly humane application of science's wonders. As Milton Eisenhower once noted, "Science tells man only what is possible, not what is right." I trust that Dr. Hackerman and Dr. Murray have the ability to distinguish what is truly right, and I believe that we, as a just and decent people, need men like them to direct the course of our national scientific effort.

Mr. Chairman, I urge the committee's thoughtful consideration and approval of the nominations of two outstanding scientists and my good friends, Dr. Norman Hackerman and Dr. Grover Murray.

The CHAIRMAN. Dr. Stever, as Director of the National Science Foundation would you care to present the Board members.

STATEMENT OF DR. H. GUYFORD STEVER, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. STEVER. Mr. Chairman, you have already met three of the Board Members, Dr. Cobb, Dr. Hackerman, and Dr. Murray.

There are others, Dr. William N. Hubbard, Jr., president, The Upjohn Co., from Kalamazoo, Mich. Dr. Hubbard is the only one who could not be here today. He is on a business trip in Europe. He regrets not being present.

He will be glad to appear before the committee at any time, with either the committee or the staff, individually or collectively, at your convenience.

[The biographical sketch of Dr. Hubbard appears on p. 128.]

Dr. STEVER. Dr. Saunders Mac Lane is Max Mason Distinguished Service Professor of Mathematics, University of Chicago. He is here.

Dr. Donald B. Rice, Jr., president of the Rand Corp., from Santa Monica, Calif., is present.

Also we have Dr. L. Donald Shields who is president of California State University at Fullerton.

And Dr. James H. Zumberge, who is chancellor, University of Nebraska at Lincoln.

Mr. Chairman, as you know, this is an historic occasion because it is the first time that a public hearing has been held by the Senate on nominations for membership on the National Science Board. I can tell you that the Board has expressed great pleasure that this has occurred.

I would like to enter most of my statement in the record because I know you do want to get on to the other business, and interview the nominees themselves.

In my statement there are a few pages, from 3 to 7, which deal with the National Science Foundation, its Board, the responsibilities of the Board, which, as has been pointed out many times, is not an advisory board but is a policy board. It has both a policy forming role and an oversight role on our performance. So it really has a role analogous to that of the Congress with respect to the broad sweep of administration programs.

If you would like, we can go into the organization of the Board.

Two of the nominees are also old members, and they can comment on that if you would like. There is one thing that I would like to comment on specifically, and that has to do with the composition of the National Science Board and the criteria which are used to select new members.

Actually the National Science Foundation Act itself describes the criteria: it provides that members of the Board shall be eminent in the fields of the basic, medical, or social sciences, engineering, agriculture, education, research management, or public affairs. They shall be selected solely on the basis of established records of distinguished service, and shall be so selected as to provide representation on the views of scientific leaders in all areas of the Nation.

This stress then is on diversity. The membership of the Board has a broad base. It includes eminent scientists and educators, persons experienced in research management and public affairs. Membership also

takes into account a number of other factors, including balance among professional fields, various types and sizes of educational institutions, public and private, inclusion of women and minorities.

Both geographical and disciplinary balances are of significant importance in reaching sound judgment on many pressing problems and important programs which affect the entire country.

The current Board consists of persons from 12 universities, one small college, 3 industries, and 1 educational association. It includes 4 practicing scientists and 13 administrators. The present Board members represent some 10 different disciplines. They come from nine States and the District of Columbia.

The nominees appearing before your committee today would add substantially to the balance of the Board. They include two biologists, two chemists, an economist, two geophysicists, and a mathematician. They would add representation from three States—Connecticut, Illinois, and Nebraska. The reappointment of Dr. Hackerman and Dr. Murray would continue representation from Texas on the Board. The nominees are drawn from a small college, two State universities, a land-grant university, two private universities, a pharmaceutical company, and a research organization.

The balance of the Board I think is a very important subject and is always considered. It is difficult because the National Science Foundation supports work in 15 or 20 different fields of basic science, and it is impossible to get every field represented all the time, but to have it spread over during the years is an important thing.

Mr. Chairman, I would be glad to answer questions either on what I have said here or on the testimony I have introduced.

[The prepared statement of Dr. Stever follows:]

STATEMENT BY DR. H. GUYFORD STEVER
DIRECTOR, NATIONAL SCIENCE FOUNDATION
BEFORE THE COMMITTEE ON LABOR AND PUBLIC WELFARE
UNITED STATES SENATE
SEPTEMBER 11, 1974

Mr. Chairman and Members of the Committee:

I want to thank you for the opportunity to meet with the Committee. First, I should like to express my appreciation of the Committee's consistent interest in and support of the National Science Foundation.

As you know, the six-year terms of the Members of the National Science Board are staggered so that eight are appointed in each even numbered year. Today I would like to introduce the nominees for membership on the Board for the term 1974 to 1980. With your permission I would then like to make a short introductory statement describing the functions and methods of operation of the Board. The nominees are:

Dr. Jewel P. Cobb, Dean, Connecticut College.

Dr. Norman Hackerman, President, William Marsh Rice University. Dr. Hackerman has been a Member of the Board for the past six years and has been renominated.

Dr. W. N. Hubbard, Jr., President, The Upjohn Company, Kalamazoo, Michigan. Dr. Hubbard is on an important business trip in Europe. He was unable on short notice to reschedule appointments in order to appear before your Committee today. He regrets not being present. He will be glad to appear before the Committee or to confer with members or staff at their convenience.

Dr. Saunders Mac Lane, Max Mason Distinguished Service Professor of Mathematics, University of Chicago.

Dr. Grover E. Murray, President, Texas Tech University. Dr. Murray has also been nominated for a second term.

Dr. Donald B. Rice, Jr., President, Rand Corporation, Santa Monica, California.

Dr. L. Donald Shields, President, California State University at Fullerton.

Dr. James H. Zumberge, Chancellor, University of Nebraska at Lincoln.

Mr. Chairman, this is an historic occasion. It is the first hearing to be held by a Senate committee on nominations for membership on the National Science Board. On behalf of the Board and myself I am delighted to have this opportunity to discuss the basic role of the Board and the manner in which it operates and to describe the way in which nominees for membership are selected.

The National Science Foundation Act (Public Law 81-507) states that "The National Science Foundation shall consist of a National Science Board... and a Director." This means that the Board is an integral part of the Foundation, not an advisory body. In general, the Board's principal function is to provide policy guidance for the conduct of the Foundation's activities. It, therefore, concerns itself with all major aspects of the Foundation's mission. In particular, it participates with the Director in the formulation and review of programs. The Board must approve all new programs. Further, all individual projects within these new programs are reviewed by the Board until the objectives of the program are well established.

The Board in collaboration with the Director is expressly charged by the National Science Foundation Act with recommending and encouraging the pursuit of national policies for the promotion of basic research and education in the sciences. Allied to this responsibility is a requirement that the Board render to the President for submission to the Congress an annual report on the status and health of science and its various disciplines including such matters as national resources and manpower.

The Board meets its national science policy responsibilities in a variety of ways. The Board renders informal guidance for use by me in

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my capacity as science adviser to the President. Preparation of the annual report necessarily involves consideration of policy issues. The Board has completed and issued five annual reports. 1/ The sixth and seventh reports are in preparation. The seventh Board report will expand and further refine the indicators on the state of the science enterprise in the United States developed in the fifth report.

The Board from time to time establishes special commissions or other working groups to conduct special studies or analyses and to recommend policies for future action. Three such special commissions have been established and have rendered major reports. 2/

1/ Toward a Public Policy for Graduate Education in the Sciences (1969)

The Physical Sciences (1970)

Environmental Science--Challenge for the Seventies (1971)

The Role of Engineers and Scientists in a National Policy for Technology (1972)

Science Indicators--1972 (1973)

2/ Special Commission for Rubber Research--Recommended Future Role of the Federal Government with respect to Research in Synthetic Rubber (1955)

Special Commission on Weather Modification--Weather and Climate Modification (1966)

Special Commission on the Social Sciences--Knowledge Into Action: Improving the Nation's Use of the Social Sciences (1969)

In April the National Science Board convened a Seminar on Scientific and Technical Manpower Projections. To this Seminar the Board invited some fifty persons interested in the analysis and use of manpower projections. It is expected that a report of this meeting with the Board's recommendations on manpower projections will be available soon.

To meet its responsibilities the Board has organized itself into two major committees, the Programs Committee and the Planning and Policy Committee. The Programs Committee examines new and ongoing programs and those individual projects which require Board approval. The results of the Committee's examinations are presented to the full Board in the form of recommendations for specific action.

The Planning and Policy Committee concerns itself with general policies and budgets, particularly the balance among Foundation programs. An important adjunct of the Planning and Policy Committee is its Budget Management Subcommittee. This Subcommittee provides a mechanism for integrating National Science Board and National Science Foundation staff work on program plans and priorities, budget proposals and issues. The Planning and Policy Committee also presents its recommendations to the full Board for action.

Ad hoc committees are also formed from time to time to make special studies or to perform specific tasks.

With the growth in the Foundation's budget and its increasing proportion of the Federal support of science, the Board is playing a more significant role in the review and evaluation of the status and health of U. S. science. It usually holds eight meetings a year of two or three day's duration. In the intervening months the Executive Committee of the Board meets to transact necessary business of the Board and the Foundation. The result is that the Board or its Executive Committee meets every month.

I would like to discuss briefly the composition of the present National Science Board and the criteria used for selecting new Members. The National Science Foundation Act provides that "... members of the Board (1) shall be eminent in the fields of the basic, medical, or social sciences, engineering, agriculture, education, research management or public affairs; (2) shall be selected solely on the basis of established records of distinguished service; and (3) shall be so selected as to provide representation of the views of scientific leaders in all areas of the Nation."

I should like to emphasize the stress this section places on diversity. The membership of the Board has a broad base. It includes eminent scientists and educators, persons experienced in research management and public affairs. Membership also takes into account a

number of other factors, including balance among professional fields, various types and sizes of educational institutions (public and private), inclusion of women and minority individuals.

Both geographical and disciplinary balance are of significant importance in reaching sound judgments on many pressing problems and important programs which affect the entire country. The current Board consists of persons from twelve universities, one small college, three industries, and one educational organization. It includes four practicing scientists and thirteen administrators. The present Board Members represent some ten different disciplines. They come from nine states and the District of Columbia.

The nominees appearing before your Committee today would add substantially to the balance of the Board. They include two biologists, two chemists, an economist, two geophysicists, and a mathematician. They would add representation from three states--Connecticut, Illinois, and Nebraska. The reappointment of Dr. Hackerman and Dr. Murray would continue representation from Texas on the Board. The nominees are drawn from a small college, two State universities, a land-grant university, two private universities, a pharmaceutical company, and a research organization. They also include two working scientists.

The process of selection, also determined by statute, requires the President to consider recommendations from the National Academy of Sciences, the National Association of State Universities and Land-Grant Colleges, the Association of American Universities, the Association of American Colleges, the Association of State Colleges and Universities, or by other scientific or educational organizations. In practice recommendations both solicited and unsolicited are received from many other sources.

In June 1973 the Board appointed an Ad Hoc Committee to Recommend Board Nominees to consider the recommendations received from the scientific and educational communities, the Congress, and other sources. It solicited recommendations from 25 leading scientific and educational associations. This Committee met formally on four occasions during the fall. It established guidelines for the selection of candidates and analyzed their qualifications taking into account their discipline, background, experience, major interests, and geographical location in light of those of the present Board Members. Following this extensive review by the Committee of some 250 suggestions, the Board and I agreed on a slate of candidates which we transmitted to the White House for consideration in November 1973.

The selection process is indeed complex and the eight nominees being presented to you today have been the subject of most careful evaluation.

I believe that you have biographical information on all the nominees. I would like to reiterate Dr. Hubbard's regret that he was not able to be here and his willingness to meet with the Committee or any of its members at their convenience.

Mr. Chairman, this concludes my introductory remarks. I will be glad to answer any questions and I am sure that the group of distinguished nominees before the Committee also will be glad to answer questions.

Dr. STEVER. I am pleased to present the distinguished nominees to the committee.

The CHAIRMAN. Thank you very much. Dr. Stever.

Gentlemen, I appreciate your being here, and we will afford you the opportunity immediately to express yourselves.

First, we will hear from Congressman Alfonso Bell.

Mr. BELL. Thank you, Mr. Chairman.

STATEMENT OF HON. ALPHONZO BELL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. BELL. I would like to take this opportunity to introduce to the committee the president of the Rand Corp., in Santa Monica, Calif., Mr. Donald Rice.

Mr. Rice was formerly Assistant Director of the Office of Management and Budget and Deputy Assistant Secretary of Defense for Resource Analysis.

In 1970 he was awarded the Meritorious Civilian Service Medal by Secretary of Defense Melvin Laird.

I want to add also that he is a very highly respected civic leader in Santa Monica, which is in my congressional district. He is well-known there and considered a leader in the community.

It is my pleasure, Mr. Chairman, to introduce Don Rice, president of the Rand Corp.

The CHAIRMAN. We appreciate that, and I am sure Dr. Rice appreciates that too.

Congressman Andrew Hinshaw.

STATEMENT OF ANDREW J. HINSHAW, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. HINSHAW. It is a pleasure for me to be here and to introduce Dr. Donald Shields president of the California State University at Fullerton.

That institution has over 19,000 students and over 750 faculty and other staff.

I have known Dr. Shields for a good many years. It is a distinct recognition of his service that he assumed the office of president of the California State University at Fullerton at the relatively young age of 33, an age when many persons in the academic world find themselves not even reaching their full professorship.

He is a research scientist. He has worked in education for a long time. He has worked in both government and business.

He is the author of many books and publications which have been published and has received a great deal of esteem.

There are many honors which have been conferred on Dr. Shields and a listing of these honors as well as extensive information regarding his background, are, I believe in his file for your consideration.

I think his experience in government, in the academic world, and in the business world, has brought him recognition in our local area, as well as throughout the entire country, one who is extremely well respected by his colleagues in the world of chemistry and by his faculty, staff and students.

We know him as a very forthright person who is well respected by everyone who comes in contact with him. I believe that his experience would bring valuable background to the National Science Board.

The CHAIRMAN. Thank you very much, Congressman Hinshaw.

Senator Kennedy who is the chairman of our subcommittee which deals with the National Science Foundation will be with us in a moment.

I wonder if giving you an opportunity here to present in capsule form your views and attitudes toward the role that you will play in the Science Foundation would be appropriate. Would that be an inefficient way to get to know you better?

Dr. STEVER. I think that is a great way, Senator Williams.

The CHAIRMAN. We can start from right to left.

Dr. Mac Lane.

STATEMENT OF SAUNDERS MAC LANE, D. PHIL., OF ILLINOIS, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD

Dr. MAC LANE. The National Science Foundation in the 25 years that it has existed has been a tremendous and very useful force in American society and science. It has brought scientific activity in this country to great heights. It has made great contributions.

I think it is going to be very important to keep on with these developments, to emphasize the great things which high quality scientific research can contribute. It is often investment in basic research which will pay out in the future.

The CHAIRMAN. Thank you, Dr. Mac Lane.

A copy of Dr. Mac Lane's biographical sketch will be included at this point in the record.

[The information referred to follows:]

Saunders Mac Lane

CURRICULUM VITA

Saunders Mac Lane was born in Norwalk, Connecticut on August 4, 1909. His father, Donald Bradford Mac Lane, was a Congregational minister then preaching at Taftville, Connecticut. His mother, née Winifred Andrews Saunders and graduated from Mount Holyoke College, was a secondary school teacher. There was one sister, Lois, who died in infancy, and two younger brothers, Gerald R. Mac Lane and David T. Mac Lane. During successive pastorates of his father, Saunders Mac Lane lived with the family in Taftville, Connecticut, Boston, Massachusetts, Wilbraham, Massachusetts and Utica, New York. He started high school at the Utica Free Academy and finished high school at Leominster High School (Massachusetts), where he was living with his mother and brothers with his grandfather. His grandfather, William Ward McLane, was also a Congregation minister.

Education

Saunders Mac Lane attended Yale College from 1926-1930 and received his Ph.B. there in 1930. In college his primary interest had shifted from chemistry to mathematics. In 1930-1931 he was a graduate student in mathematics at the University of Chicago, where he received an M.A. in 1931. With stipends from the Institute for International Education and later from the Alexander von Humboldt Foundation, he then went to Germany where he studied mathematics at the famous German Center for Mathematics at Göttingen. His studies were completed in 1933 with a degree of D.Phil (at which time over half the faculty of mathematics was dismissed by the Nazi government). He was awarded the degree of D.Phil. upon publication of his thesis in 1934.

Mathematical Research

(See attached list of publications)

Mac Lane's first scientific paper was in physics written with Irving Langmuir and K. B. Blodgett. This was a result of a summer spent at the Research Laboratories of the General Electric Company in Schenectady, New York (1929). Subsequently his mathematical

research work was successively in the fields of logic, graph theory and topology, algebra, algebraic topology, homological algebra, and category theory, as in the approximately 90 research papers listed in the attached bibliography. For example, these include a discovery of spaces K(Π-n) now called the Eilenberg-Mac Lane spaces, and the discovery of category theory and of the cohomology of groups, both jointly with Samuel Eilenberg.

Positions

Sterling Fellow in Mathematics, Yale, 1933-1934; Benjamin Pierce Instructor in Mathematics, Harvard University, 1934-1936; Instructor, Cornell, 1936-1937; University of Chicago, 1937-1938; Assistant Professor, Harvard University, 1938-1941; Associate Professor, 1941-1946; Professor, 1946-1947; University of Chicago, 1947-1963. Max Mason Distinguished Service Professor, 1963- . Also, from 1943-1945 during the Second World War, Research Mathematician at the Applied Mathematics Group at Columbia University (concerned largely with airborn lead computing sights). During 1944-1945 Mac Lane was Director of this group.

Chairman, Department of Mathematics, University of Chicago, 1952-1958. Member, Council of the Faculty Senate, University of Chicago, 1948-1951 and 1970-1973. Member of other University Committees such as the Committee on Criteria for University Appointments.

Mathematical Education

With Garrett Birkhoff, Mac Lane published in 1941 the text, Survey of Modern Algebra. This text, which has now gone through three editions, had a substantial influence on undergraduate courses in algebra at American institutions. It has been followed by a more recent text, Algebra, Macmillan, 1966, giving a somewhat more up-to-date treatment of this subject.

In graduate education Mac Lane has directed 35 Ph.D. theses, as on the attached list. Two of these Ph.D.'s (Irving Kaplansky and John G. Thompson) are now members of the National Academy of Sciences. In undergraduate education Mac Lane was active in various movements for reform. In 1951-1953 he served as President of the Mathematical

Association of America, which is the professional organisation concerned with collegiate mathematical education.

Professional Societies

Since 1933 Mac Lane has been a member of the American Mathematical Society, the principle organization for the encouragement of mathematical research in the United States. He has served at various times as a member of the Council (1939-1941), Colloquium Lecturer, 1963, Editor of the Bulletin of the American Mathematical Society (1943-1947), Editor of the Transactions of the American Mathematical Society (1949-1954), Vice-President of the American Mathematical Society (1946-1947), Editor of the Colloquium Series of the American Mathematical Society (1966-1972), and finally as President of the American Mathematical Society (1973-1974). He is also a member of other professional societies, including the Association for Symbolic Logic since about 1935, the American Association for the Advancement of Science and the Society of Industrial and Applied Mathematics, 1973- .

In 1949 Mac Lane was elected to membership in the National Academy of Sciences. He served as an elected member of the Council of that Academy from 1958-1961, and again from 1969-1972. From 1960-1968 he was Chairman of the Editorial Board of the Proceedings of the National Academy of Sciences. Finally, in 1973 he was elected to a four-year term as Vice-President of the National Academy of Sciences, and in this connection currently also serves as Chairman of the Report Review Committee of that Academy.

Science Policy

When the National Academy of Sciences first established its Committee on Science and Public Policy in about 1964, Mac Lane was one of the members of that Committee and also served on the subpanel which prepared for the Committee on Science and Astronomics of the U. S. House of Representatives a report, "Basic Research and National Goals" (Mac Lane contributed an article,"Leadership and Quality in Science").

Honors

Phi Beta Kappa, 1929 (Yale); Associate Member, Sigma Xi, 1929 (Yale) full Member, 1934; Montclair Yale Cup (given to the student who had

made his Y in scholarship) 1929; Chauvenet Prize for mathematical exposition by Mathematical Association of America, 1941; John Simon Guggenheim Fellow, 1947-1948 (Paris and Zurich) and 1972-1974 (Cambridge, England and Aarhus, Denmark); elected to membership, American Academy of Arts and Sciences, 1945- ; American Philosophical Society 1949- member of the Council, 1956-1968 and Vice-President, 1970-1971. Honorary degrees: D.Sc. Purdue, 1965; Yale, 1969; Glasgow, 1971; Coe College, 1974; Fellow, Royal Society of Edinburgh, 1972- ; Foreign Associate, Danish Academy of Sciences, 1971- .

Publications of Saunders Mac Lane

1930 -

A. Physics

1. With Irving Langmuir and K. B. Blodgett, Effect of end losses on the characteristics of filaments of tungsten and other materials, Physical Review vol 35(1930) pp 478-503.

B. Logic

2. Abgekürzte Beweise in Logikkalkul, Thesis, Gottingen, 1934.
3. A logical analysis of mathematical structure, The Monist, Jan. 1935 pp 118-130
4. Hilbert-Bernays on proof theory, Review Bulletin, vol 40(1935) pp 162-165
5. Carnap on logical syntax (Review), Bulletin, vol 44(1938) pp 171-176

C. Algebra

6. Abstract absolute values which give new irreducibility criteria, Proceedings, NAS, vol 21(1935) pp 472-474
7. The ideal-decomposition of rational primes in terms of absolute values, Proceedings, NAS, vol 21(1935) pp 663-667
8. A construction for prime ideals as absolute values of an algebraic field, Duke, vol 2(1936) pp 492-510
9. Note on some equations without affect, Bulletin, vol 41(1936) pp 731-736
10. A construction for absolute values in polynomial rings, Transactions, vol 40(1936), pp 363-395
11. The Schonemann-Eisenstein irreducibility criteria in terms of prime ideals. Transactions, vol 43(1938) pp 226-239
12. A lattice formulation for transcendence degrees and p-bases, Duke, vol 4 (1938), pp 455-468
13. The uniqueness of the power series representation of certain fields with valuations, Annals, vol 39(1938) pp 370-382
14. The universality of formal power series fields, Bulletin, vol 45(1939) pp 888-890
15. Subfields and automorphism groups of p-adic fields, Annals, vol 40(1939) pp 423-442
16. Note on the relative structure of p-adic fields, Annals, vol 41(1940) pp 751-753
17. Modular fields. I Separating transcendence bases, Duke, vol 5(1939) pp 372-393
18. Steinitz field towers for modular fields, Transactions, vol 46(1939) pp 23-45
19. (with M. F. Becker) The minimum number of generators for inseparable algebraic extensions, Bulletin, vol 46(1940) pp 182-186
20. (with F. K. Schmidt) The generation of inseparable fields, Proceedings, NAS. vol 27(1941) pp 583-587

21. (with A.H. Clifford) Factor sets of a group in its abstract unit group. Transactions...vol 50(1941) pp 285-406

22. A conjective of Ore on chains in partially ordered sets, Bulletin... vol 49(1943) pp 567-68

D. Papers on algebra, written jointly with Prof. O.F.G. Schilling.

23. Infinite number fields with Noether ideal theories, American Journal... vol 61(1939) pp 771-782

24. Zero-dimensional branches of rank one on algebraic varieties, Annals... vol 40(1939) pp 507-520

25. Normal algebraic number fields, ProceedingsNASvol 26(1940) pp 122-126

26. Normal algebraic number fields, Transactions...vol 50(1941) pp 295-384

27. A formula for the direct product of crossed product algebras, Bulletin... vol 48(1942) pp 108-114

28. A general Kummer Theory for function fields, Duke...vol 9(1942) pp 125-157

29. Groups of algebras over an algebraic number field, American Journal... vol 65(1943) pp 299-308

E. Expository works on algebra.

30. Notes on higher algebra, Planographed, Edwards Brothers, Ann Arbor, Mich. 1939, 211 pp

31. Algebraic functions, Planographed, Edwards Brothers, Ann Arbor, Mich., 1940 62 pp

32. With Garrett Birkhoff:
A Survey of modern algebra, New York, The Macmillan Company, 1941

33. Some recent advances in Algebra, American Math... Monthly, vol 46(1939) pp 3-19

34. Modular fields, American Math...Monthly, vol 47(1940) pp 259-274

F. Topology

35. Some unique separation theorems for graphs, American Journal, vol 57(1935) pp 805-820

36. Some interpretations of abstract linear dependence in terms of projective geometry, American Journal, vol 58(1936) pp 236-240

37. A combinatorial condition for planar graphs, Fundamenta Mathematical, vol 28(1936) pp 22-32

38. A structural characterization of planar combinatorial graphs, Duke... vol 3(1937) pp 460-472

G. Papers on Topology, written jointly with Prof. V.W. Adkisson (Univ. of Arkansas)

39. Planar graphs whose homeomorphisms can all be extended for any mapping on the sphere, American Journal, vol 59(1937), pp 823-832

40. Fixed points and the extension of the homeomorphisms of a planar graph, American Journal, vol 60(1938) pp 611-639

41. Extending maps of plane Peano continua, Duke, vol 6(1940) pp 216-228

42. Extensions of homeomorphisms on the sphere, Lectures in Topology, the University of Michigan, Conference of 1940, University of Michigan Press, 1941, pp 223-236

H. Papers on Topology and Algebra, written jointly with Prof. S. Eilenberg (University of Michigan and Indiana University)

43. Infinite cycles and homologies, Proceedings, NAS, vol 27(1941), pp 535-539

44. Group extensions and homology, Annals, Vol 43(1942) pp 757-831

45. Relations between homology and homotopy groups, Proceedings, NAS, vol 29 (1943) pp 155-158

46. Relations between homology and homotopy groups of spaces, Annals of Mathematics, vol 46(1945) pp 480-507

47. Natural isomorphisms in group theory, Proceedings, NAS, vol 28(1942) pp 537-543

48. General Theory of natural equivalence, Transactions, vol 58(1945) pp 231-294

49. Cohomology theory in abstract groups I, Annals of Mathematics, vol 48 (1947) pp 51-78

50. Cohomology theory in abstract groups II, Group extensions with a non-abelian kernel, Annals of Mathematics (1946) pp 326-341

51. Determination of the second homology and cohomology groups of a space by means of homotopy invariants, Proceedings, NAS, pp 277-280(1946)

52. On Homology groups of infinite complexes and compacta, Appendix A in S. Lefschetz, Algebraic Topology (1942) pp 344-349

53. Algebraic cohomology and loops. Duke Math. J. v 14(1947) pp 435-463

54. Cohomology and Galois theory I. Normality of algebras and Teichmuller's cocycle. Trans. AMS, v. 64(1948) pp 1-20

55. Symmetry of algebras over number fields. Bulletin AMS, v. 54(1948) pp 328-333

56. Groups, categories and duality. Proc. National Acad. Sci. USA. v. 34 (1948) pp 263-267

57. Non-associative method for associative algebras. Bulletin AMS, v 54(1948) pp 897-902

58. Homology of spaces with operators II. Transactions AMS, v. 65(1949) pp 49-99

59. Cohomology theory in abstract groups III Operator homeomorphisms of kernels. Ann. Math. v. 50(1949) pp 736-761

60. Relations between homology and homotopy groups of spaces II. Ann. Math. v. 51(1950) pp 514-533

61. Cohomology theory of abelian groups and homotopy theory. Proc. NAS (I, v. 36(1950) pp 443-447)

62. Cohomology theory of abelian groups and homotopy theory. Proc. NAS (II, v. 36(1950) pp 657-663)

63. Cohomology theory of abelian groups. Proc. Inter. Congr. Math. v 2(1950) Cambridge pp 8-14

64. Cohomology theory of abelian groups and homotopy theory III. Proc. Nat. Acad. Sci. USA. (1951) pp 307-310

65. Homology theories for multiplicative systems. Trans. AMS. v. 71(September 1951) pp 294-330

66. Cohomology theories of abelian groups IV. Proc. Nat. Acad. Sci. USA v. 38 (1952) pp 325-329

67. Acyclic models. Amer. Jour. Math. v. 75(January 1953) pp 189-199

68. On the groups H(π, n) I. Ann. Math. v. 58(1953) pp 55-106

69. On the groups H(π,n) II. Methods of computation. Ann. Math. v. 60(1954) pp 49-139

70. On the groups H(π,n) III. Operations and obstructions. Ann. Math. v. 60 (1954) pp 513-557

71. Homology theory of abelian groups. Canadian J. Math. v. 7(January 1955) pp 43-55

I. Other Joint Papers:

72. With J.H.C. Whitehead: On the 3-type of a complex. Proc. Nat. Acad. Sci. v. 36(January 1950) pp 41-48

J. Papers on Homological Algebra

73. Homology products in K(π,n). Proc. AMS. v. 5(August 1954) pp 642-651

74. Slide and torsion products for modules. Unive. Politec. Torino Rend. Sem. Mat. 15(1955-56) pp 281-309

75. Homologie des anneaux et des modules. Colloque de Topologie algebraique, Louvain 1956, pp 55-80

76. Extensions and obstructions for rings. Ill. J. Math. vol. 2, No. 3(Sept. 1958) pp. 316-356

77. A proof of the subgroup theorem for free products. Mathematika 5(1958) pp 13-19

78. Group extensions by primary abelian groups. Trans. Amer. Math. So. (April, 1963) vol. 95, No. 1, pp 1-16

K. Category Theory

79. Duality for groups. Bulletin AMS. v. 56(November 1950) pp 485-516

80. Locally small categories and the foundations of set theory. Proc. Symp. on Foundations Math (Warsaw 1959) pp 25-43

81. An algebra of additive relations. Proc. Natl. Acad. Scis. vol. 47 No. 7 (July 1961) pp 1043-1051

82. Natural associativity and commutativity. Rice University Studies, vol 49, No. 4. Fall, 1963 pp 28-46

83. Categorical algebra. Bull. AMS (January 1965) v. 71, No. 1. pp 40-106

84. Projective classes and acyclic models, with A. Dold and U. Oberst, Forthcoming, Springer Lecture Notes

84. Projective classes and acyclic models, with A. Dold and U. Oberst, pp 78-91 in Reports of the Midwest Category Seminar, Lecture Notes in Mathematics, vol. 47, Springer-Verlag, New York, 1967.

85. Possible programs for categorists, pp 123-131 in Category Theory, Homology Theory and Their Applications I, Lecture Notes in Mathematics, vol. 86, Springer-Verlag, New York, 1968.

86. Foundations for Categories and Sets, pp. 146-164, in Category Theory, Homology Theory and Their Applications II, Lecture Notes in Mathematics, vol. 92, Springer-Verlag, New York, 1969.

87. Foundations of Mathematics, Category Th ory, pp 286-294, in Contemporary Philosophy, A Survey, edited by Raymond Klibansky, Florence, La Nuova, Italia Editrice.

88. Coherence and canonical maps, pp 231-242 in Symposia Mathematica, vol. IV, Azzoguidi, Bologna, 1970 (Conference held March 25, 1969).

89. The influence of M. H. Stone on the origins of category, in Functional Analysis and Related Fields, edited by Felix E. Browder, Springer-Verlag, New York, 1970.

90. The Milgram Bar construction as a tensor product of functor, pp 135-152, in The Steenrod Algebra and its Applications (A Conference to celebrate N.E. Steenrod's sixtieth birthday) Lecture Notes in Mathematics, vol. 168, Springer-Verlag, New York, 1970.

91. Categorical algebra and set-theoretic foundations, in Axiomatic Set Theory, Proceedings of Symposia in Pure Mathematics, Vol. XIII, Part I, American Mathematical Society, Providence, R. I. 1971.

92. (with G.M.Kelly) Coherence in closed categories, J. Pure and Applied Algebra, vol. 1, no. 1 (1971), pp 97-140.

93. (with G. M. Kelly) Closed coherence for a natural transformation, pp 1-28, in Coherence in Categories, Lecture Notes in Mathematics, Vol. 281, Springer-Verlag, New York, 1972.

94. One universe as a foundation for category theory, pp. 192-200, in Reports of the Midwest Category Seminar III, Lecture Notes in Mathematics, Vol. 106, Springer-Verlag, 1969.

L. Mechanics

1. Hamiltonian mechanics and geometry, American Math. Monthly, Vol. 77, No. 6, June-July (1970), pp 570-586.

2. Geometrical Mechanics, Parts I and II, Lecture Notes, University of Chicago, 1968.

M. Expositions and Books

1. Corso de topologia general (Notas de Matematica) No. 11. Translated by J.C. Valdares, Instituto de Mate. Para e Appli de cons. Nat. de Pesquises, Rio de Janeiro, p 102 (1954).

2. Of course and courses, Amer. Math. Monthly, Vol. LXI, No. 3, March 1954, pp. 151-157.

3. Algebra, Twenty-Third Year Book, Natl. Council of Teachers of Math., 1957, pp. 100-144.

4. Metric postulates for plane geometry, Amer. Math. Monthly, Vol. 66, No. 7, August-September, 1959, pp. 543-555.

5. Some recent advances in algebra, MAA Studies in Modern Algebra, pp 9-34.

6. Some additional advances in algebra, MAA Studies in Modern Algebra, pp 35-58.

7. Preliminary meeting on college level mathematics education, Amer. Math. Monthly, vol. 72, No. 2, February, 1965, pp. 174-175.

8. Homology (422 pages), 1963, Springer-Verlag.

9. (with Garrett Birkhoff) A Survey of Modern Algebra, 1st edition 1941, 2nd edition 1953, 3rd edition 1965, Macmillan, New York.

10. (with Garrett Birkhoff) Algebra, 1967, Macmillan, New York.

11. Categories for the Working mathematician, Springer-Verlag, New York, 1972.

12. Mappings as a Basic Mathematical Concept, pp 200-218, in Journeys in Science, Twelfth AFOSR Science Seminar, edited by David L. Arm, The University of New Mexico, Albuquerque, 1967.

N. Science Policy

1. Leadership and quality in science, Basic Research and National Goals, Report to Committee on Science and Astronautics, U.S. House of Representatives, Natl. Acad. of Sciences, pp 189-202.

2. The future role of the federal government in mathematics, Amer. Math. Monthly, vol. 74, No. 1, Part II (January, 1967) pp 92-100.

O. Bibliographical Memoirs

1. Gilbert Ames Bliss, Year Book of the American Philosophical Society for 1951, pp 288-291.

2. Oswald Veblen, A biographical memoir, NAS (1964) pp 325-341.

3. (with Jerome Hunsaker) Edwin Bidwell Wilson, A biographical memoir, NAS (1973) pp 285-320.

July 1974

Ph.D. Students - Saunders Mac Lane

Student	School	Qtr.	Year	Thesis
Kaplansky, Irving	Harvard		1942	Valuation Theory
Putnam, Alfred, L.	Harvard		1942	Formal power series
Phelps, C.R.	Harvard		1942	A homogeneous algebra with limited associativ
Lyndon, Roger	Harvard		1946	The cohomology theory o group extensions
Moyles, B.N.	Harvard		1947	Extensions of valuation with prescribed value group and residue class field
Carter, W.C., Jr.	Harvard		1947	On the cohomology theory of fields
Novosad, Robert S.	Chicago	Aug.	1952	Relations between homotc and homology groups
Hughart, Stanley P.	Cal.Tech		1954	Representation for dicategories
Nunke, Ronald J.	Chicago	Sept.	1955	Modules of extensions over Dedekind rings
Kruse, Arthur H.	Chicago	June	1956	Introduction to the theory of block assemblages and developments in the theory of retraction
Howard, William A.	Chicago	Dec.	1956	k-fold recursion and well-ordering
Nerode, Anil R.	Chicago	June	1956	Composits, equations, and, recursive definitio
Ballard, William R.	Chicago	Aug.	1957	Cohomology theory in fie
Halpern, Edward	Chicago	Mar.	1957	On the structure of hyperalgebras
Thompson, John G.	Chicago	June	1959	A proof that finite grou with a fixed-point free automorphism of prime order are nilpotent
Yao, Joseph	Chicago	June	1960	Moore-Cartan theorems and Leray-Serre theorem
Szczarba, Robert	Chicago	June	1960	The homology of twisted Cartesian products
Liulevicius, Arunas	Chicago	June	1960	The factorization of cyclic reduced process by secondary cohomology operations
Kristensen, Leif	Chicago	Sept.	1961	On the cohomology of two-stage Postnikov systems

Student	School	Qtr.	Year	Thesis
Morley, Michael	Chicago	Aug.	1962	Categoricity in power
Hungerford, Thomas W.	Chicago	Dec.	1963	Bockstein spectra
Solovay, Robert	Chicago	June	1964	A functorial form of the differentiable Riemann-Roch theorem
Kuo, T.C.	Chicago	Sept.	1964	Universal Objects for Spectral Sequences
Mountjoy, Robert H.	Chicago	Sept.	1964	Abelian Varieties attache to Representations of dis continuous groups
Zvengrowski, Peter	Chicago	Dec.	1964	Vector Fields and Vector products
MacDonald, John	Chicago	Sept.	1965	Group derived functors and relative representa-bility
Schafer, James	Chicago	Sept.	1965	On the homology Ring of an abelian group
Shafer, David	Chicago	Sept.	1966	The Hamel basis theorem and the countable axiom of choice; an exercise ir the method of Paul Cohen
Palmquist, Paul	Chicago	Mar.	1969	The Double Category of adjoint squares
Stauffer, Howard	Berkeley	Sept.	1969	Completion of Categories, Satellites, and derived functors
Dubuc, Eduardo	Chicago	Dec.	1969	V-completion by V-monads through the use of Kan extensions
Eisenbud, David	Chicago	June	1970	Torsion modules over Dedekind Prime rings
Voreadou, Rodiani	Chicago	Sept.	1972	A Coherence Theorem for Closed Categories
Hamsher, Ross	Chicago	Sept.	1973	Eilenberg-Mac Lane Algebr and Their Computation
Decker, Gerald John	Chicago	June	1974	The Integral Homology Alg bra of an Eilenberg-Mac I Space

The CHAIRMAN. Dr. Hackerman.

STATEMENT OF NORMAN HACKERMAN, PH. D., OF TEXAS, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD (Reappointment)

Dr. HACKERMAN. Senator, I think it is quite important to recognize the continuity between science in its most ignorant form and the use of science in behalf of society.

As things now stand science and technology are vital forces—not the only forces but vital forces—in the continuing growth of this world.

Because of that it is very important that the National Science Board recognize all aspects of science and technology, and its usefulness, not only as an area of creative work, distinct work, but also as an area in which application can be made.

That does not mean that all pure science is applicable, and it does not mean that one can move so purposefully that one can focus directly on those areas of pure science that will be useful. So it becomes very important, it seems to me, that the members of the Board and the staff of the Foundation recognize the importance of all areas and the hinderances to the transfer of this reduction of pure ignorance to the increase in applicability.

As a member of the Board—and I am sure my colleagues feel the same way—it is our job to make sure that all areas are adequately taken care of.

The CHAIRMAN. You are the scientist who basically explores the unknown.

Mr. HACKERMAN. He exposes his own ignorance and tries to reduce it.

The CHAIRMAN. I should confess to being pretty close to zero in science. I think probably my closest association to basic science was as caretaker for a year at Vannevar Bush's farm.

I will say that he liked to escape, to be released from the demands of science, because everything operational in that home that I was the caretaker of went back to another century. Everything worked with wood—a wood burning cookstove, a wood burning furnace. I learned a great deal about trees that winter in New Hampshire.

A copy of Dr. Hackerman's biographical sketch will be included at this point in the record.

[The information referred to follows:]

NORMAN HACKERMAN

BIOGRAPHICAL DATA January 1974

Full name:	Norman Hackerman
Address:	President's House, Rice University, Houston, Texas 77001
Date of birth:	March 2, 1912
Place of birth	Baltimore, Maryland
Education:	A. B., Johns Hopkins University, 1932
	Ph. D., Johns Hopkins University, 1935

Positions held:

Rice University	
President	September 1970-
Professor of Chemistry	September 1970-
The University of Texas at Austin	
President	1967-70
Vice Chancellor for Academic Affairs	1963-67
Vice President and Provost	1961-63
Dean of Research and Sponsored Programs	1960-61
Director of the Corrosion Research Laboratory	1948-61
Chairman of the Chemistry Department	1952-61
Professor of Chemistry	1950-70
Associate Professor of Chemistry	1946-50
Assistant Professor of Chemistry	1945-46
Research Chemist, Kellex Corporation	1944-45
Assistant Professor of Chemistry, Virginia Polytechnic Institute	1941-43
Assistant Chemist, United States Coast Guard	1939-41
Research Chemist, Colloid Corporation	1936-40
Assistant Professor of Chemistry, Loyola College	1935-39

Memberships in Learned Societies

Member, American Philosophical Society	1972-
Member, National Academy of Sciences	1971-

Electrochemical Society (Chairman, Corrosion Division, 1951; Vice President, 1954-57; President, 1957-58; Interim Editor, Electrochemical Technology, 1965-68; Technical Editor, Journal of the Electrochemical Society, 1950-68; Editor, 1969-)
Honorary Member, 1973.

Memberships in Learned Societies (continued)

American Chemical Society (Executive Committee, Colloid Division, 1955-58; Board of Editors, American Chemical Society Monograph Series, 1956-62)

National Association of Corrosion Engineers (Board of Directors, 1952-55; Chairman, A. B. Campbell Young Authord Award Committee, 1960-)

Intersociety Corrosion Committee (Chairman, 1956-58)

Fellow, American Association for the Advancement of Science

Memberships on Boards, Committees, and Councils

National Board on Graduate Education, 1971-

National Science Board, 1968-

Argonne National Laboratory (Chemical Engineering Division Review Committee, 1963-69; chairman, Board of Trustees, 1969-73)

Gordon Research Conferences (Chairman, Conference on Corrosion, 1950; chairman, Conference on Chemistry at Interfaces, 1959; Member, Board of Trustees, 1970-)

Universities Research Association (Council of Presidents); chairman, 1973

Environmental Pollution Panel, the President's Science Advisory Committee, 1965-66

Industry Consultant to the Metal Surface Treatment Equipment Show, Stockholm Trade Center, for U. S. Department of Commerce, 1967

National Academy of Science-National Research Council (Division of Chemistry and Chemical Technology, 1958-)

Association of Universities for Research in Astronomy, Inc. (Consultant, 1964-)

Editorial Board, Catalysis Reviews, 1968-1973

Advisory Editorial Board, Corrosion Science, 1965-

Awards

Whitney Award of National Association of Corrosion Engineers	1956
Joseph L. Mattiello Award	1964
Palladium Medalist of the Electrochemical Society	1965
Southwest Regional Award of the American Chemical Society	1965

Honorary Societies

Alpha Chi Sigma
Phi Kappa Phi
Phi Lambda Upsilon
Sigma Xi

Important Publications*

N. Hackerman and R. A. Powers, J. Phys. Chem., 57, 139 (1953), "Surface Reactions of Chromium in Dilute $Cr^{51}O_4$ Solutions."

A. C. Makrides and N. Hackerman, Ind. Eng. Chem., 46, 523 (1954), "Action of Polar Organic Inhibitors in Acid Dissolution of Metals."

W. H. Wade and N. Hackerman, Trans. Faraday Soc., 53, 1636 (1957), "Anodic Phenomena at an Iron Electrode."

P. V. Popat and N. Hackerman, J. Phys. Chem., 62, 1198 (1958), "Capacity of the Electrical Double Layer and Adsorption at Polarized Platinum Electrodes. I. Adsorption of Anions."

N. Hackerman, Z. fur Elektrochemie, 62, Nr. 6/7, 632 (1958), "Sorption, Oxidation and Passivity."

E. S. Snavely, Jr. and N. Hackerman, Can. J. Chem., 37, 268 (1959), "The Anodic Passivation of Iron."

N. Hackerman, J. Electrochem. Soc. (India), VIII (1), 9 (1959), "Corrosion Inhibition and Chelating Agents."

N. Hackerman, Comptes Rendus du Symp. Eur. sur les Inhibiteurs de Corrosion, Ferrara, Italy, 1960, "An Adsorption Theory of Corrosion Inhibition by Organic Compounds."

N. Hackerman and R. M. Hurd, First Int. Cong. on Metallic Corrosion, London, 1961, "Corrosion Inhibition and Molecular Structure."

N. E. Wisdom, Jr. and N. Hackerman, J. Electrochem. Soc., 110, 318 (1963), "Surface Studies on Passive Iron."

*Dr. Hackerman is the author and co-author of more than 160 publications. The publications listed are among the more important ones.

Important Publications (continued)

W. H. Wade and N. Hackerman, Advances in Chem. Series, 43, 222 (1964), "Thermodynamics of Wetting of Solid Oxides."

N. Hackerman and W. H. Wade, J. Phys. Chem., 69, 314 (1965), "A Microcalorimetric Study of Liquid-Liquid Displacement Phenomena."

R. M. Hurd and N. Hackerman, Electrochimica Acta, 9, 1633 (1964), "Passivity Phenomena at the Silicon/Electrolyte Interface."

N. Hackerman, E. S. Snavely, Jr., and J. S. Payne, Jr., J. Electrochem. Soc., 113, 677 (1966), "Effects of Anions on Corrosion Inhibition by Organic Compounds."

D. M. Mohilner and N. Hackerman, Electrochimica Acta, 11, 1669 (1966), "Thermodynamic Treatment of Interfacial Curvature in Electrocapillarity."

N. Hackerman, E. S. Snavely, Jr., and L. D. Fiel, Electrochimica Acta, 12, 535 (1967), "Anodic Passivity of Nickel in Hydrogen Fluoride."

K. Kawasaki and N. Hackerman, Japanese Journal of Applied Physics, 6, 1184 (1967), "Vapor Adsorption and Displacement on Porous Glass by Surface Conductivity."

K. Aramaki and N. Hackerman, J. Electrochem. Soc., 115, 1007 (1968), "Structure Effects of Many-Membered Polymethyleneimine on Corrosion Inhibition."

K. Aramaki and N. Hackerman, J. Electrochem. Soc., 116, 568 (1969), "Inhibition Mechanism of Medium-sized Polymethyleneimine."

LIST OF PUBLICATIONS

Norman Hackerman

1. W. A. Patrick and Norman Hackerman, J. Phys. Chem. 40, 679-88 (1936). "Studies on Molecular Weight Changes of Sulfur Monochloride."

2. Leonard H. Cohan and Norman Hackerman, Ind. Eng. Chem., Anal. Ed. 12, 210-13 (1940) "Determining Emulsifying Efficiencies."

3. Norman Hackerman and D. I. Marshall, Trans. Electrochem. Soc. 89, 195-205 (1946). "Corrosion Studies on Electrolytic Chromium."

4. Norman Hackerman, J. Chem. Educ. 23, 45-46 (1946). "The Equilibrium Concept in Beginning College Chemistry Courses."

5. Norman Hackerman and D. A. Shock, Chem. Eng. 53, 296 (1946). "Checking Corrosion on Oil Well Pipe Lines."

   Norman Hackerman and D. A. Shock, ACS 110th Meeting, Chicago, September 1946. "Formation and Nature of Surface Layers on Steel in High-Pressure Natural Gas Condensate Wells." (Abstract of Papers 39-401)

6. Norman Hackerman and D. A. Shock, Ind. Eng. Chem. 39, 863-67 (1947). "Surface Layers on Steel in Natural Gas Condensate Wells."

7. D. A. Shock and Norman Hackerman, Ind. Eng. Chem. 39, 1283-86 (1947). "Corrosion Studies in Natural Gas Condensate Wells. Protective Layers."

8. Norman Hackerman and D. A. Shock, World Oil 127, 198-206 (1947). "Corrosion in Condensate Wells."

9. Norman Hackerman, Corrosion 4, 45-60 (1948). "Use of Inhibitors in Corrosion Control."

10. Norman Hackerman and D. I. Marshall, J. Electrochem. Soc. 93, 49-54 (1948). "Passivity of Chromium."

11. Norman Hackerman and J. D. Sudbury, J. Electrochem. Soc. 93, 191-98 (1948). "Effect of the Addition of Amines on the Electrode Potential of Copper in Buffered Acid Solution."

12. D. A. Shock and Norman Hackerman, Ind. Eng. Chem. 40, 2169-72 (1948). "Extraction of Polar Constituents from Hydrocarbon Solutions. Field Application in Natural Gas Condensate Wells."

13. Norman Hackerman and H. R. Schmidt, Corrosion 5, 237-43 (1949). "The Role of Adsorption from Solution in Corrosion Inhibitor Action."

14. Norman Hackerman and H. R. Schmidt, Ind. Eng. Chem. 41, 1712-16 (1949). "Kinetics of the Corrosion Process in Condensate Gas Wells."

14a. F. A. Matsen, Jack Myers and Norman Hackerman, Pre-Medical Physical Chemistry, The Macmillen Company, New York, 1949.

15. D. A. Shock and Norman Hackerman, Ind. Eng. Chem. 41, 1974-77 (1949). "Corrosion of Steel in Sulfur-Producing Tubes. Frasch Process."

16. Norman Hackerman and H. R. Schmidt, J. Phys. and Colloid Chem. 53, 629-38 (1949). "The Adsorption of Organic Corrosion Inhibitors on Iron and Steel Surfaces."

17. E. E. Glenn, Jr., E. L. Cook and Norman Hackerman, J. Electrochem. Soc. 95, 110C-112C (1949). "Possible Role of the Solid Surface in Electroless Plating."

18. Norman Hackerman and E. E. Glenn, Jr., J. Phys. and Colloid Chem. 54, 497-505 (1950). "Orientation of a Polyfunctional Organic Molecule at a Steel Surface."

19. Norman Hackerman and E. L. Cook, J. Electrochem. Soc 97, 1 (1950). "Effect of Adsorbed Polar Organic Compounds on the Activity of Steel in Acid Solutions."

20. Norman Hackerman and J. D. Sudbury, J. Electrochem. Soc. 97, 109 (1950). "The Effect of Amines on the Electrode Potential of Mild Steel in Tap Water and Acid Solutions."

21. E. E. Glenn, Jr. and Norman Hackerman, Rev. Sci. Instru. 21, 148-49 (1950). "Positive Displacement Pump for Corrosive Fluids."

22. Norman Hackerman and D. A. Shock, Corrosion 6, 195-200 (1950). "Corrosion in Sulphur Production. The Use of an Alloy Protective Coating."

23. Norman Hackerman and Leland L. Antes, Science 112, 471 (1950). "Contact Potentials of Evaporated Iron Films in Air and in Nitrogen at Low Pressure."

24. Norman Hackerman and Ray M. Hurd, J. Electrochem. Soc. 98, 51-56 (1951). "Dichromate Reduction Rate at a Steel Surface in Air-free, Acetic Acid Solution."

25. E. L. Cook and Norman Hackerman, J. Phys. and Colloid Chem. 55, 549-557 (1951). "Adsorption of Polar Organic Compounds on Steel."

26. A. L. McClellan and Norman Hackerman, J. Phys. and Colloid Chem. 55, 374-382 (1951). "The Sorption of Gases on Metals at Room Temperature."

27. Leland L. Anges and Norman Hackerman, J. Appl. Phys. 22, 1395-1398 (1951). "Contact Potential Variations on Freshly Condensed Metal Films at Low Pressures."

29. Robert A. Powers and Norman Hackerman, J. Phys. Chem. 56, 187-88 (1952). "Nickel Plating by Chemical Reduction. I. Effect of the Basis Metal."

30. Norman Hackerman and Tyleen Jensen, J. Electrochem. Soc. 99, 60-63 (1952). "The Effect of Indium Sulfate in Chromium Plating Baths."

28. Norman Hackerman, Corrosion 7, 321 (1951).

31. Hung Li Wang and Norman Hackorman, J. Phys. Chem. 56, 771-774 (1952). "Sorption of Gases on Metal Powders and Subsequent Change in Metal Reactivity at Room Temperature."

32. Norman Hackerman and E. L. Cook, J. Phys. Chem. 56, 524-526 (1952). "Dual Adsorption of Polar Organic Compounds on Steel."

33. Norman Hackerman, Corrosion 8, 143-49 (1952). "Physical Chemical Aspects of Corrosion Inhibition."

34. Norman Hackerman, Ind. Eng. Chem. 44, 1752-55 (1952). "Effect of Temperature on Corrosion of Metals by Water."

35. Norman Hackerman and R. A. Powers, J. Phys. Chem. 57, 139-42 (1953). "Surface Reactions of Chromium in Dilute $Cr^{51}O_4^{=}$ Solutions."

36. Colby D. Hall, Jr. and Norman Hackerman, J. Phys. Chem. 57, 262-68 (1953). "Charging Processes on Anodic Polarization of Titanium."

37. Norman Hackerman. U.S. Patent 2,630,407, March 3,1953. Electrodeposition of Chromium. (Assigned to Research Corporation, New York.)

38. R. A. Powers and Norman Hackerman, J. Electrochem. Soc. 100, 314-19 (1953). "Surface Reactions of Steel in Dilute $Cr^{51}O_4$ Solutions: Applications to Passivity."

39. Norman Hackerman and E. E. Glenn, Jr., J. Electrochem. Soc. 100, 339-44 (1953). "Corrosion of Steel by Air-free, Dilute, Weak Acids."

40. M. J. Joncich and Norman Hackerman, J. Phys. Chem. 57, 674-78 (1953). "The Reaction of Hydrogen and Oxygen on Submerged Platinum Electrode Catalysts. I. Effect of Stirring, Temperature and Electric Polarization."

41. M. Muskat, A. Chatenever and Norman Hackerman, API Proceedings, November 1953. "Mechanism of the Displacement of Oil from Porous Materials."

42. Norman Hackerman, Corrosion 10, 70-72 (1954). "The Measurement of Electrode Potentials."

43. Norman Hackerman and A. C. Makrides, Ind. Eng. Chem. 46, 523-26 (1954). "Mechanism of Inhibition by Organic Compounds."

44. Norman Hackerman and A. H. Roebuck, Ind. Eng. Chem. 46, 1481-85 (1954). "Adsorption of Polar Organic Compounds on Steel."

45. Norman Hackerman and Colby D. Hall, Jr., J. Electrochem. Soc. 101, 321-27 (1954). "Electrochemical Polarization of Titanium in Aqueous Solutions of Sodium Chloride."

46. Norman Hackerman and Olin B. Cecil, J. Electrochem. Soc. 101, 419-425 (1954). "The Electrochemical Polarization of Zirconium in Neutral Salt Solutions."

47. K. W. Hannah, M. J. Joncich and Norman Hackerman, Rev. Sci. Instr. 25, 636-39 (1954). "An Automatic System for the Study of Catalytic Reactions Involving Gases."

48. Barton L. Cross and Norman Hackerman, Corrosion 10, 407-12 (1954). "Inhibitor Evaluation by the Pearson Null Bridge."

49. Norman Hackerman and Sarah Jane Stephens, J. Phys. Chem. 58, 904-8 (1954). "The Adsorption of Sulfate Ions from Aqueous Solutions by Iron Surfaces."

50. F. A. Matsen, A. C. Makrides and Norman Hackerman, J. Chem. Phys. 22, 1800-1803 (1954). "Charge-Transfer-No-Bond Adsorption."

51. Norman Hackerman, Trans. New York Acad. Sci. 17, 7-11 (1954). "Effect of Sorption on Metal Dissolution in Aqueous Acid Solution."

52. R. A. George and Norman Hackerman, Corrosion 11, 249t-54t (1955). "Acid Corrosion Inhibition by High Molecular Weight Nitrogen-Containing Compounds."

53. Donald M. Sowards and Norman Hackerman, J. Electrochem. Soc. 102, 297-303 (1955). "Kinetics of Surface Reactions of Metals. I. Iron."

54. N. H. Simpson and Norman Hackerman, Nucleonics 13, 67-68 (1955). "Following Surface Diffusion of Radioisotopes."

55. A. C. Makrides, N. M. Komodromos and Norman Hackerman, J. Electrochem. Soc. 102, 363-69 (1955). "Dissolution of Metals in Aqueous Acid Solutions. I. Current-potential Relations for Iron and Mild Steel."

56. A. C. Makrides and Norman Hackerman, J. Phys. Chem. 59, 707-10 (1955). "Inhibition of Acid Dissolution of Metals. I. Some General Observations."

57. Ray M. Hurd and Norman Hackerman, J. Electrochem. Soc. 102, 594-97 (1955). "Electrokinetic Potentials of Bulk Metals by Streaming Current Measurements. I. Method."

58. A. C. Makrides and Norman Hackerman, Ind. Eng. Chem. 47, 1773-78 (1955). "Effect of Thiourea Compoungs on Dissolution Rate of Iron and Mild Steel."

59. Norman Hackerman and Emerson H. Lee, J. Phys. Chem. 59, 900-06 (1955). "The Effect of Gases on the Contact Potentials of Evaporated Metal Films."

60. N. H. Simpson and Norman Hackerman, J. Electrochem. Soc. 102, 660-61 (1955). "Surface Contamination of Copper by Phosphate Ion During Electropolishing — -- Use of P^{32}."

61. Ray M. Hurd and Norman Hackerman, J. Electrochem. Soc. 103, 316-19 (1956). "Electrokinetic Potentials on Bulk Metals by Streaming Current Measurements. II. Gold, Platinum and Silver in Dilute Aqueous Electrolytes."

62. Norman Hackerman, Bulletin of the India Section, The Electrochem. Soc. 5, 31-35 (1956). "Corrosion and Its Inhibition."

63. Norman Hackerman and Norman H. Simpson, Trans. Faraday Soc. 52, 628-33 (1956). "Rates of Surface Self-Diffusion Over the Principal Planes of a Single Crystal of Copper."

64. W. J. Krodel and Norman Hackerman. U.S. Patent 2,743,178, April 24, 1956. "Process for De-inking Printed Waste Paper." (Assigned to W. J. Krodel)

65. Norman Hackerman, A.G.A. Proceedings, April 1957. "Vapor Phase Corrosion Inhibition."

66. Ray M. Hurd and Norman Hackerman, J. Electrochem. Soc. 104, 482-485 (1957). "Kinetic Studies on Formation of Black-Oxide Coatings on Mild Steel in Alkaline Nitrite Solutions."

67. William H. Wade and Norman Hackerman, Trans. Faraday Soc. 53, 1636-47 (1957). "Anodic Phenomena at an Iron Electrode."

68. John J. Bordeaux and Norman Hackerman, J. Phys. Chem. 61, 1323-27 (1957). "Adsorption from Solution of Stearic Acid on Iron; Effect on Electrode Potential."

69. Ralph J. Brodd and Norman Hackerman, J. Electrochem. Soc. 104, 704-09 (1957). "Polarization Capacity at Solid Electrodes and True Surface Area Values."

70. A. C. Makrides and Norman Hackerman, J. Electrochem. Soc. 105, 156-62 (1958). "Dissolution of Metals in Aqueous Acid Solutions. II. Depolarized Dissolution of Mild Steel."

71. Norman Hackerman, Ray M. Hurd and Earl S. Snavely, Corrosion 14, 203t-05t (1958). "Corrosion Rates of Mild Steel in NH_4NO_3-NH_3-H_2O Solutions."

72. Helmut Kaesche and Norman Hackerman, J. Electrochem. Soc. 105, 191-98 (1958). "Corrosion Inhibition by Organic Amines."

73. Norman Hackerman, J. Electrochem. Soc. 105, 119C-21C (1958). "On Research -- Its Care and Nourishment." (Presidental Address)

74. Norman Hackerman and Arthur C. Hall, J. Phys. Chem. 62, 1212-14 (1958). "The Adsorption of Water Vapor on Quartz and Calcite."

75. P. V. Popat and Norman Hackerman, J. Phys. Chem. 62, 1198-1203 (1958). "Capacity of the Electrical Double Layer and Adsorption at Polarized Platinum Electrodes. I. Adsorption of Anions."

76. Norman Hackerman, Z. für Elektrochemie 61, 632-637 (1958). "Sorption, Oxidation and Passivity."

77. Earl S. Snavely, Jr. and Norman Hackerman, Can. J. Chem. 37, 268-275 (1959). "The Anodic Passivation of Iron."

78. Norman Hackerman, Bulletin of the India Section, The Electrochem. Soc. 8, 9-15 (19[illegible]). "Corrosion Inhibition and Chelating Agents."

79. J. J. McMullen and Norman Hackerman, J. Electrochem. Soc. 106, 341-46 (1959). "Capacities of Solid Metal-Solution Interfaces."

80. A. C. Makrides and Norman Hackerman, J. Phys. Chem. 63, 594-98 (1959). "Heats of Immersion. I. The System Silica-Water."

81. William H. Wade and Norman Hackerman, J. Phys. Chem. 63, 1639-41 (1959). "Heats of Immersion. II. Calcite and Kaolinite - The Effect of Pretreatment."

82. R. A. Legault and Norman Hackerman, Corrosion 15, 517t-522t (1959). "Corrosion Inhibitor Evaluation from Cathodic Polarization Measurements."

83. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 107, 142-43 (1960). "The A-C Resistance of a Polarized Stainless Steel Wire Cathode."

84. W. H. Wade, R. L. Every and Norman Hackerman, J. Phys. Chem. 64, 355-58 (1960). "Heats of Immersion. III. The Influence of Substrate Structure in the SiO_2-H_2O System."

85. Howard F. Finley and Norman Hackerman, J. Electrochem. Soc. 107, 259-63 (1960). "Effect of Adsorption of Polar Organic Compounds on the Reactivity of Steel."

86. Norman Hackerman, "Kinetics of Dissolution Processes," in The Surface Chemistry of Metals and Semi-conductors, H. C. Gatos, ed., John Wiley & Sons, Inc., New York, 1960.

87. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 107, 647-51 (1960). "The A-C Resistance of a Stainless Steel Electrode and Specific Adsorption."

88. W. H. Wade and Norman Hackerman, J. Phys. Chem. 64, 1196-99 (1960). "Heats of Immersion. IV. The Alumina-Water System -- Variations with Particle Size and Outgassing Temperature."

89. Norman Hackerman, Chem. Eng., January 23, 1961. "A Survey of the New Chemistry."

90. R. L. Every, W. H. Wade and Norman Hackerman, J. Phys. Chem. 65, 25-29 (1961). "Free Energy of Adsorption. I. The Influence of Substrate Structure in the SiO_2-H_2O, SiO_2-n-Hexane and SiO_2-CH_3OH Systems."

91. R. L. Every, W. H. Wade and Norman Hackerman, J. Phys. Chem. 65, 937-41 (1961). "Free Energy of Adsorption. II. The Influence of Substrate Structure in the Systems Al_2O_3 and TiO_2 with n-Hexane, CH_3OH and H_2O."

92. J. S. Riney, G. M. Schmid and Norman Hackerman, Rev. Sci. Instru. 32, 588-92 (196 "Single Pulse Method for Measurement of Electrical Double Layer Parameters."

93. P. V. Popat and Norman Hackerman, J. Phys. Chem. 65, 1201-05 (1961). "Electrical Double Layer Capacity of Passive Iron and Stainless Steel Electrodes."

94. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 108, 741-44 (1961). "Anodic Polarization of Stainless Steel in Chloride Solutions."

95. Norman Hackerman, Comptes Rendus du Symposium Europeen sur les Inhibiteurs de Corrosion, Ferrara (Italie), pp. 101-109, 1961.
"An Adsorption Theory of Corrosion Inhibition by Organic Compounds."

96. W. H. Wade and Norman Hackerman, J. Phys. Chem. 65, 1681-83 (1961).
"Heats of Immersion. V. The TiO_2-H_2O System -- Variations with Particle Sizes and Outgassing Temperature."

97. J. D. Goodrich and Norman Hackerman, J. Electrochem. Soc. 108, 1092-97 (1961).
"The Dissolution of Steel in the System NH_4NO_3-NH_3-H_2O."

98. W. H. Wade, H. D. Cole, D. E. Meyer and Norman Hackerman, Advances in Chemistry Series 33, 35-41 (1961).
"Adsorptive Behavior of Fused Quartz Powders."

99. Norman Hackerman, R. M. Hurd and R. R. Annand, Corrosion 18, 37t-42t (1962).
"Some Structural Effects of Organic N-Containing Compounds on Corrosion Inhibition."

100. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 109, 243-247 (1962).
"Double Layer Capacities of Single Crystals of Gold in Perchloric Acid Solutions."

101. W. H. Wade and Norman Hackerman, J. Phys. Chem. 66, 1823-26 (1962).
"Heats of Immersion. VII. The Immersion of Silica, Alumina, and Titania in Hexane -- Variation with Particle Size and Outgassing Temperature."

102. Norman Hackerman and R. M. Hurd, "Proceedings of the First International Congress on Metallic Corrosion," pp. 166-172, Butterworths, London, 1962.
"Corrosion Inhibition and Molecular Structure."

103. Norman Hackerman, Corrosion 18, 332t-337t (1962).
"Recent Advances in Understanding of Organic Inhibitors."

104. J. D. Goodrich and Norman Hackerman, J. Electrochem. Soc. 109, 795-98 (1962).
"Polarization and Inhibition of Steel in the NH_4NO_3-NH_3-H_2O System."

105. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 109, 1096-99 (1962).
"Electrical Double Layer Capacities of Iron During Forced Cathodic Decay of Passivity."

106. T. L. Ashcraft, John Riney and Norman Hackerman, Rev. Sci. Instr. 34, 5-7 (1963).
"Electrostatic Voltmeter for the Measurement of Surface Potentials."

107. Norvell E. Wisdom, Jr. and Norman Hackerman, J. Electrochem. Soc. 110, 318-25 (1963)
"Surface Studies on Passive Iron."

108. G. M. Schmid and Norman Hackerman, J. Electrochem. Soc. 110, 440-44 (1963).
"Electrical Double Layer Capacities and Adsorption of Alcohols on Gold."

109. Norman Hackerman and R. R. Annand. U.S. Patent 3,091,591, May 28, 1963.
"Method of Inhibiting Corrosion." (Assigned to Texas Research Associates.)

110. Robert C. Ayers, Jr. and Norman Hackerman, J. Electrochem. Soc. 110, 507-13 (1963). "Corrosion Inhibition in HCl Using Mothyl Pyridines."

111. Gerald Aronowitz and Norman Hackerman, J. Electrochem. Soc. 110, 633-40 (1963). "The Passivity of Iron-Chromium Alloys."

112. M. C. Banta and Norman Hackerman, J. Electrochem. Soc. 111, 114-19 (1964). "The Effect of Acidity on the Differential Capacity of Polarized Platinum Electrodes."

113. William H. Wade and Norman Hackerman, Advances in Chemistry Series 43, 222-31 (1964). "Thermodynamics of Wetting of Solid Oxides."

114. Norman Hackerman and W. H. Wade, J. Phys. Chem. 68, 1592-94 (1964). "Certain Aspects of the Interpretation of Immersional Heats of Gels."

115. M. J. Joncich and Norman Hackerman, J. Electrochem. Soc. 111, 1286-89 (1964). "Preparation and Surface Area Measurements of Platinized-Platinum Electrodes."

116. Norman Hackerman, Official Digest 36, 1405-32 (1964). "Surfaces, Sorption and Polymers in the Inhibition of Corrosion Reactions." (The Joseph J. Mattiello Memorial Lecture for 1964.)

117. R. R. Annand and Norman Hackerman, in The Encyclopedia of Electrochemistry, Clifford A. Hampel, Ed., pp. 274-80, Reinhold Publishing Co., New York, 1964. "Corrosion Inhibition."

118. Takao Murakawa and Norman Hackerman, Corrosion Sci. 4, 387-96 (1964). "The Double Layer Capacity at the Interface Between Iron and Acid Solutions With and Without Organic Materials."

119. R. M. Hurd and Norman Hackerman, Electrochim. Acta 9, 1633-43 (1964). "Passivity Phenomena at the Silicon/Electrolyte Interface."

120. Norman Hackerman and W. H. Wade, J. Phys. Chem. 69, 314-15 (1965). "A Microcalorimetric Study of Liquid-Liquid Displacement Phenomena."

121. Raymond L. Venable, William H. Wade and Norman Hackerman, J. Phys. Chem. 69, 317-21 (1965). "Heats of Immersion. VIII. Differential Heats of Adsorption as a Function of Particle Size for the Alumina-Water System."

122. R. R. Annand, R. M. Hurd and Norman Hackerman, J. Electrochem. Soc. 112, 138-44 (1965). "Adsorption of Monomeric and Polymeric Amine Corrosion Inhibitors on Steel."

123. R. R. Annand, R. M. Hurd and Norman Hackerman, J. Electrochem. Soc. 112, 144-48 (1965). "Inhibition of Acid Corrosion by Soluble Monomer and Polymer Amines Containing Identical Functional Groups."

124. William J. Krodel and Norman Hackerman. U.S. Patent 3,179,555, April 20, 1965. "Process for De-Inking Printed Waste Paper." (Assigned to W. J. Krodel)

125. Norman Hackerman, E. S. Snavely, Jr. and J. S. Payne, Jr., J. Electrochem. Soc. 113, 677-681 (1966). "Effects of Anions on Corrosion Inhibition by Organic Compounds."

126. Donald E. Meyer and Norman Hackerman, J. Phys. Chem. 70, 2077-86 (1966). "Adsorption Thermodynamics of the Interaction of Water and Various Silica Powders."

127. D. M. Mohilner and Norman Hackerman, Electrochim. Acta 11, 1669-84 (1966). "Thermodynamic Treatment of Interfacial Curvature in Electrocapillarity."

128. Norman Hackerman, E. S. Snavely, Jr. and L. D. Fiel, Electrochim. Acta 12, 535-51 (1967). "Anodic Passivity of Nickel in Hydrogen Fluoride."

129. Norman Hackerman, E. S. Snavely, Jr. and L. D. Fiel, Corrosion Sci. 7, 39-50 (1967). "The Anodic Polarization Behaviour of Metals in Hydrogen Fluoride."

130. Takao Murakawa, Shigeo Nagaura and Norman Hackerman, Corrosion Sci. 7, 79-89 (1967). "Coverage of Iron Surface by Organic Compounds and Anions in Acid Solutions."

131. Takao Murakawa, Toshiharu Kato, Shigeo Nagaura and Norman Hackerman, Corrosion Sci. 7, 657-64 (1967). "Differential Capcity Curves of Iron in Perchloric Acid in the Presence of Anions."

132. Koji Kawasaki and Norman Hackerman, Japanese J. Appl. Phys. 6, 1184-92 (1967). "Vapor Adsorption and Displacement on Porous Glass by Surface Conductivity."

133. Norman Hackerman and Nelson N. Estes. U.S. Patent 3,324,025, June 6, 1967. "Method of Treating Electrodes for Use in Electrochemical Devices." (Assigned to Union Carbide Corporation.)

134. David M. Mohilner, Norman Hackerman and A. J. Bard, Anal. Chem. 39, 1499-1501 (1967). "On Derivation and Application of Linearized Current-Potential Characteristic."

135. Marcellus T. Coltharp and Norman Hackerman, J. Phys. Chem. 72, 1171-77 (1968). "The Surface of a Carbon with Sorbed Oxygen on Pyrolysis."

136. Larry G. Spears and Norman Hackerman, J. Electrochem. Soc. 115, 452-56 (1968). "The Electrolysis of Ammonium Bifluoride in Anhydrous Hydrogen Fluoride."

137. Koji Kawasaki and Norman Hackerman, Surface Sci. 10, 299-302 (1968). "On the Variation of Surface Conduction Current of Porous Vycor Glass by the Adsorption of Water Vapor."

138. Takao Murakawa, Toshiharu Kato, Shigeo Nagaura and Norman Hackerman, Corrosion Sci. 8, 341-347 (1968). "Differential Capacity vs. Electrode Potential Curves for Fe-$HClO_4$ in the Presence of Organic Anions."

139. Larry G. Spears and Norman Hackerman, Rev. Sci. Instr. 39, 688-89 (1968). "Low Temperature ir Cell for Studies Using Anhydrous HF as a Solvent."

140. Takao Murakawa, Toshiharu Kato and Norman Hackerman, Corrosion Sci. 8, 433-435 (1968). "A Transition State of Corrosion Inhibition Mechanism from Adsorption to Film Forming."

141. Takao Murakawa, Toshiharu Kato, Shigeo Nagaura and Norman Hackerman, Corrosion Sci. 8, 483-89 (1968). "A Contribution to the Understanding of the Synergistic Effect of Anions for the Corrosion Inhibition of Fe by Amines."

142. Larry G. Spears and Norman Hackerman, J. Gas Chromatography 6, 392-93 (1968). "Analysis of F_2, HF, NF_3, t-N_2F_2 , and N_2F_4 Mixtures by Gas Chromatography."

143. P. E. Hudson, E. S. Snavely, Jr., J. S. Payne, L. D. Fiel and Norman Hackerman, Corrosion 24, 189-96 (1968). "Absorption of Hydrogen by Cathodically Protected Steel."

144. David Jones and Norman Hackerman, Corrosion Sci. 8, 565-572 (1968). "The Corrosion of Fe in the NH_4NO_3-NH_3-H_2O System."

145. Kunitsugu Aramaki and Norman Hackerman, J. Electrochem. Soc. 115, 1007-13 (1968). "Structure Effects of Many-Membered Polymethyleneimine on Corrosion Inhibition."

146. Katsumi Kanzaki Niki and Norman Hackerman, J. Phys. Chem. 73, 1023-29 (1969). "The Effect of Normal Aliphatic Alcohols on Electrode Kinetics."

147. Kunitsugu Aramaki and Norman Hackerman, J. Electrochem. Soc. 116, 568-74 (1969). "Inhibition Mechanism of Medium-Sized Polymethyleneimine."

148. Norman Hackerman, Chimie et Ind.-Genie Chim. 103, 532-39 (1970). "Inhibition de la corrosion des metaux par les composes organiques. Structure moleculaire et sorption."

149. Keh-Chi Tsai and Norman Hackerman, J. Electrochem. Soc. 118, 28-36 (1971). "Effects of Amides on the Passivation of Iron."

150. K. K. Niki, Y. Okuda, T. Tomonari, E. Buck and Norman Hackerman, Electrochim. Acta 16, 487-93 (1971). "The Determination of Kinetic Parameters from Potential-Step Measurements with a Digital Computer."

151. Erwin Laengle and Norman Hackerman, J. Electrochem. Soc. 118, 1273-78 (1971). "Electrode Behavior of Iron in 2M HCl Containing Oximes or Quinuclidine."

152. R. Narayan and Norman Hackerman, J. Electrochem. Soc. 118, 1426 (1971). "Adsorption of Thiourea and Derivatives at the In-Hg Electrolyte Interface."

153. Norman Hackerman, J. Chem. Ed. 48, 643 (1971). "Chemistry Instruction in the 70's."

154. K. K. Niki and Norman Hackerman, J. Electroanal. Chem. 32, 257 (1971). "Effect of n-Amyl Alcohol on the Electrode Kinetics of the V(II)/V(III) and Cr(II)/Cr(III) Systems."

155. H. Vaidyanathan and Norman Hackerman, Corros. Sci. 11, 737 (1971). "Effect of Furan Derivatives on the Anodic Dissolution of Fe."

156. H. Vaidyanathan and Norman Hackerman, Electrochim. Acta 16, 2193-2199 (1971). "Further Aspects of the Differential Capacitance of Iron."

157. E. McCafferty and N. Hackerman, J. Electrochem. Soc. 119, 146-154 (1972). "Double Layer Capacitance of Iron and Corrosion Inhibition with Polymethylene Diamines."

158. D. Larkin, N. Hackerman et al., J. Electrochem. Soc. 119, 189-191 (1972). "Liquid Ammonia as a Non-Aqueous Solvent: The Kinetics of Tb/Tb^{+2} Exchange."

159. E. McCafferty and N. Hackerman, J. Electrochem. Soc. 119, 999-1009 (1972). "Kinetics of Iron Corrosion in Concentrated Acidic Chloride Solutions."

160. K. Ogura and N. Hackerman, Electrochim. Acta 17, 1717-1722 (1972). "Diffusion of Cations in the Anodic Oxidation of Metals: Numerical Calculations."

161. Norman Hackerman, Science 175, 475 (1972). "The Future of Graduate Education, If Any."

162. Norman Hackerman, Science 179, 1081 (1973). "Enclaves of Pluralism: The Private Universities."

163. Norman Hackerman, Corrosion 29, 85 (1973). "Science and Technology in the Service of Society."

164. Marcellus T. Coltharp and Norman Hackerman, J. Colloid Interface Sci. 43, 176-184 (1973). "Heterogeneity in Solution Adsorption: Edge Carbon and Oxide Coverages I. Methanol-Benzene."

165. Marcellus T. Coltharp and Norman Hackerman, J. Colloid Interface Sci. 43, 185-189 (1973). "Heterogeneity in Solution Adsorption: Edge Carbon and Oxide Coverages II. n-Butanol-Benzene."

166. Charles D. Thompson and Norman Hackerman, Corrosion Science 13, 317-324 (1973). "Effect of Nitriles on the Polarization of Iron in 1.0N HCl."

167. Charles D. Thompson and Norman Hackerman, Rev. Sci. Instrum. 44, 1029-1030 (1973). "Apparatus to Measure Hydrogen Evolution from Corroding Metals."

168. Kotaro Ogura and Norman Hackerman, J. Electrochem. Soc. 120, 1638-1644 (1973). "The Transient Behavior of Passivated Iron under Cathodic Potential Pulsing."

169. Norman Hackerman, Science 183, 907 (1974). "Ignorance as the Driving Force."

The CHAIRMAN. Dr. Cobb.

STATEMENT OF JEWEL PLUMMER COBB, PH. D., LL.D., D. SC., OF CONNECTICUT, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD

Dr. COBB. I am very pleased to be here as the third generation of a family devoted to science: my grandfather was a pharmacist, my father was a physician, and I am a biologist.

It is a great pleasure indeed to have the privilege to serve on the National Science Board.

I see my particular role as one that involves the scientist as well as the educator. I am very much interested in training and bringing into the mainstream those human resources we have in America to enlarge upon the talents for science, the improvement of science, and of course the progress of human welfare.

I particularly feel strongly about the area of health and about the area of education. I would hope that these two areas combined with the continued interest in basic research (as an area for charting unknown courses about which we cannot now predict future value) be continued and supported. I see my particular role as an important one, and certainly for me a very exciting one.

The CHAIRMAN. Thank you very much, Dr. Cobb.

A copy of Dr. Cobb's biographical sketch will be included at this point in the record.

[The information referred to follows:]

CURRICULUM VITA

Jewel Plummer Cobb, Ph.D., LL.D., D.Sc.
Dean of the College and
Professor of Zoology
Connecticut College, New London, Connecticut 06320

Home
Address: 740 Williams Street
New London, Connecticut 06320
Phone: [redacted]

Business
Address: Office of the Dean
(Fanning 202)
Connecticut College
New London, Connecticut 06320
Phone: (203) 442-5391, Ext.241

Birthdate: January 17, 1924

Fields of Specialization:

Tissue culture of mammalian normal and neoplastic cells.

Cytological effects produced in vitro by cancer chemotherapeutic agents.

Cytological effects of hormones following direct cell exposure.

Factors influencing growth and morphology of the normal and abnormal pigment cell.

Academic Background:

University of Michigan: 1941-1942.

Talladega College: 1942-1944. A.B. degree.

New York University: 1944-1947. M.S. degree in Cell Biology.

New York University: 1947-1950. Ph.D. degree in Cell Biology.

Graduate work in cell physiology under the direction of Doctor M. J. Kopac.

Master's Thesis: "Effect of Several Aromatic Amidines on the Respiration and Aerobic Metabolism of Yeast Cells."

Doctorate: "Mechanisms of Pigment Formation."

Research Experience:

1949: Summer spent at Marine Biological Laboratory, Woods Hole, Massachusetts, as an independent investigator working on mitotic inhibition in Arbacia eggs.

1950 to 1952: Post-doctorate Fellow, National Cancer Institute working at the Harlem Hospital Cancer Research Foundation in New York City, "Cytological and Histochemical Studies of Human Cancer Cells in Tissue Culture in the Presence of a Series of Drugs."

1953 to 1955: Research Grant, National Cancer Institute, "Production of Melanin in vitro using Tissue Cultures of Amelanotic Tumors."

1955 to 1958: Research Grant, National Cancer Institute, "Factors Influencing Normal and Abnormal Pigment Cell Growth." This study was continued up to and including the year 1964.

1955 to 1960: Head of the tissue culture lab of the cancer research group of Fourth Surgical Division of New York University Post-Graduate College of Medicine (later changed to third division).

Major area of lab studies: The in vitro effects of several newly synthesized promising chemotherapeutic agents against cancer, using human neoplastic tissues. This work was conducted in conjunction with a clinical chemotherapy program.

Growth characteristics and cytology of rare human tumors with reference to modulation phenomena occurring in vitro.

Warburg respirometer studies of oxygen consumption, respiratory quotients, glucose utilization and aerobic and anaerobic glycolysis of the human neoplastic cell line, Hela.

1960 to 1969: Studies of hormonal factors invluencing the growth and melanization in vitro and in vivo of the Cloudman S 91 mouse melanoma. U.S.P.H.S. Research Grants.

Studies of induced tolerance of melanoma to a foreign host strain. Determination of optimal nutritive requirements of the S 91 melanoma in organ culture. U.S.P.H.S. Grants.

Head of cell biology laboratory, in the biology department, Sarah Lawrence College.

Current Research Activities (continued):

1969 to -- : Director, cell biology laboratory, Zoology department, Connecticut College.

Research Grant (1969-1974), National Cancer Institute, Public Health Service: Melanogenesis and Growth of Pigment Cells In Vitro.

Research Grant (1971-1973), American Cancer Society: Direct Hormone Action on Human and Mouse Melanoma in Tissue Culture.

Teaching Experience:

Undergraduate college credits in Education: thirty semester hours.

1945 to 1950: Teaching Fellow, Biology Department, Washington Square College, New York University.

1952 to 1954: Instructor in Anatomy, University of Illinois College of Medicine. Organized and directed the Tissue Culture Laboratory of U. of I. Taught histology, and organized and conducted a graduate course in the laboratory and theory of tissue culture as a research technique.

1955 to 1956: Instructor in Research Surgery, New York University Post-Graduate Medical School.

1956 to 1960: Assistant Professor of Research Surgery at same medical school.

1956 to 1957: Visiting Lecturer, Hunter College, in Research Associates Program for M.S. degree. Taught first lab and lecture course on Tissue Culture.

1960 to 1969: Professor, Biology Department, Sarah Lawrence College, Bronxville, New York; senior member and tenured.

1969 to -- : Dean of the College and Professor of Zoology, Connecticut College, New London, Connecticut.

Awards:

Teaching Fellowship, Biology Department, New York University, 1945-1950.

Post-Doctorate Fellowship, National Cancer Institute, 1950-1952.

N.Y.U. Alumni Key Pin Award for scholarship as outstanding woman alumna of 1952, Graduate School of Arts and Science, New York University.

Elected to Sigma Xi, National Honorary Science Society, 1952.

University of Illinois Achievement Award, 1953-1954. "Cinematographic Studies of Human and Mouse Neoplastic Cells in Tissue Culture."

Elected a Fellow of the New York Academy of Sciences, 1965.

Member of Sigma Delta Epsilon, national women's scientific fraternity.

Awarded travel grant by the National Science Foundation as United States Scientist to the 7th International Cancer Congress in London (1958) and to the 8th Congress in Moscow (1962).

Sabbatical leave spring semester 1967 spent doing research at the Laboratory Internazionale di Genetica e Biofisica (International Lab of Genetics and Biophysics) on cancer viruses, (specific genetic studies on polyoma virus). Awarded special Research Fellowship by the National Institutes of Health to support this work in Naples, Italy, for a seven-month period. Held from February 1 to September 1, 1967.

Who's Who in America.

Who's Who in American Science.

Honorary Doctorate of Laws degree awarded at May, 1971 Commencement, Wheaton College, Norton, Massachusetts.

Who's Who Among the Women in the Nation--American, 1972-73 Edition.

Honorary Doctorate of Science degree awarded at June, 1972 Commencement, Lowell Technological Institute, Lowell, Massachusetts.

Other Educationally Related Activities:

1. Biology course designed and taught as part of National Science Foundation In-Service Institute for High School Science Teachers held at Sarah Lawrence College 1960, 1961, 1962, 1963, and 1964.

2. Science Advisory Board in 1960 for planning of new Mt. Vernon High School.

3. Directed Undergraduate Research Participants Program of National Science Foundation at Sarah Lawrence College, 1962-1966.

4. Woodrow Wilson Fellowship Nominating Committee, Region II, from 1964 to 1970.

5. Author of Partners in Education program, a teacher-assistant program for junior high school underachievers, where college students will combine their talent with classroom needs to inspire, lead, guide, and help this age group.

6. Trustee, Hartt College of Music, Hartford, Connecticut. 1969-1972.

7. Board of Regents, University of Hartford, Hartford, Connecticut. 1969-1972.

8. Board of Trustees, The Institute for Educational Management. 1973-

9. Board of Directors, American Conference of Academic Deans. 1972-73.

10. Evaluation Committee, New England Association of Schools and Colleges.

11. Developer and Director of Fifth Year Post Baccalaureate Pre-Med Program for minority students at Connecticut College, New London, Connecticut.

12. Consultant to the Director of the National Institutes of Dental Research and Member of National Advisory Dental Research Council, Department of Health, Education and Welfare. 1972-

13. Commission on Academic Affairs, American Council on Education, Washington, D.C. 1973-

14. Member of the Corporation, Marine Biological Institute, Woods Hole, Massachusetts. 1972-

15. Board of Directors, American Council on Education, Washington, D.C., 1973-1976.

16. Board of Directors, Educational Policy Center, New York, New York.

17. Ford Foundation travel and study grant to publish proceedings of a 1973 New England college conference of university and college administrators from institutions with significant increases in black students over the past five years.

18. Member Institute of Medicine of the National Academy of Sciences, 1974

Other Educationally Related Activities (continued)

19. Committee on Opportunities for Women and Minorities in Science of the American Association for the Advancement of Science. Washington, D.C. 1973-

20. National Science Board, policy-making body of the National Science Foundation, Washington, D.C. 1974-

Public Service:

1. Education Committee, Tissue Culture Association. 1972-
2. Advisory Board, Mohegan Community College, Norwich, Connecticut.
3. Incorporator of Lawrence and Memorial Hospitals, New London, Connecticut.
4. Board of Directors, Family Services, New London, Connecticut.
5. Board of Directors, The National Center for Resource Recovery, Inc. Washington, D.C.
6. Conservation Committee, City of New London, Connecticut, 1970-71.
7. State of Connecticut Health and Educational Facilities Authority--a body politic and corporate of the state constituting a public instrumentality.
8. Board, 21st Century Foundation.
9. Advisory Committee, Southeastern Region, Hartford National Bank and Trust Company.

Memberships:

New York Academy of Science
Tissue Culture Association
American Association for Cancer Research
American Society for Cell Biology
American Association for Advancement of Science
Sigma Delta Epsilon
Sigmi Xi
International Union Against Cancer

American Conference of Academic Deans
American Association of University Women
American Association of University Professors

Publications:

1. The effect of triethylene melamine, aureomycin, and some 4-amino derivatives of folic acid on tissues in vitro. G. Antikajian, L.T. Wright, J.Plummer, and S.Weintraub. J. Nat. Canc. Inst. 12: 269-274, 1951

2. The in vitro effects of A-methopterin. J.Plummer. Blood VII, Supplement, Jan. 1952.

3. Triethylene melamine in vitro studies. I. Mitotic alterations produced in chick fibroblast tissue cultures. Cancer Res. 12: 796-800. J.Plummer, L.T. Wright, G.Antikajian and S.Weintraub, 1952.

4. Triethylene melamine in neoplastic diseases. Acta Hematol, 8: 122. A.Prigot, J.C.Wright, J.Plummer, and L.T. Wright, 1952.

5. The in vitro production of pigment granules: Pigment Cell Growth. Academic Press, Inc., New York, N.Y. J.Plummer and M.J.Kopac, 1953.

6. The in vivo and in vitro effects of chemotherapeutic agents on human neoplastic diseases. J.C.Wright, J.I.Plummer, R.S.Goidan, and L.T.Wright. Harlem Hospital Bull., VI: 58-63, 1953.

7. Human bladder neoplastic cells in tissue culture. J.P.Cobb, J.H.Kiefer, and H.Woods. J. Urology, 73: 1039-1044, 1955.

8. Tissue culture observations of the effects of chemotherapeutic agents on human tumors. J.P.Cobb. Trans. N.Y. Acad. Sci., 17: 237-249, 1955.

9. Effect of in vitro X-irradiation on pigmented and pale slices of Cloudman S91 mouse melanoma as measured by subsequent proliferations in vivo. J.P.Cobb. J. Nat. Canc. Inst., 17: 657-666, 1956.

10. Evaluation of variation in transplantability and growth of pigmented and pale fragments of the Cloudman S91 mouse melanoma following X-irradiation in vitro. J.P.Cobb. Proc. Amer. Assn. Canc. Res., 2: 10, 1955.

11. The effect of triethylene thiophosphoramide on fifty patients with incurable neoplastic diseases. J.C.Wright, P.Foster, B.Billow, S.L.Gumport, and J.P.Cobb. Cancer, 10: 239-245, 1957.

12. Investigation of the relationship between clinical and tissue response to chemotherapeutic agents on human cancer. J.Wright, J.P.Cobb, S.L.Gumport, F.M.Golomb, and D.Safadi. New England J. Med., 257: 1207-1211, 1957.

13. Effect of Actinomycin D on tissue cultures of normal and neoplastic cells. J.P.Cobb and D.G.Walker. J. Nat. Canc. Inst., 21: 263-277, 1958.

14. Observations on the action of triethylene thiophosphoramide within individual cells. J.P.Cobb, D.G.Waller, and J.C.Wright. Acta of VII International Cancer Congress, 1960.

Publications (continued):

15. Studies on a craniopharynioma in tissue culture. J.P.Cobb and J.C.Wright. J. Neuropath. and Exper. Neurology, 18: 563-568, 1959.

16. Chemotherapy of disseminated carcinoma of the breast. J.C.Wright, J.P.Cobb, F.M.Golomb, S.L.Gumport, D.Lyall, and D.Safadi. Ann. Surgery, 150 (2), 1959.

17. The comparative cytological effects of several alkylating agents on human normal and neoplastic cells in tissue culture. J.P.Cobb. Annals of New York Academy of Sciences, 84: 513-542, 1960.

18. Comparative chemotherapy studies on primary short-term cultures of human normal, benign, and malignant tumor tissues--a five year study. J.P.Cobb, D.G.Walker. Cancer Res., 21: 583-590, 1961.

19. Effect of heterologous, homologous, and autologous serums on human normal and malignant cells in vitro. J.P.Cobb and D.G.Walker. J. Nat. Canc. Inst., 27: 1-15, 1951.

20. Studies on human melanoma cells in tissue cultures. I. Growth characteristics and cytology. J.P.Cobb and D.G.Walker. Canc. Res., 20: 858-867, 1960.

21. The chemotherapy of human solid tumors by perfusion techniques. F.M.Golomb, J.C.Wright, J.P.Cobb., S.L.Gumport, A.Postel, and D.Safadi. Proc. Amer. Assoc. Canc. Res., 3, 1960.

22. Further investigation of the relation between the clinical and tissue culture response to chemotherapy agents on human cancer. J.C.Wright, J.P.Cobb, S.L.Gumport, D.Safadi, D.G.Walker, and F.M.Golomb. Cancer, 15: 284-293, 1962.

23. In vitro selection of chemotherapeutic agents for perfusion therapy of human cancer. F.M.Golomb, J.P.Cobb, D.G.Walker, and J.C.Wright. Surgery, 51: 639-644, 1962.

24. Studies on human melanoma cells in tissue culture. II. Effects of several cancer chemotherapeutic agents on cytology and growth. J.P.Cobb and D.G.Walker. Acta Union Internationale Contre Le Cancer., XX: 206-208, 1964.

25. Melanin mobilization in cultured Cloudman S91 mouse melanocytes. C.H.Nadolney and J.P.Cobb. Excerpta Medica. Tissue Culture Meetings, 1964.

26. Significance of large molecular protein molecules in the nutrition of mouse melanoma organ cultures. J.P.Cobb and E.S.Rose. Excerpta Medica, Section I, Vol. 19, No. 10, 1965.

27. Time lapse cinematography in Medical Research. J.P.Cobb and D.G.Walker. Bolex Magazine, 1966.

Publications (continued)

28. Cytological studies on human melanoma cells in tissue culture following exposure to five chemotherapeutic agents. J.P. Cobb and D.G. Walker. Cancer Chemotherapy Rpts., 52: 543-5552, 1968.

29. Environmental influences on the growth of Cloudman S91 mouse melanoma in organ culture. J.P. Cobb. Proc. Oral Res. Seminars 1967/1968.

30. Article by J.P. Cobb, The Impact of the Black Experience on Higher Education in New England. (An occasional paper of the School of Education, University of Connecticut, and edited by Glenn C. Atkyns): 100-115, 1969/1970.

31. S91 mouse melanoma sublines following total in vitro versus alternate in vivo passages. Jewel P. Cobb and Anne McGrath. J. Nat. Canc. Inst. 48:885-891, 1972.

32. "I am Woman, Black, Educated." Article in Hartford Courant, February 4, 1973.

33. In vitro effects of melanocyte-stimulating hormone, adrenocorticotropic hormone, 17β-estradiol, or testosterone propionate on Cloudman S91 mouse melanoma cells. Jewel P. Cobb and Anne McGrath. J. Nat. Canc. Inst. 52:567-570, 1974.

34. "The Morning After--A Retrospective View of a Select Number of Colleges and Universities with Increased Black Student Enrollment in the Past Five Years." The report of a conference at the University of Connecticut, Storrs, April 30, 1973. Edited by Jewel Plummer Cobb and Carolyn McDew. Library of Congress Cat. Card No.: 74-79612. 1974

July 1974

References on file at:

New York University Placement Services
Education Division
10 Washington Place - Room 200
New York, New York 10003
Telephone: (212) 598-2961
Mr. John M. Buckey, Director

The CHAIRMAN. Senator Kennedy, we are running through the panel here in capsule form getting to know members of the Foundation better. They are giving just a brief statement of their view of their role.

We have reached Dr. Shields.

STATEMENT OF L. DONALD SHIELDS, PH. D., OF CALIFORNIA, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD

Dr. SHIELDS. Mr. Chairman, Senator Kennedy, I am very pleased for the opportunity to be nominated to the National Science Board.

My particular interests over the years have been in the areas of basic science and basic science research. I have also been particularly interested in applied research and more recently in science education.

I appreciate the opportunity, particularly in the applied science area and in the science education area, to participate in a policymaking board.

I represent a segment of higher education which educates about 25 percent of the young people in the colleges and universities today, and about 50 percent of the young people who enter teaching at the elementary and secondary level.

I have particular interests in the latter two areas.

The CHAIRMAN. Thank you, Dr. Shields.

A copy of Dr. Shield's biographical sketch will be included at this point in the record.

[The information referred to follows:]

california state university, fullerton
fullerton, california 92634

office of the president

VITA

L. DONALD SHIELDS

President and Professor of Chemistry
California State University, Fullerton

Education:

B.A., Chemistry, University of California, Riverside, 1959
Ph.D., Chemistry, University of California, Los Angeles, 1964

Administrative Positions Held:

President, CSUF, May, 1971--present (appointed at age 34 as the youngest president of a major state university in the U.S.A.)
Executive Committee, Council of Presidents, California State University and Colleges System, September, 1973--present
Acting President, CSUF, October, 1970 - May, 1971
Vice President for Administration, CSUF, 1967-70
Chairman, CSUF Faculty Council, 1967
Assistant to the Chancellor (School Relations), University of California, Riverside, 1955-57

Academic Positions Held:

Professor of Chemistry, CSUF, 1967--present
Visiting Professor of Chemistry, UCLA, Summers 1964-67
Associate Professor of Chemistry, CSUF, 1966-67
Assistant Professor of Chemistry, CSUF, 1963-66

Government and Industry Positions Held:

Consultant to California State Senator Dennis E. Carpenter for Review of the California Master Plan for Higher Education, 1972-73
Consultant to the National Science Foundation, 1970
Consultant to California State Senator John L. Harmer for Legislation In Support of Research in the California State Colleges, 1968-69
Chemist, United States Department of Agriculture, Riverside, California, Summers 1958-59
Research Chemist, Kelco Company, San Diego, California, Summers 1955-57

Honors:

Orange County Press Club Award, "1973 Headliner of the Year In Education," May, 1974
Distinguished American Award - National Football Foundation and Hall of Fame, Orange County Chapter, April, 1974
California State Jaycees Award--"One of California's Five Outstanding Young Men of 1970," April, 1971
California State Legislature Distinguished Teaching Award, CSUF, 1965
Sigma Xi Membership (Honorary National Science Fraternity), 1963
du Pont Teaching Fellowship, UCLA, 1961-62
Phi Lambda Upsilon Membership (Honorary National Chemistry Fraternity), 1961
Graduate Teaching Assistant Fellowships at UCLA, University of Illinois, and USC, 1959
Watkins Award (Outstanding Graduating Senior Award) UCR, 1959
California Club Membership (Honorary statewide student society, membership by invitation from the President of the University of California), 1956
Four Year Academic Scholarships to Stanford University and UCR, 1954

Directory Listings:

American Men of Science, 11th Edition
Leaders in Education, 4th Edition
Who's Who in American College and University Administration, 1970-71
Who's Who in California, 9th Edition

Professional Publications:

Modern Methods of Chemical Analysis, 2nd Edition, John Wiley and Sons, New York, in preparation.
Modern Methods of Chemical Analysis, John Wiley and Sons, New York, 1968, Tokyo Kagaku Dozin Co., Ltd., Tokyo, 1971, Editorial Limusa, México, 1973.
Analytical Methods of Organic and Biochemistry, John Wiley and Sons, New York, 1966.
"Complexes of Chromium (II) with Diethylenetriamine and Triethylene-tetramine," Inorganic Chemistry, Volume 4, No. 4, 1965.
"Complexes of Chromium (II) and (III) with Ethylenediaminetetraacetic Acid," Inorganic Chemistry, Volume 3, No. 1, 1964.
"A Method for the Determination of Equilibrium Sulfur Pressures of Metal Sulfide Reactions," Economic Geology and the Bulletin of the Society of Economic Geologists, Volume 57, No. 7, 1962.
"Chelates of Cadmium with Kojic Acid," Journal of the American Chemical Society, Volume 83, 1961.

Professional Activities:

Speaker, 1973 Annual Meeting, National Council of Colleges of Letters and Science, Scottsdale, Arizona, "Management Systems In Higher Education"
Speaker, 1973 Conference On California State University and Colleges Chemistry Programs, San Francisco, California, "The Future of Graduate Programs in the California State Universities and Colleges"
Speaker, 1973 Annual Meeting, Auxiliary Organizations Association of the California State University and Colleges, Pomona, California, "Partners for the Future"
Speaker, 1972 National Meeting of the National Center for Higher Education Management Systems (NCHEMS), Denver, Colorado, "Higher Education Resource Requirements Prediction Model: A Case Study"
Speaker, 1972 National Meeting of the Association of Collegiate Registrars, Newport Beach, California, "New Challenges In Higher Education"
Chairman, Pacific Coast Conference on Chemistry and Spectroscopy, Anaheim, California, April, 1970
Member, American Association for the Advancement of Science
Member, American Chemical Society
Member, American College Public Relations Association
Member, American Institute of Chemists

Community Activities:

Chairman, Disneyland Community Service Awards Committee, 1973
Member, Town Hall of California, 1972 - present
Member, Orange County Economics Development Council, 1972 - present
Board of Trustees, World Affairs Council of Orange County, 1972 - present
Board of Directors, Orange County Sports Celebrities, 1972 - present
Member, Orange County Chamber of Commerce
Member, Fullerton Chamber of Commerce

Personal Information:

Born: September 18, 1936, San Diego, California
Parents: Mr. and Mrs. Clifford L. Shields, El Cajon, California
Married: Patricia Ann Baldwin, September 1, 1957
Children: Ronald, 1958; Steven, 1960; Cynthia, 1962; and Laurie, 1968

Office Address: California State University, Fullerton
Fullerton, California 92634
Telephone: (714) 870-3456

Home Address: 1010 Eastridge Knoll
Fullerton, California 92635
Telephone: [redacted]

6/28/74

CONGRESS OF THE UNITED STATES

Charles E. Wiggins

Member of Congress • 25th (New 39th) District of California

SEP 16 4 00 PM '74

September 13, 1974

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District Office

BASLER PROFESSIONAL BLDG.
2218 NORTH HARBOR BLVD.
FULLERTON, CA. 92635
714—870-7268

Honorable Harrison A. Williams, Jr.
Russell Building #352
Washington, D.C.

Dear Senator Williams:

L. Donald Shields, President of California State University, Fullerton, has been nominated by President Ford to the National Science Board. I understand that you recently held confirmation hearings on his nomination.

It is a pleasure to endorse Dr. Shields' appointment. As President of a major California State University, Dr. Shields will serve an important role on the National Science Board which is now unfulfilled. If confirmed, he will be, I believe, the only representative from this type of institution.

I have known Dr. Shields for many years, both as a friend and as President of California State University. Dr. Shields has held many responsible positions both in and out of the academic field and has previously held the position of Consultant to the National Science Foundation. He has demonstrated himself to be highly competent.

He is a deserving person and would be a definite asset to the National Science Board.

Sincerely yours,

Charles E. Wiggins

CHARLES E. WIGGINS
Member of Congress

CEW:lm

The CHAIRMAN. Dr. Rice.

STATEMENT OF DONALD B. RICE, JR., PH. D., OF CALIFORNIA, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD

Dr. RICE. Mr. Chairman, Senator Kennedy, I am personally deeply honored to be here and to have this prospective opportunity, because I see it as a chance to assist with what I consider to be very important work.

I recall when I was in the Office of Management and Budget some years ago thinking that the word foundation could well have been coined for the work of the National Science Foundation. That is one very appropriate way to think about it, because NSF has provided much of the support for the research activity which builds the foundation base of knowledge.

I think we are in an age that is requiring, more and more, interdisciplinary approaches to problems that our society faces.

The basic science programs of the NSF contribute to the foundation, the knowledge that is important to all of the areas of our existence.

The applied programs of the NSF try to help to put that knowledge to work on some real problems. Many of those toughest problems that our society has to face today require bringing together several disciplines to work on one problem.

I think it is important to keep in mind the three-part missions of the Foundation: the basic work, the applied work on real problems, and educational efforts of the Foundation.

I would hope that the Board can continue to come up with and provide better policies in all those areas.

The CHAIRMAN. Thank you, Dr. Rice.

A copy of Dr. Rice's biographical sketch will be included at this point in the record.

[The information referred to follows:]

Donald B. Rice

President of The Rand Corporation since April 1972. Rand is a non-profit, public service institution which carries out research and analysis on problems related to national security and the public welfare.

Dr. Rice's most recent service prior to coming to Rand was as assistant director of the U.S. Office of Management and Budget, in the Executive Office of the President. There he had responsibility for the budgeting, program analysis, and management improvement activities of OMB in the areas of agriculture, atomic energy, commerce, energy, environment, natural resources, public works, science and technology, space, and transportation.

He currently serves as Member, National Advisory Committee on Oceans and Atmosphere; Member, National Science Board of the National Science Foundation (nominated June 1974 subject to Senate confirmation); Director, Purdue Research Foundation; and Member, Advisory Council for College of Engineering, University of Notre Dame.

He attended Notre Dame on a Union Carbide scholarship in chemical engineering, 1957-1961, and received his B.S. in 1961. During his senior year he was elected to membership in Tau Beta Pi, the national engineering honorary society. His Army ROTC service resulted in a commission as 2nd Lt., USAR upon graduation in 1961. Purdue University awarded him his M.S. in industrial administration the next year, and his Ph.D. in management and economics in 1965. While pursuing his doctorate, he was a Ford Foundation doctoral Fellow, 1962-1965, and served as an instructor and research associate in quantitative methods for management.

From 1965 to 1967, he served as an officer in the U.S. Army attaining the rank of captain. During that time he held the post of assistant professor of management at the Naval Postgraduate School at Monterey, California, and later became acting deputy director for academics of the Navy Management Systems Center there. In these capacities he helped develop and teach a program to train Department of Defense officials in techniques of planning and analysis. He also taught statistics at the University of California at Santa Cruz in 1966.

In June 1967, he became director of cost analysis in the Office of the Secretary of Defense. The following year his responsibilities for defense cost analysis were broadened to include analysis of the economic impact of defense spending.

He became Deputy Assistant Secretary of Defense (Resource Analysis) in February 1969, with responsibilities for analysis of cost, manpower and logistics requirements, for preparation of fiscal guidance issued by the Secretary of Defense to the military services, and for the coordination of the Department of Defense's program and budget planning with the National Security Council.

Upon his departure from the Department of Defense to join the OMB in September 1970, Secretary of Defense Melvin R. Laird awarded him the Meritorious Civilian Service Medal "for his contributions to the increased effectiveness and capabilities of the U.S. defense program and the management and efficient use of defense resources."

He is a member of the American Economic Association, the Institute of Management Sciences, and the American Association for the Advancement of Science.

He has contributed articles to Management Science ("Discrete Optimizing Procedures for Solving Linear and Non-Linear Integer Programming Problems," '66); The International Journal of Production Research ("Experimental Determination of Optimum Operating Conditions," '66); Behavioral Science ("Nature, the Experimental Laboratory and the Credibility of Hypotheses," '65); and The Armed Forces Comptroller ("Cost Analysis in the Department of Defense," '69).

Dr. Rice married the former Susan Fitzgerald of Evanston, Illinois, in 1962. They reside with their sons, Donald, Joseph, and Matthew at 518 Georgina Avenue, Santa Monica, California 90402.

July 1974.

The CHAIRMAN. We will now receive for the record the statements of the two Senators from the State of Nebraska, Messrs. Hruska and Curtis.

STATEMENT OF HON. ROMAN L. HRUSKA, A U.S. SENATOR FROM THE STATE OF NEBRASKA

Senator HRUSKA. It is my extreme pleasure today to have with me Dr. James H. Zumberge, chancellor of the University of Nebraska-Lincoln. Dr. Zumberge is a very distinguished and deserving nominee for the National Science Board of the National Science Foundation.

I note with pleasure that another Nebraskan, Clifford Hardin, then chancellor of the University of Nebraska, served on this board from 1966 until he was appointed Secretary of Agriculture.

Dr. Zumberge is a respected scientist with an international reputation. I am convinced he will make a tremendous contribution to the Board.

In addition to his duties as chancellor, he is vice president of the University of Nebraska System and a Nebraska delegate to the task force on Midwest energy requirements and environmental protection for 1973–74.

An eminent geologist, Dr. Zumberge is chairman of the Committee on Polar Research of the National Academy of Sciences, and the U.S. delegate to the Scientific Committee on Antarctic Research of the International Council of Scientific Unions. He was chief glaciologist for the U.S. Ross Ice Shelf project in Antarctica for the International Geophysical Year in 1957–58 and was a recipient of the Antarctic Service Medal in 1966.

Prior to joining the University of Nebraska, Dr. Zumberge was dean of the College of Earth Sciences at the University of Arizona, president of Grand Valley State College of Allendale, Mich., and professor of geology at the University of Michigan. He received his Ph. D. from the University of Minnesota.

I know Dr. Zumberge welcomes the opportunity to serve as a member of the National Science Board. I feel the Nation will benefit by his presence on this distinguished body. His contributions to the field of science have been many in past years. As a member of the Board he will be able to continue to play a vital role in the advancement of science in this country.

It is my pleasure to introduce to you Dr. James H. Zumberge.

STATEMENT OF HON. CARL T. CURTIS, A U.S. SENATOR FROM THE STATE OF NEBRASKA

Senator CURTIS. Mr. Chairman, I wholeheartedly join my colleague, Senator Hruska, in supporting the nomination by the president of Nebraska University Chancellor James H. Zumberge to fill a vacancy on the National Science Foundation Board.

Nebraska University has found not only an able and capable administrator in Dr. Zumberge, but a scientific scholar of international repute as well.

As Senator Hruska pointed out, Dr. Zumberge is chairman of the Committee on Polar Research of the National Academy of Sciences,

and the U.S. delegate to the Scientific Committee on Antarctic Research of the International Council of Scientific Unions.

As chief glaciologist for the U.S. Ross Ice Shelf project in Antarctica in 1957–58, Dr. Zumberge has achieved national and international acclaim for his accomplishments and for his writings and lectures on a mysterious continent most of us will never see.

We are in an era when scientists are groping to the outreaches of human knowledge to meet the problems of a technological age. Men such as Dr. Zumberge are equipped to explore and to direct the exploration of projects aimed at meeting urgent energy requiments, directing critical medical research, promoting use of the seas and of space to harness God's gifts for man's needs.

Dr. Zumberge is equal to the task. I feel great pride in commending him to this committee.

The CHAIRMAN. Dr. Zumberge.

STATEMENT OF JAMES H. ZUMBERGE, PH. D., L.L.D., L.H.D., OF ARIZONA, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD

Dr. ZUMBERGE. Thank you, Mr. Chairman, Senator Kennedy.

I come to this table with a feeling that I have an awesome responsibility. In the 25 years that I have been in the professional world of science, I have dealt with affairs of the Earth and have learned to pursue my own scientific interest in geology with great zeal and enthusiasm. But I know now that I must take a broader view of the world of science, and that my own views have to be tempered by more attention to a total balance of science in the United States.

I therefore am honored if someone thinks I can bring this capability to the National Science Board with other colleagues around this table.

I have been in the field of Earth studies, and these have taken me into foreign countries many times where I find that science is the one common language of those of different philosophical persuasions. I have the feeling that more and more over the years we may be looking to this common language as a way of beginning a dialog with people with whom we have little else in common.

I know that the National Science Foundation over the years has a role to play in bettering our foreign relations through our science programs.

I do find it a great thrill to be here and look forward to offering my services to the Nation in the cause of science if I am confirmed by this committee.

The CHAIRMAN. Thank you very much.

A copy of Dr. Zumberge's biographical sketch along with other information will be included at this point in the record.

[The information referred to follows:]

BIOGRAPHICAL SKETCH OF JAMES H. ZUMBERGE

July 17, 1974

Dr. James H. Zumberge is Chancellor of the University of Nebraska - Lincoln and Vice President of the University of Nebraska System. He was born in Minneapolis, Minnesota on December 27, 1923 and is married to the former Marilyn Edwards of Western Springs, Illinois. Their four children are currently enrolled in college, Mark at the University of Michigan, Jim at Cal Tech, JoEllen at Arizona State University, and John at the University of Arizona.

Dr. Zumberge received his Ph.D. degree in 1950 in geology with a minor in soils from the University of Minnesota. He joined the faculty of the University of Michigan in 1950 as an instructor and advanced to the rank of full professor in 1960. From 1950 to 1962 he was a consultant in ground water and non-metallic deposits in the State of Michigan.

In 1962, Dr. Zumberge was named president of the then new Grand Valley State College at Allendale, Michigan. That institution was created by the Michigan State Legislature in 1960 as the tenth state-supported college in Michigan. It was to have a liberal arts program. Under Dr. Zumberge's administrative direction, it opened in the fall of 1963 with 225 freshman students and 15 faculty members. When he resigned the presidency to return to his academic discipline in August of 1968, Grand Valley State College had more than 2,000 students and 100 faculty. Its physical plant was valued at $15 million.

He became director of the School of Earth Sciences at the University of Arizona in 1968, developing a program which included geology, hydrology, arid land studies, and dendrochronology. Within three years the school was elevated to college status with Dr. Zumberge being the first dean. On February 1, 1972, he left the University of Arizona to become Vice President of the University of Nebraska System and Chancellor of the University of Nebraska - Lincoln.

Dr. Zumberge is a veteran of the U. S. Marine Corps having served from March 24, 1943 to December 27, 1945. He was commissioned a Second Lieutenant on July 27, 1945.

He is chairman of the Committee on Polar Research of the National Academy of Sciences, and the U. S. Delegate to the Scientific Committee on Antarctic Research of the International Council of Scientific Unions. He was the chief glaciologist for the United States Ross Ice Shelf Project in Antarctica for the International Geophysical Year (1957-1958) and was the chief organizer for three subsequent Antarctic expeditions.

His awards include the James H. Zumberge Library named in his honor at Grand Valley State College in 1968, and Cape Zumberge, Antarctica, named in his honor in 1962. He was the recipient of the Antarctic Service Medal in 1961 and received a University of Minnesota Outstanding Alumni Service Award in 1972. He holds two honorary degrees, an L.L.D. from Grand Valley State College and an L.H.D. from Nebraska Wesleyan University.

Dr. Zumberge belongs to the following professional organizations: Sigma Xi, American Association for the Advancement of Science, Geological Society of America (Fellow), Society of Economic Geologists, American Geophysical Union, International Glaciological Society, Arctic Institute of North America, National Association of Geology Teachers, Cosmos Club of Washington, D. C., Who's Who, and he served as president of the Michigan Academy of Sciences in 1967.

He also holds membership in the Navy League, two discussion clubs -- Round Table and Candlelight, and is an honorary member of Rotary International. He is a member of the First Plymouth Congregational Church and serves on its Board of Trustees. He is a director of Bankers Life Nebraska, the Cooper Foundation, and the Nebraska Farmer Company.

Dr. Zumberge is the author of technical articles, books, and numerous papers given at national and international meetings. Attached is a listing of his publications.

PUBLICATIONS OF JAMES H. ZUMBERGE

1948

1. The Geology of Bemidgi State Park, Minn. Conservation Volunteer, Nov.-Dec., pp. 17-20.

1949

2. The Geology of Scenic State Park, Minn. Conservation Volunteer, July-August.

3. The Origin of Minnesota Lakes (Abstract), Proc. Minn. Acad. Sci., Vol. , pp. 116-117.

1950

4. Origin of Bedrock Lakes in Northwestern Minnesota (Abstract), GSA Bull., Vol. 61, No. 12, p. 1517.

1951

5. Laboratory Manual for Physical Geology, W. C. Brown Co., Dubuque, 77 pp.

1952

6. The Geology of Itasca Park, Minn. Conservation Volunteer.

7. Ice-push Studies on Wamplers Lake, Michigan (Abstract), GSA Bull., Vol. 63, p. 1318 (with J.T. Wilson).

8. The Lakes of Minnesota: their origin and classification, Minn. Geol. Survey Bull. 36, University of Minnesota Press, 99 p.

1953

9. Quantitative Studies on Thermal Expansion & Contraction of Lake Ice, Journ. of Geology, Vol. 61, No. 4, pp. 374-383 (with J.T. Wilson).

1954

10. Effects of Ice on Shore Development, Proceedings of the 4th Conference on Coastal Engineering, pp. 201-205 (with J.T. Wilson).

11. A Study of Ice on an Inland Lake, Snow Ice and Permafrost Research Establishment, Report No. 5, Corps of Engineers, USA, Wilmette, Ill., 78 p. (with J.T. Wilson and E. Marshall).

1955

12. Glacial Erosion in Tilted Rock Layers, Journ. Geol., Vol. 63, No. 2 (1955) pp. 149-158.

13. Pollen Profiles, Radiocarbon Dating, and Geologic Chronology of the Lake Michigan Basin, Science, Vol. 121 (Feb. 1955), pp. 309-311 (with J. E. Potzger).

14. Bottom Coring in Lake Superior (Abstract), in Institute on Lake Superior Geology, April 1-2, 1955, unpaged, University of Minnesota Center for Continuation Study, Minneapolis, 1955.

1956

15. The Cary-Mankato-Valders Problem, GSA Guidebook, Minn. Meeting, 1956 pp. 65-81 (with H. E. Wright, Jr.).

16. The Northwestern Part of the Southern Peninsula of Michigan, Univ. Michigan Dept. Geology, Friends of the Pleistocene, Midwest Section, Guidebook, 36 pp. (with S. H. Spurr and W. H. Melhorn).

17. Late Pleistocene Features of Cheboygan and Emmet Counties, Michigan, Amer. Journ. of Sci., Vol. 254 (Feb. 1956), pp. 96-109 (with S. H. Spurr).

18. Late Wisconsin Chronology of the Lake Michigan Basin Correlated with Pollen Studies, GSA Bull., Vol. 67 (March 1956) pp. 271-288 (with John E. Potzger).

19. Late Pleistocene History of the Lake Michigan Basin, Friends of the Pleistocene, Midwest Sec., Guidebook, 7th Field Conf., pp. 3-12.

1957

20. Laboratory Manual for Physical Geology, 2nd revised ed., Wm. Brown Co., Dubuque, 1957, 77 pp.

21. Land Drainage and the Water Table in Southern Michigan and Northern Indiana, Papers of the Michigan Academy of Science, Arts, and Letters, 42 (1957), pp. 105-113, 2 figs.

1958

22. Elements of Geology, John Wiley & Sons, Inc., N.Y., 328 pp.

23. Preliminary Report on the Ross Ice Shelf Deformation Project, Feb. 1958, in Symposium on Antarctic Res., Dept. of Scientific and Industrial Res. Wellington, New Zealand, Feb. 18-22, 1958, pp. 20-27.

24. Preliminary Report on the Ross Ice Shelf Deformation Project, July 1958, ICY Glaciological Report Series, No. 1, IGY World Data Center A: Glaciology American Geographical Society, N.Y., pp. IV-1,13.

25. Preliminary Report on the Ross Ice Shelf Deformation Project, Sept. 1958, Publ. 47, L'Association Internationale d'Hydrologie Scientifique, Symposium de Chamonix, Sept. 16-24, 1958, pp. 56-63.

26. Studies in Sialolethiasis, Annals of Otology, Rhinalogy, and Laryngology, Sept. 1958, Vol. 67, No. 3, pp. 595-617 (with Blatt, Denning, and Maxwell).

1959

27. Glaciers, World Scope Encyclopedia.

28. Review: Geology of the Great Lakes, by Jack Hough, Amer. Journ. of Sci., Vol. 257, No. 7, pp. 542-544.

29. Summary of 1959 Geology, World Scope Encyclopedia.

30. Review: The Polar Regions in Their Relation to Human Affairs, by Laurence M. Gould, Michigan Alumnus Quarterly Review, Aug. 8,1959, p. 367.

1960

31. Deformation of the Ross Ice Shelf Near the Bay of Whales, Antarctica, IGY Glaciological Report Series No. 3, American Geographical Society, May 1960, 148 pp. (with M. Giovinetto, R. Kehle, J. Reid).

32. Correlation of Wisconsin Drifts in Illinois, Indiana, Michigan, and Ohio, GSA Bull., Vol. 71, pp. 1177-1188.

33. Geologic Structures of the Ross Ice Shelf, Antarctica, Report of the XXI International Geologic Congress, Part XXI, 1960, pp. 60-67.

1961

34. The Dynamics of Ice Shelves (abstract), Abstracts of Symposium Papers, Tenth Pacific Science Congress. Honolulu, Hawaii, p. 321 (with C.W.M. Swithinbank).

35. Elementos de Geologia (translation of English version of Elements of Geology) Mexico City, 1961, 451 pp.

36. Report of the University Committee on Polar Research, James H. Zumberge,Chairman, Ann Arbor, 1961, 48 pp.

37. Weathering of a Quartz Diorite at Marble Point, McMurdo Sound, Antarctica, Journ. of Geol., Vol. 69, No. 3, July 1961 (with W. C. Kelly).

38. Geologic Investigations in Lake Superior, Geotimes, Vol. 6, No. 4, Nov.-Dec. 1961, pp. 10-14 (with Paul Gast).

1962

39. Problems on the Origin of Lake Superior, Metropolitan Detroit Science Review, Vol. 23, May Issue, pp. 57-59.

40. A New Shipboard Coring Technique, Journ. Geophysical Research, Vol. 67, No. 6, pp. 2529-2536.

41. Problems on the Origin of Lake Superior, Proceedings, 5th Conference on Great Lakes Research, Great Lakes Research Division, Institute Science and Technology, Univ. of Mich., p. 139.

42 The Dynamics of Ice Shelves, Antarctic Research, Geophysical Monograph No. 7, AGU, pp. 197-208 (with C.W.M. Swithinbank).

1963

43. Elements of Geology, 2nd Edition, John Wiley & Sons, Inc., N.Y. 342 p.

1964

44. Hydrology of Lakes and Swamps, Handbook of Applied Hydrology, Sec. 23, McGraw-Hill Book Co., N.Y., 33 pp.(with John Ayers).

45. Horizontal Strain and Absolute Movement of the Ross Ice Shelf Between Ross Island and Roosevelt Island, Antarctica, 1958-1963, Antarctic Snow and Ice Studies, Antarctic Research Series, Vol.2, AGU, pp. 65-81.

46. Report of the President, Grand Valley State College: An Account of the Formative Years of a New Liberal Arts College in Michigan, vii and 70 pp., 14 figs., 2 tables, Grand Valley State College, Allendale, Mich., Sept.1964

1965

47. The Ice Sheives, Antarctica, Methuen & Co., Ltd., Chapter 8, pp. 199-200 (with C.W.M. Swithinbank).

48. Pleistocene Geology of Indiana and Michigan, Quaternary of the U.S. Review volume for VII Congress, Princeton Univ. Press, Princeton,N.J., pp. 63-84 (with Wm. J. Wayne).

49. Review: Hydrogeology, by J. B. Lamarck, Geographical Review, Vol. 55, No. 4, pp. 612-614.

1966

50. Geology of the Deep Basin of Lake Superior (abstract), 9th Conference on Great Lakes Research, Michigan Technological University, Houghton, March 1966, p. 6 (with Wm. Farrand, J. Parker).

51. Review: Principles of Structural Glaciology, by P.A. Schumskii, translated by David Kraus, American Mineralogist, Vol. 51, No. 5 and 6, pp. 944-945.

52. New Bathymetric map of Lake Superior and some geological implications (abstract), Twelfth Annual Institute on Lake Superior Geology, May 6-7, 1966, p. 6 and back cover (with Wm. Farrand, J. Parker).

53. Review: Guidebooks for the 7th International Association for Quaternary Research (INQUA), Nebraska Academy of Sciences, Lincoln, Neb. (1965), Geotimes, Vol. 11, No. 2, Sept. 1966, pp. 36-37.

54. Review: A Continent for Science: The Antarctic Adventure, by Richard S. Lewis, Arctic, Journal of the Arctic Institute of N.A., Vol. 19, No. 3, Sept. 1966, pp. 280-281.

55. Report on Ross Ice Shelf Survey II (RISS II) 1965-66, Antarctic Journal of the United States, July-August 1966 issue, Washington, D.C., p. 138.

56. Geomorphology of the Floor of Lake Superior (abstract), Program 1966 Annual Meeting. Geological Soc. America, San Francisco, California, p. 66 (with Wm. Farrand).

1967

57. Laboratory Manual for Physical Geology, Third Edition, W.C. Brown Co., Dubuque, 74 pp., 43 figs. & diags.

58. Today's College Crisis and Grand Valley, The Torch, Vol. 40, No. 3, pp. 28-31.

1968

59. Lobes, Lobations, Rheinhold Encyclopedia of the Earth Sciences Series, Vol. III, Geomorphology (ed. Rhodes Fairbridge), pp. 672-674.

60. The Michigan Academy - Time for a Change, Seventy-Second Annual Report, The Michigan Acad. of Sci. Arts & Letters, ed. Robert Martin, Ann Arbor, Mich., p. 41-44.

61. The Ice Regime of the Eastern Part of the Ross Ice Shelf Drainage System, International Assoc. of Scientific Hydrology, General Assembly of Bern 1967, Pub. No. 79, p. 255-266 (with Mario Giovinetto).

62. Review: Etudes sur les Glaciers, by Louis Agassiz (English translation by Albert V. Carozzi, Hafner, N.Y., 1967, Journal Geol. Education, Vol. 16 (Oct. 1968), pp. 149-150.

1969

63. Grand Valley State College: Its developmental years. Allendale, Michigan, March 1969, 172 p.

64. Ross Ice Shelf Studies, 1969, Antarctic Journal, Vol. IV, No. 5, Sept.-Oct. 1969, p. 215-216 (with B. M. E. Smith and Anne Fuzesy).

65. A Mid-Wisconsin Peat in Michigan, U.S.A., Polen et Spores, Vol. 11, No. 3, 1969, p. 585-601 (with W. S. Benninghoff).

66. Memorial to Edward Willard Berry (1900-1968), GSA Proceedings Volume for 1968, November 1969.

1970

67. Memorial to Reynolds McConnell Denning (1916-1967), GSA Proceedings Volume for 1967, January 1970, p. 193-196 (with James T. Wilson).

68. Review: New Media and College Teaching, edited by James W. Thornton, Jr., and James W. Brown, The Journal of Higher Education, May 1970, p. 417-419.

69. Ross Ice Shelf Studies, 1970, Antarctic Journal of the U.S., Vol. V, No. 5, Sept.-Oct. 1970, p. 153-154.

70. The Need for Environmental Planning: An Overview, Proceedings, Western Agricultural Economics Association, Corvallis, Ore., p. 263-267.

1971

71. Fission or Fusion, Institute of Electrical and Electronics Engineers Transactions on Education, Vol. E-14, No. 1, February 1971, p. 24-26.

72. Review: International Symposium on Antarctic Glaciological Exploration (ISAGE) by A. J. Gow, C. Keeler, C. C. Langway and W. F. Weeks (eds.), Science, v. 171, no. 3969, Jan. 29, 1971, p. 369-370.

73. The Ross Ice Shelf Project (RISP), Antarctic Journal, v. 6, no. 6 6 p. 258-263.

1972

74. Report on the Ross Ice Shelf Project (RISP), SCAR BULLETIN No. 40, p. 840-844; The Polar Record, v. 16, no. 100, p. 190-194.

75. Review: Research in the Antarctic, Louis Quam and Horace D. Porter (eds.), 1971, AAAS, Pub. No. 93, Washington, D. C. 768 p., OS Transactions Amer. Geophysical Union, v. 53, no. 4, pp. 299-301

76. Elements of Geology, 3rd ed., John Wiley and Sons, New York (with C. A. Nelson), 431 p.

1973

77. Laboratory Manual for Physical Geology, 4th ed., Wm. C. Brown Co., Dubuque, Iowa.

78. The Report of the National Water Commission and Its Significance for Irrigated Agriculture in Nebraska, Nebraska Resources, Winter 1973, No. 10, pp. 10-11.

1974

79. Glaciation - Landforms Produced by, Encyclopaedia Britannica 15th Edition, Macropaedia, vol. 8, p. 164-177.

80. Camp Michigan, 1957-1972. Antarctic Journal of the U. S. May-June issue, 1974.

81. The Fortunes of Agriculture and the University, Farm, Ranch, and Home Quarterly, Summer 1974.

The CHAIRMAN. Doctor Murray.

STATEMENT OF GROVER E. MURRAY, PH. D., OF TEXAS, TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD (Reappointment)

Dr. MURRAY. Mr. Chairman, Senator Kennedy, I would echo most strongly the words of Dr. Hackerman, my fellow Texan, who has also been renominated, and another member of this group, sitting on my left, Dr. Zumberge.

At the request of Senator Kennedy's office, I provided his office with

a statement regarding my attitudes about a national science policy and activities in that regard. I would ask, with the Senator's permission, that that statement be entered into the record.

The CHAIRMAN. It will be.

[The statement referred to follows:]

STATEMENT RE NATIONAL SCIENCE POLICY BY GROVER E. MURRAY, PH. D.

I am a firm and strong supporter of the continued development and the clarification of a National Science Policy. I believe that the National Science Board should be charged with assisting the Congress in developing this national policy. I am an advocate of Federal Government support for both basic scientific research and applied research. The United States has grown strong and has maintained its position in world leadership because of its strong universities. Faculties and students have developed extensive research capaliblities in the various scientific and engineering disciplines. At this critical period in world history, the United States cannot afford to decelerate its efforts in scientific research.

I believe that basic scientific and applied research should be conducted both in universities and in industry. Our Nation needs to place special emphasis on basic and applied research in all sources of energy, in food, in the social sciences, and in the medical sciences. But we must remember that this should not be done at the exclusion of research in the basic scientific disciplines, since they undergird all scientific knowledge.

To ensure continued leadership in international research and education, the strength of the universities in the United States must be maintained. The Nation needs to continue its obvious on-going commitment to the education and training of scientists and engineers in numbers necessary to maintain its world position. The Congress, I believe, should provide guidance, leadership, and the support vital for scientific growth.

Dr. MURRAY. Thank you, sir.

Briefly, I might say that I serve both as president of Texas Tech University and as president of the Texas Tech University School of Medicine. Therefore my vistas have been broadened far beyond the fields of the Earth sciences.

I believe the National Science Board has responsibility to work with the Congress to develop a national science policy to insure continued leadership of our United States in science and technology in the world.

I believe we must place great emphasis on basic research in food and fiber, energy, oceanography, materials, the social sciences, and the medical sciences. We must insure, through cooperation and work with industry, that advances resulting from basic research are put into practice.

It is a great pleasure for me to be renominated to the National Science Board, and I would assure the committee that I shall do everything within my power to work with Senators, with Congressmen, and with the Director of the Foundation, to insure success of the National Science Foundation.

The CHAIRMAN. Thank you, Dr. Murray.

A copy of Dr. Murray's biographical sketch along with other information will be included at this point in the record.

[The information referred to follows:]

GROVER E. MURRAY

President and Professor of Geosciences, Texas Tech University
President, Texas Tech University School of Medicine at Lubbock

University of North Carolina, 1937
Bachelor of Science
Louisiana State University, 1939
Master of Science
Louisiana State University, 1942
Ph.D.

EXPERIENCE:

1937-1938	Teaching Fellow, Louisiana State University
1938-1941	Louisiana Geological Survey (Research Fellow)
1941-1948	Magnolia Petroleum Company
1948-1949	Louisiana Geological Survey, Director of Research
1948-1955	Professor, Stratigraphic Geology, Louisiana State University
1950-1953	Chairman of Department of Geology, Louisiana State University
1949-1966	Consulting Geologist (part-time)
1949-1951, 1961	Director of geology field courses for Louisiana State University and the University of Texas in Louisiana, Texas, Colorado
1949-1951	Visiting Professor of Geology, University of Texas (summers)
1951-1960	Technical Advisor to Arkansas Fuel Oil Corporation
1953-1954	Consultant to Houston Oil Company of Texas
1955-1966	Boyd Professor of Geology, Louisiana State University
1956-1960, 1966	Director, National Science Foundation field studies in Sierra Madre Oriental and adjacent areas and Parras Basin in northeastern Mexico
1959-1960	Visiting Geoscience Lecturer with the American Geological Institute

1962-1966	Technical Advisor, Austram Oil, Ltd. (Australia)
1963-1964	Consultant to Delhi Australian Petroleum, Ltd. (Australia)
1963-1965	Vice President and Dean of Academic Affairs, Louisiana State University
1965-1966	Vice President for Academic Affairs, (Louisiana State University System)
1966-1967	Consultant to Venezuelan Ministry of Mines and Hydrocarbons
1963-1969	Member, Advisory Committee, International Center for Medical Research and Training (Costa Rica)
1966-	Consulting Professor of Geology, Louisiana State University
1966-	President and Professor of Geosciences, Texas Tech University
1969-	President, Texas Tech University School of Medicine at Lubbock

AWARDS:

1971	Distinguished Alumnus Award, University of North Carolina

PROFESSIONAL AFFILIATIONS AND ACTIVITIES: (NATIONAL AND INTERNATIONAL)

1968- 1974	National Science Board (Member)

Geological Society of America (Fellow)

1951-1954	Commissioner to American Commission of Stratigraphic Nomenclature
1952	Chairman, Symposium of Sedimentary Volumes
1955	Chairman, Program Committee. New Orleans Meeting
1955-1958	Program Committee
1959-1960	Chairman, Southeastern Section
1961-1964	Member, Council
1963-1964	Chairman, Committee on Nominations
1963-1968	Associate Editor
1964	Chairman, Committee on Honors and Awards

1964	Chairman, Committee on Penrose Medal
1967	Chairman, Annual Meeting, New Orleans

Society of Economic Paleontologists and Mineralogists (Member)

1948-1950	Committee on Members and Papers
1948-1950	Nominating Committee
1952-1954	Editor, Journal of Paleontology
1951-1955	Research Committee, Member
1957-1960	Research Committee, (Vice Chairman, 1957; Chairman, 1958)
1957-1960	Member, Gulf Coastal Section, (Vice President, 1959)
1954-1955	Representative to Paleontological Society Council
1963-1964	President
1964-1965	Past-President and member of Executive Council
1964-1968	Representative to American Geological Institute's House of Society Representatives
1973	Honorary Member, Gulf Coast Section

American Association of Petroleum Geologists (Member)

1944-1945	Distinguished Lecture Committee
1946-1955	Geologic Names and Correlations Committee; Chairman, 1952-54
1954	Distinguisned Lecturer
1955	Emblem Committee
1955-1960	Tectonic Map Committee
1957-1963	Commissioner to American Commission on Stratigraphic Nomenclature
1958-1962 and 1965-1968	Representative for American Association of Petroleum Geologists to House of Society Representatives
1959-1963	Editor of AAPG Bulletin; Member of Executive Committee
1959-1963	Business Committee
1959-1961	Committee on Salt Dome Volume

1963-1965	Voluntary Research Fund Campaign Committee
1964-1965	President
1965-1966	Past President and Member, Executive Committee
1966-1967	Chairman, Nominating Committee
1966-1967	Vice Chairman, Academic Advisory Committee
1966-1967	Executive Advisory Committee
1966-1969	Medal Awards Committee (Chairman, 1968-1969)
1969	Chairman, Annual Meeting, Southwestern Section
1970	Honorary Member

American Commission on Stratigraphic Nomenclature

1951-1954	Commissioner from Geological Society of America
1957-1963	Commissioner from American Association of Petroleum Geologists
1960-1962	Vice Chairman and Secretary

U. S. National Committee on Geology: 1963-1968, Member, 1964-1968, Chairman

American Society for Oceanography: 1965-71 , Member, Board of Directors

Gulf Universities Research Corporation

1964-1969	Member, Board of Directors
1965-1966	President and Member of Executive Committee
1966-1967	Chairman of the Board of Directors and Member, Executive Committee
1967-1969	Member of Executive Committee
1967	Presiding Officer, Symposium on Science and Engineering in the Gulf of Mexico

American Geological Institute

1965-1968	Representative for Society of Economic Paleontologists and Mineralogists to House of Society Representatives

1958-1962 and 1965-1968 Representative to American Geological Institute House of Society Representatives

American Association for Advancement of Science, Member

Western Information Network Association, 1967- , Board of Directors

ICASALS, Inc., Board of Governors, 1967-

Organization for Tropical Studies, Inc., 1966-69, Board of Directors

Department of the Interior (U.S.A.) 1967-1969, Marine Resources Advisory Committee

United Health Foundations, Inc., 1969-1972, Board of Directors

Royal Resources Exploration, Inc., 1969- , Board of Directors

The Antarctican Society, Member, 1970-

American Geophysical Union, Member, 1968-

Society of Exploration Geophysicists, 1963-

National Panel of Arbitrators of the American Arbitration Association, 1964-

Public Affairs Research Institute of Louisiana, 1963-1966

Texas System of Natural Laboratories, Board of Directors, 1967

National Foreign Policy Conference for Educators, Washington, D.C., 1966

Gulf Coast Association of Geological Societies

Geoscience News, Senior Editorial Advisor, 1966-1968

World Academy of Art and Science (Fellow), 1967-

Texas Partners of the Americas (with Peru), Board of Directors, 1971-

The Philosophical Society of Texas, Member, 1971-

National Association of State Universities and Land-Grant Colleges
1. Member, Mineral Resources Committee, 1970-
2. Member, Commission on Home Economics, 1971-73
3. Member, Educational Telecommunications Committee, 1971-
4. Member, Liaison Committee, Foundation for the Arts and Humanities

Sigma Xi

Sigma Gamma Epsilon

Omicron Delta Kappa

Cosmos Club

Sociedad Cactelogia Mexicana

Sociedad Geologica Mexicana

Norsk Geologisk Forening (Life Member)

Association Mexicana de Geologos Petroleros

University Club (New York)

Cactus & Succulent Society of America

Paleontological Research Institute

Paleontological Society

International Commission on Stratigraphy

National Order of Chad

International Geological Congress, Mexico City, August-September, 1956; Official Delegate of the State of Louisiana and Official Delegate of Louisiana State University.

International Geological Congress, Copenhagen, Denmark, August-September, 1960; Official Delegate of the State of Louisiana, Louisiana State University, the American Association of Petroleum Geologists, and the Society of Economic Paleontologists and Mineralogists.

International Geological Congress, New Delhi, India, December, 1964; Official U. S. Delegate, Head Delegate from the American Association of Petroleum Geologists, Official Delegate of the State of Louisiana, and Official Delegate of Louisiana State University.

International Geological Congress, Prague, Czechoslovakia, 1968; Official U. S. Delegate.

International Geological Union, Organizing Committee of the Constituent Assembly of the International Commission on the History of the Geological Sciences, Yerevan, Armenia (U.S.S.R.), June, 1967; Official Delegate as Chairman of the U. S. National Committee on Geology; Delegate from Texas Tech University and the American Association of Petroleum Geologists.

PUBLICATIONS: STRUCTURAL GEOLOGY; MICROPALEONTOLOGY; STRATIGRAPHY AND REGIONAL GEOLOGY OF COASTAL PROVINCE; GEOMORPHOLOGY; GEOPHYSICS; SURFACE GEOLOGY; PETROLEUM GEOLOGY MEXICO, AUSTRALIA, UNITED STATES; EDUCATION

LISTED IN: WORLD WHO'S WHO IN SCIENCE; AMERICAN MEN OF SCIENCE; WHO'S WHO IN AMERICA; WHO'S WHO IN THE SOUTH AND SOUTHWEST; DIRECTORY OF CERTIFIED PETROLEUM GEOLOGISTS OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS; DIRECTORY OF CERTIFIED PROFESSIONAL GEOLOGISTS OF THE AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS; PRESIDENTS AND DEANS OF AMERICAN COLLEGES AND UNIVERSITIES; LEADERS IN AMERICAN SCIENCE; CONTEMPORARY AUTHORS; WHO'S WHO IN EDUCATION

Born - Maiden, North Carolina, October 26, 1916
Married to the former Nancy Beatrice Setzer
Two daughters: Martha (Mrs. Wylie Poag) and Barbara Elizabeth
Two granddaughters and one grandson

1974

GEORGE MAHON
19TH DIST., TEXAS

CHAIRMAN
COMMITTEE ON APPROPRIATIONS

CHAIRMAN
JOINT HOUSE-SENATE COMMITTEE ON
REDUCTION OF FEDERAL EXPENDITURES

Congress of the United States
House of Representatives
Washington, D.C. 20515

September 12, 1974

Honorable Harrison A. Williams, Jr.
Chairman
Labor and Public Welfare Committee
United States Senate
2226 Dirksen Senate Office Building
Washington, D. C. 20515

Dear Mr. Chairman:

Due to the fact that I had an important pre-conference meeting on the Defense Appropriations Bill, I was unable to attend your hearing yesterday regarding confirmation of nominees to the National Science Board. I had wanted to be present to testify in behalf of Dr. Grover Murray, President of Texas Tech University, who has been nominated for reappointment to the Board.

I would deeply appreciate your including in your hearings the attached statement in Dr. Murray's behalf. Thanks very, very much.

Sincerely,

George Mahon

George Mahon

M:pw

Attachment

Mr. Chairman:

I would like to express my strong interest in the reappointment to the National Science Board of Dr. Grover Murray, President of Texas Tech University, in my home town of Lubbock, Texas.

Dr. Murray, during his time on the National Science Board, has demonstrated his great ability and intense interest in the field of science through his outstanding contributions to the success of National Science Foundation programs. He has been extremely active and most effective during his tenure on the Board.

Of course, abundant information is available to you regarding Dr. Murray's outstanding capabilities and qualifications for reappointment, but I did want the committee to know of my great admiration for Dr. Murray and of my feeling that his eminence as a scientist and an educator will make his reappointment to the Board highly desirable from the standpoint of the American people.

Thank you.

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The CHAIRMAN. I just have at this point two questions or observations, and then I would like to turn to Senator Kennedy.

First, there are dangers and wasteful conditions that exist that we have to struggle to live with, situations that I would think science could find an answer to eliminating as far as the danger and the waste and turning it into energy.

Those of us who live along the coast particularly see the answer to one of our dangerous and wasteful fallouts of industry, sludge, dumped off the coast, and it is a killer in the oceans, and maybe it is going to be closer to shore.

It would just seem to me that applied science could give us an answer to the sludge problem, which is the fallout of heavy industry.

Unless I am way off on this, the particular is whether science could productively be applied to changing the nature of sludge.

How would you persons of science relate that to the operations of Government and make it a priority of interest and see that a program of scientific effort is urged?

That is a long question, but do you understand the point I have attempted to make?

Dr. STEVER. Yes; I think these Board members will be exposed to a number of proposals that work in this field which is part of, I suppose, the emerging materials crisis or emerging materials problem, and in a number of our programs this does come up.

In fact, one of the RANN programs used industrial waste in Philadelphia in road construction. It had never been used before. It was sewage actually, and it was converted and used in road construction.

I forget the figures now, but the amount for that road base was reduced from $16 million, or something like that, down to $3 million. I am not sure of the figures, but it was a very substantial reduction.

So I think science, especially in our applied research area, will meet many of these problems, but also in our basic materials science program, we will be touching on substitute materials and recycling of materials.

Maybe Dr. Hackerman would want to speak to that.

Dr. HACKERMAN. That is precisely what I would have said. Recycling is a trick we certainly have to do more of and better. There is no doubt about it.

We have to use what is left of our resources now. We must use our brains to find ways to recycle the things that we use.

This particular example certainly fits very well. It is indeed a material that lends itself to production, not only of roadways, but also building blocks.

The CHAIRMAN. You who are on the Board and being reappointed to the Board, what is your opportunity to feed this into the action parts of the Government?

Dr. STEVER. Quite a number.

As you know, the Congress and the administration have worked together in the last 6 years to strengthen the applied science base of this Foundation, not to divert us away from basic science, but to give a smoother flow from the basic research to the applied.

The RANN program has established for the Foundation a very close contact with the mission agencies. All of the RANN grants—and

this year the budget at RANN will be almost $150 million—make a requirement on the researcher that the research team will make contact with the potential users of that applied research.

This is a forcing method of trying to insure the flow of our ideas right to the user. It is interesting. Sometimes the user will be an industrial company, sometimes it is a State or local municipal government. Sometimes it is the Federal Government.

I think that the last 6 years has shown an increased conscious approach to precisely this problem and has forced and encouraged the NSF to build bridges that are necessary to tape the flow of basic knowledge.

Again I ask one of the old Board members to comment on how well we are succeeding in that, but that is a specific objective of the program.

Dr. MURRAY. Mr. Chairman, I believe the RANN program has been progressing very well in the Foundation. There was some slowness at the start, it is true. But as the general scientific and technological public, and the working people in these areas, have come to understand the purposes of this program, I think interest in participating in Government stimulation of research in these areas is increasing substantially.

I note that in the past it has been easier for us to use materials and to waste the byproducts than it has been to utilize the byproducts. But those in the environmental and Earth sciences, and those interested in environmental problems, realize there are finite resources available to us on planet Earth, and we are hearing the economic limits of some of our limited resources.

So we must encourage, either through reasonable legislation or other incentives, industrial companies and organizations of all kinds to learn to convert waste into usable products in order to conserve our total natural resources.

Dr. SHIELDS. Mr. Chairman, I would just comment in the area of chemistry of organic waste significant progress has been made more recently in conversion to low energy uses, such as methane, and also progress has been made to convert organic wastes into agricultural products, fertilizers in particular.

I think, as Dr. Murray has indicated, we all have a much more active interest and concern about utilizing those resources that we had just been setting aside.

Dr. HACKERMAN. I might just say there were two things that were difficult to deal with when this program started.

One was the unease in the scientific community itself, which was not used to being tied quite so closely to objectives.

The other was how to go about the doing.

The unease has diminished. It takes a long time to change people's attitudes, but it has diminished. It has not entirely disappeared.

The methods of going about what you perceive as a need have improved considerably over the last 2½ years.

I would say from my contact with our program that it is certainly a very effective program. There may be places which are weak and they are having difficulty. But, by and large, it is doing a first-rate job.

The question you pose would be cared for very well in that program.

The CHAIRMAN. Thank you.

Senator Cranston.

Senator CRANSTON. I just want to say that I am very proud that two Californians are among this very fine group of nominees to the National Science Foundation, Dr. Donald Shields, president of the California State University at Fullerton, and Dr. Donald Rice, president of the Rand Corp.

Both have achieved national prominence as leaders in their respective fields.

Dr. Shields, who, when he was appointed as president of one of the major State universities, was the youngest person to hold that position in the Nation, has been a dynamic force in building that university to the highly regarded and respected academic stature it holds today. That achievement has been accomplished in only 3 years. I am confident that Dr. Shields will bring this same vitality and initiative to the National Science Board.

Dr. Rice will bring to the Board his broad experience in public service, both in the Federal Government and the Rand Corp. As assistant Director of the Office of Management and Budget, he had responsibility for evaluation and analysis of all Federal programs in areas related to science.

The CHAIRMAN. As a former comptroller, that does not disturb you too much.

Senator CRANSTON. No, it does not disturb me at all.

This experience gives him a unique opportunity to grasp the extent of all Federal activities touching upon the interests of the National Science Foundation, knowledge which will be invaluable in carrying out his duties as a member of the National Science Board.

He also served in the Department of Defense with major responsibilities in cost analysis and budgeting.

As President of the Rand Corp., for the past 2 years, Dr. Rice has been in the vanguard of those organizations which are concerned with research and analysis on problems affecting scientific development and the public welfare.

Dr. Rice's strong background in science and in budgeting will make him an invaluable member of the Board. His qualifications will bring an essential dimension to the Board's collaborative thinking as this Nation faces the scientific and the economic challenges of today.

Dr. Shields and Dr. Rice bring to the Board the strength it needs to be a positive and constructive force in shaping our Nation's future. I am pleased that two men of their caliber have been nominated, and I look forward to working with them in the future.

The CHAIRMAN. Thank you, Senator Cranston.

I will come back to a question later.

I would like to recognize Senator Kennedy.

Senator KENNEDY. Thank you very much, Mr. Chairman.

Mr. Chairman, Senator Cranston, Dr. Stever, new nominees, and those who are up for reconfirmation, I want to express my appreciation for this hearing.

Rather than take your valuable time in reading the statement I prepared I ask unanimous consent that it be entered in the record as if read.

PREPARED STATEMENT OF HON. EDWARD M. KENNEDY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator KENNEDY. Today's hearing on the nominations we have received from the President for membership on the National Science Board, gives this committee and the public an excellent opportunity to examine some of the critical science policy questions which we face in this Nation. I hope that the nominees will be able to give us their view on how we can improve the dialog between the scientific community and the general public, and between the scientific community and the Congress.

In the 6 years I have served as Chairman of the Special Subcommittee on the National Science Foundation, the Foundation has been given expanded responsibilities in the area of applied research. We have seen the Foundation budget double, from $400 million to close to $800 million. And as this has occurred, there has been an increasing awareness on the part of the public of the impact and importance of the Foundation's mission. This has been accompanied by an increasing interest on the part of Members of Congress in the work being supported by the Foundation—and recent debate on the Foundation's budget produced both positive comments and suggestions on areas where the Foundation might improve either its administrative procedures or the way it allocates funds among competing research disciplines and proposals.

The two charts we have in the committee room today indicate the gap which exists between the public's view as to how they would like their tax dollars for research to be spent and how those funds are actually allocated in the Federal budget.

The bar graph shows that over 50 percent of Federal research dollars are spent for defense—yet opinion surveys indicate that only 11 percent of the public supports these expenditures, with 30 percent actually stating that this is the area of research which they least support.

The bar graph also shows that we are only spending about 10 percent of each Federal research dollar for improving health care; yet 65 percent of the public feels this should be the area of highest priority.

I hope our hearing today will serve to open up the communication process between members of the Board and those of us in the Congress who are working to improve the effectiveness of the Federal Government's role in the support of science and technology. I hope that, when the new members join the Board, they will keep in touch with us—that they will let us know, both formally and informally, of areas where the Congress can be helpful in assisting them in fulfilling their responsibilities. I hope that the new members, as well as present members, will take an active role in communicating with the public at large—sharing with all of us their expertise and judgments on the critical science policy issues this Nation faces.

I look forward to the opportunity to hear the views of the nominees today on the difficult questions we face here in the Congress in trying to hold down Federal spending, while at the same time ensuring that adequate resources are devoted to science and science education. I hope that the nominees will share with us their views on legislation that

will be before the committee shortly with regard to the adequacy of present science advisory mechanisms available to the President.

And of interest to all Members of the Congress, are the views of the nominees on what contribution the scientific community has been making to the amelioration of critical materials shortages; their assessment of steps this Nation should be taking to deal with dwindling food supplies; to assist in the development of an energy policy which will assure us the fuel we need, without negating the progress we have made toward improving the quality of the air we breathe, the water we drink, and the land which sustains us. And underlying all of these concerns the condition of our economy and our need for the best possible scientific and technical advice if we are to restore the purchasing power of the dollar and return this Nation to a period of sustained economic growth, prosperity, and price stability.

The National Science Board is the only Federal body which has as its broad charter responsibility for the overall health of science in the United States. It is a policymaking governing Board; not an advisory board. It should be at the forefront in looking for new ideas and structures to improve the programs of the National Science Foundation, and the direction of national science policy.

Senator KENNEDY. This is the first time that we here in the Senate, have had an opportunity to meet across the hearing table with nominees to the National Science Board.

I think this hearing is extremely important, useful, and helpful in enabling us to exchange views with the Board, not only in meetings such as this but, hopefully, through direct contacts that may be made with the Board members by the members of this committee or other Members of Congress.

I would hope that, as a result of this meeting the Board will realize our very serious concern about many of the matters which are before the Board.

You are aware we have a small subcommittee which deals with the authorization of appropriations for the National Science Foundation, and I think all of us who serve on that subcommittee, which I chair, recognize the very significant importance of this Board.

There are many boards within the Federal Government. Most of them are advisory, and a few of them have the power and influence in the area of public policy which this Board quite clearly does.

I feel that the American people, our constituents, want us to work closely with this Board as well as with the National Science Foundation, as we focus our attention at the congressional level, as the President does at the executive level, on many problems which are in the forefront of the minds of the American people.

I think this relationship can be helpful and useful in trying to communicate some of those concerns to policymakers.

There will be obvious areas of agreement, probably some significant areas of disagreement, but I do not think those channels have really been open in the past, and I am very hopeful, as a result of this meeting and continued work, that we can establish full communication in the very near future.

Over here, for example, [indicating charts] on the one hand, results of a poll included in Science Indicators, a report from the National Science Board. It gives at least some indication about where the American people would like their resources spent in science and technology. Highest priority was assigned to improving health care, reducing and controlling pollution, and reducing crime.

Then, on the other chart, we show where the money is actually being spent. We see $998.8 million for health care, and over $10 billion for national defense. Only $55 million is allocated for crime prevention and control.

I am not suggesting, just by this observation, that you ought to be able to establish priorities by public opinion polls—obviously that is not the point I am trying to make.

I do think, however, that we must be more sensitive to the public's concerns and try to find ways in which these concerns, whether in energy, food, ocean policy, materials shortages, health care, crime, pollution, or any of these areas, can be met—I am very hopeful that you are going to help us reflect the sensitivity and the concern that are abroad in the land on these issues.

We are attempting to do that with our Office of Technology Assessment. We are beginning to deal with some difficult and important areas, and I am hopeful that you can help and that you will work with us in the Congress.

The Foundation is really a powerful instrument for policymaking and can help us reflect our constituents' concerns, and not in the narrow parochial sense but in the broader national sense.

I hope that in your own deliberations and your own judgments you will be sensitive to these concerns, because I think that is a matter of great importance.

I would like to ask Dr. Stever before we get into some of the other questions, Mr. Chairman, if he could tell us about how he makes decisions about who is going to serve on various committees of the Board.

Do you have a procedure?

Dr. STEVER. Within the Board, board committees?

Senator KENNEDY. How do you decide that?

What can these new nominees expect?

Will they serve on committees?

Dr. STEVER. You mean advisory committees or the Board itself?

Senator KENNEDY. I mean committees of the Board.

Dr. STEVER. The Board has, over the years, organized itself in different ways.

Today, there are two major substantive committees and several minor ones, or administrative ones. There is an executive committee which, by law, I chair, and that is an administrative committee of the Board.

The substantive committees are a planning and policy committee and a programs committee. Each of those committees has subcommittees working on different problems.

Dr. Hackerman has been chairman of the programs committee for 3 years.

Did you, Dr. Murray?

Dr. MURRAY. I have served on both committees.

Dr. STEVER. The programs committee essentially is the oversight committee. It looks over what we are doing, recommends Board action on proposals and programs, and challenges us on grants. We report performance to them. The planning and policy committee is exactly that, it looks to the future, future budgets, future directions.

Then each of these committees has ad hoc subcommittees working on different problems.

For example, the planning and policy has a committee on science and manpower at the present time. It has a committee on long-term budgeting which Dr. Murray chaired.

We, of course, have other ad hoc committees. The 25th anniversary of the National Science Foundation is coming up, and we have one for that occasion.

Now, to speak to the selection of various members on these. All Board members serve on at least one committee. They are given a chance by the Chairman, or have been in the past, to express an interest in the area in which they would like to serve.

I would say that every one of the new nominees will be swept up in committee work very quickly. Committee work goes on at the regular Board meetings and sometimes in between. I think it is a very effective way of getting the Board's work done.

But the committees report to the total Board, so all matters eventually come to the Board.

Senator KENNEDY. It is my understanding that each member does not serve on a committee.

Am I wrong about that?

Dr. HACKERMAN. They serve on one of the two standing committees.

Senator KENNEDY. Every person on the Board at the present time serves on one or the other committee?

Dr. HACKERMAN. Except for the executive committee members and the Director.

All other members serve on one of the two standing committees.

Senator KENNEDY. Are you familiar with this [indicating]?

Dr. STEVER. The organization? Yes; we are very familiar, but we may not know what is on it. [Laughter.]

Senator KENNEDY. It shows that Dr. Harrison from Massachusetts, who serves on six different committees, and I do not see Dr. Hackerman's name.

Dr. STEVER. This is a foreshortened Board. This is a 17 member Board instead of 25.

You see from late spring when our annual meeting is held, we did not have the new Board members nominated and confirmed and, as a consequence, this list is somewhat foreshortened.

But Dr. Harrison serves on the programs committee, and she has been a very conscientious contributor there, and on a subcommittee.

Senator KENNEDY. She serves on six committees.

She serves on the programs committee, subcommittee on R. & D. incentives and assessment programs, the subcommittee on RMI programs, and three ad hoc committees.

Dr. STEVER. Both of those are temporary committees.

Senator KENNEDY. She serves on the ad hoc nominating committee for Board Officers, she serves on the ad hoc committee on Bicentennial

celebration, and she serves on the ad hoc committee on the Sixth NSB report.

Dr. STEVER. Very well.

Senator KENNEDY. She serves on six subcommittees, I am just trying to get some idea as to the procedures which are followed.

There are Members of Congress who serve on more committees than others. I am just trying to find out what these newer members should expect.

Dr. STEVER. I think the important point is that the two substantive committees are the programs committee and the planning and policy committee, and all members of the Board have an assignment on one or the other of those except for the members of the executive committee which often meets concurrently on administrative and organizational matters.

Senator KENNEDY. Then they will serve on subcommittees of those committees?

Dr. STEVER. Yes; as their interests show up.

Senator KENNEDY. Who names those?

Dr. STEVER. The Chairman of the Board, not the Director.

All board committees are handled by the Chairman of the Board. Usually the Chairman with the Director and Vice Chairman and members of the executive committee works out the committee assignments.

Senator KENNEDY. Let me ask you this. As I understand, under the statute there is room for five professional staff personnel to support the board itself.

Dr. STEVER. I think that is correct, yes.

Senator KENNEDY. What is your view about that? Should not the Board have an independent staff? I would also be interested in the views of the new nominees.

Dr. STEVER. My view is that in all the time I have served as a Board member, and not as Director, and since I have been director, the working of the secretariat of the National Science Board has been very good. We work together. I do not know that serious problems have arisen. It has always been thought that it is better to have us together rather than to have two operations so that we would have difficulty in getting together.

I believe this is a better way of operating, but I would be glad to listen to the views of the Board members on that.

Senator KENNEDY. I would be interested. We have just gone through this issue with regard to the Office of Technology Assessment Board.

Dr. MAC LANE. If I may speak to that, I have also sat on other boards and councils and, although I have seen very little of this Board, it is certainly my impression that the staff support is there for this Board and that it is excellent and certainly superior to many.

Senator KENNEDY. I do not think anyone is questioning the quality of the staff. The real question is the need for independent judgments. Wouldn't the Board benefit from having staff accountable to the Board itself as their prime responsibility?

I do not think anyone is trying to imply for a moment that the operating staff of the Foundation is not willing and cooperative. But I am sure there are matters which hopefully you are going to discuss in attempting to develop your own policies and your own recommenda-

tions, your own ideas. It might be somewhat advisable to have staff who are accountable to you. I am wondering whether any of you feel this is advisable or desirable.

Dr. MAC LANE. I did not speak to that because obviously not having been on the Board I would not know in detail.

I suspect, Senator Kennedy, that the independence that you get will reflect the independence of the Members of the Board. If they are independent, then they will find ways and means of expressing it.

Dr. HACKERMAN. Senator, I would like to speak to that point because I have served 6 years on the Board. There is not any question that the staff, when they work for the Board, answer to the Board. The Board members I have known have been sufficiently independent so that, if they thought they were not getting an appropriate response in terms of the full sweep of the questions, they would let it be known.

Dr. MURRAY. Senator Kennedy, I would support what Dr. Hackerman has said. In my 6 years on the Board I have always found that the staff, in working for the Board, did so with dedication.

It seems to me there is an advantage to this, although I am sure arguments can be made to the contrary, and that is, the staff is intimately interwoven into the fabric of the National Science Foundation, knows what is going on internally, and can bring that expertise and knowledge to the Board, whereas an independent staff might not be able to do so.

Senator KENNEDY. That is a rather interesting expression. Is that the feeling of the rest of the Board?

Dr. RICE. Senator Kennedy, if I might comment, I too do not have experience with this Board, so I do not want to pass any judgment on what the situation is in this case.

I do serve on another statutory committee which does have permanent staff to support the committee. I would certainly say in that case I consider that staff support essential. I do not think the committee in that other case could do its work without staff support.

So I certainly would expect we would need staff support for the National Science Board.

I think on the other hand I have seen enough staff support of various kinds that I personally would be able to tell if we were not getting the quality of staff support from the mechanisms that are now there in the Foundation to provide it.

So I agree with your point that staff support for the Board is important, and it has to be support that is responsive to the Board. If that is not the case—I have no reason to question that it is the case—if it should not be the case, I am sure that would be easily determined.

Dr. STEVER. Senator Kennedy, there is also a very interesting note in our statute here. The National Science Board and the Director—that is the 25 people—are the National Science Foundation. The other people, the entire staff—in other words, they are one and the same.

By law it says:

> Be it enacted there is hereby established in the Executive Branch of the Government an independent agency to be known as the National Science Foundation. The Foundation shall consist of the National Science Board and the Director.

That is all we consist of. We hire people to help us, and that is the staff, but the National Science Board is the Foundation together with

the Director. If the Board should feel a need for its own staff it could have one. It has never requested the appointment of such a staff although it has occasionally requested and received the services of particular staff members for particular jobs.

This is the most powerful board there is as far as I can see in the Federal Government.

Senator KENNEDY. It also says: "The Board with the concurrence of the majority of its members may appoint staff consisting of not more than five professional staff members and such clerical help as may be necessary. That staff shall be appointed by the Director and assigned at the direction of the Board."

I would have thought the intention of that language was to permit the Board itself to have access to at least five professional personnel for staff support.

They at least would feel that their first responsibility would be in serving the Board.

The CHAIRMAN. We will have to declare a short recess to enable us to go to the Senate floor to vote.

[Brief recess.]

Senator KENNEDY (presiding pro tempore). The committee will come to order. I believe the chairman will be back with us shortly but he asked me to proceed.

Maybe we could talk just a little bit about what sort of priority you give to public participation in the Board's decisionmaking process.

I would like to ask those who are already members of the Board what is being done now?

Have you set up any procedures to involve the public? If so, I would like to know what they are.

Then I would also be interested in what the nominees feel about public participation. Is this important? Is this something which needs to be improved?

Dr. HACKERMAN. There is one formal way of doing it, sir, and that is through our advisory committees. There are a large number of persons associated with the various facets of the Foundation's activities, which means with the various facets of science and technology. These are colleagues which are not on the Board, not in the Foundation, who are asked these questions.

In addition each of us hears individually from our colleagues, and if we do not, we ask. That is, if we think there is an important question coming up, we will ask those whom we happen to see at meetings.

So we have both the one formal way and the informal way.

Senator KENNEDY. Maybe you could tell us a little bit about the sort of things, based upon your experiences, that these groups have come up with. What kind of input have they had? In what areas have they participated? Is there any role for a nonscientist on the Board?

Do they all have to be scientists?

Dr. STEVER. Mr. Chairman, I would like to speak a little bit to that. Of course what Dr. Hackerman has referred to is all of the advisory committees which are open to the public. I cannot say that we get a great deal of participation from the public in those advisory meetings because they very quickly get into the technical details.

A scientist who wants to participate would probably go to one of

his colleagues on the Board and tell him his ideas—either on the Board or one of these advisory committees.

We also have often on particular subjects, for example, RANN has an advisory board, and it is broader than just the scientists. We try to get the user committee in.

I think that several of our Assistant Directors—this is outside of Board action—have used workshops, two or three day workshops, in which the results of science and technology in a certain field are promulgated to a broader audience, and there are nonscientists in that.

For example, there is the tall buildings engineering problem workshop. A number of people outside the science community attended it.

It has been my experience that not very many members of the public are interested in going through the kinds of matters that are involved.

You may be asking the question, would it be wise to have completely nonscientists on the National Science Board itself to give a different viewpoint. My only comment is that the business of the Foundation is science, and therefore scientists should predominate; but the Board should also have educators and others among its members.

Senator KENNEDY. The statute says: People active in public affairs.

Dr. STEVER. The act reads the members may be active in public affairs.

Senator KENNEDY. It is pretty broad, pretty general.

Dr. STEVER. Yes. I believe that is correct. The Board has had social scientists and so on. The Board has recommended people who have broad experience, but usually they do have at least one working science interest.

Senator KENNEDY. I wish the Board would consider this and attempt to find out whether it would be helpful to have a nonscientist on the Board. You consider very complex matters and probably there would be different views on different issues. There are some in which you can get more public participation; less in others. On some matters a nonscientist can be involved all the way through; others because of their technical nature, may only be appropriate for the input of a nonscientist at certain times.

It may vary a great deal but it seems to me that it would be helpful to examine how the public could be brought into the decisionmaking process, how to get their input, would be worth considering, rather than just relying on the advisory committees. You may come up with some ideas, and you may not.

I do not underestimate the problems that you do have, but I do think it is important because of the power of this particular Board in terms of the development of science policy. Public participation seems to me to be within the range of possibility.

I would like to see what procedures could be followed. Would you take a look at that?

Dr. STEVER. Yes, I will, and give an indication of your interest to the chairman at our next meeting.

Senator KENNEDY. I would be glad to write you on this. It does seem to me that this is at least something that ought to be considered.

What kind of attendance can we expect from the members at Board meetings? What has been the experience?

Dr. STEVER. Very good. We may have statistics. The average is 22 out of 25 members.

My experience has been it is one of the hardest working groups of part-time Board members I have ever been on.

Senator KENNEDY. That is enormously impressive and a great tribute I think to the members themselves as well as to the fact that they know what they are doing is important. That is very impressive.

While we are talking about the priorities, I note that Dr. Mac Lane wrote quite extensively on priority setting in broad areas of science.

Do you think you might be able to outline briefly your own views concerning the Board's role in setting priorities?

Dr. MAC LANE. Senator, it is correct that I have written a little on setting priorities. Because the problem is so tough, I was trying to clear up my own thoughts about it.

As the Board will set such priorities I think I am going to learn a lot more.

Mainly, setting priorities runs through a range of difficulties, or a range of sorts of priorities. Setting priorities is reasonably clear when you try to set the priorities about where you would like to be, where you would like to get.

For example, one would like to solve the problems that are up at the top of that list [indicating chart].

One would, for example, like to know how sources of energy can be made better available, but how to get there is the place at which the disagreement comes.

So, for example, on sources of energy it may well be that you do not attack this frontally, or that you do not only attack this frontally. But you often set people off by themselves to think about wild ideas that do not start out to be ideas about energy, just in the hope that something wholly new will come floating up.

So that is the other half of our setting priorities. I believe the reason I emphasize that half is that it does come up in my own branches of science, especially in mathematics.

There are very few people who are wise enough to know which piece of mathematics is going to be most profitable in the future. For example, there are some wonderful problems in geometry. When I was young and learning about geometry, people said those wonderful problems are just sort of hopeless, so complicated, so I did not pay any attention to them—not only I, but nearly everybody else—until somebody had the great idea of making a breakthrough at that particular point. This particular one was done by a man named John Milner at Princeton in 1955, and it wholly changed the picture.

So there is that part of scientific priorities that depend on someone getting the incisive idea, and for that it would be hard for the National Science Board, or any other board, really to set what science can do.

What it has done in the past is to support the right sort of basic scientific research in a good environment that will encourage able people to think, and hopefully some of them will have the bright ideas.

So, to summarize, there are the sorts of priorities that one can be clear about, and sorts of priorities that depend on having a good and

encouraging climate for scientists in which to think. I hope the Board can struggle with both of them.

Senator KENNEDY. Dr. Hackerman, maybe you could tell us a little how the Board has worked to set priorities in the past.

Dr. HACKERMAN. To set priorities in the basic research areas or in the Foundation's activities generally?

Senator KENNEDY. Both.

Dr. HACKERMAN. Of course, by and large you have to consider that there are people who have representative approaches, as well some who have senatorial approaches. In fact, the debates that go on in the Board with regard to whether more support should be diverted to one science or another are really kind of vigorous, because each has its own strong supporters, and each has rights. There is no question about it.

But you can see a swing as pressures for answers to needs appear. That is not necessarily the best way to do it, but it does work that way.

For example, when the question of the environment finally came to everybody's attention, it became quite apparent that we had not really gone as far as we should in analytical chemistry, to take a single example.

The improvement in that area over a period of a few years, making it possible to analyze better, faster, and with more precision and accuracy, has been quite remarkable.

So the priorities are set by virtue of needs, even in the basic sciences.

With respect to one area as contrasted to another [referring to chart], I think this is not a matter of pressures—I would like to find another word for it—but of the stridency of the problem.

Crime is a great problem. If indeed people had good ideas as to what to do about it, I think you would find considerable research in that area. So far the ideas have not appeared. I think it is set basically in terms of needs.

Senator KENNEDY. Is that not putting the cart before the horse?

For example, at the end of the Second World War, so much money was available in the areas of defense research, at least in my part of the country, the ablest and brightest and most talented scientists and researchers went in that direction, then to the space program, because there seemed to be a Federal commitment in that area. That was where the resources were available.

The space program, of course, is an enormously imaginative program that has fascinated many of those in the scientific community.

The point is, in the area of crime prevention, for example, if a Federal commitment is made, scientists and researchers might move into that area. I agree with you that we must support those programs where there is the best opportunity for progress. We must wrestle with this and find out areas in which there is a possibility to make some breakthroughs and open up new areas in science and modern technology.

I suppose this also involves those who are out in the scientific and research community who know there is a pretty good commitment in certain special areas.

Would this not lead them to try to find these rather special programs? Is this something that should be considered as well?

Dr. HACKERMAN. It does, but in some places the ideas just do not come up. We are either not ready for it or people really have not oriented themselves properly.

In fact, the ones you are talking about—space, for example—really did crystalize. The gaps in our knowledge were discernable. We knew what to go after.

In some instances you cannot do that. You have to wait until that gap begins to appear so you can discern it and then approach that particular problem.

Senator KENNEDY. I suppose in referring to some of those areas [referring to charts], there are probably special considerations which reflect to an extent whether any of these priorities are accurate but I suppose there are some areas even within these general categories where some real opportunities for progress exist.

Dr. HACKERMAN. Yes, I think so.

Senator KENNEDY. We cannot be expected to allocate more money than you possibly can effectively use. Simply spending more may not provide answers, in cancer research, for example, but certainly there are other health areas where increased funding is needed.

Dr. MURRAY. Senator, could I make a few comments?

Senator KENNEDY. Certainly.

Dr. MURRAY. I think it is even more complicated than has been intimated by Dr. Stever and Dr. Hackerman.

I think there is an overriding attitude which I would say is subscribed to by all members of the Board, and that is the national welfare, the health of the Nation. Even though we may not speak overtly to this point, it is always there in the back of our minds. How does research in chemistry, or in the forefront of chemistry, or breakthroughs in cellular biology, for example, affect the national welfare and keep this Nation viably strong so we can compete with the rest of the world?

The Foundation staff, as well as the Board members, are in direct contact, and are intermingling and discussing at all times with leaders, with young people, as well as older people, getting thoughts as to where the major breakthroughs may be as well as to where the cutting edges of science may be, as you may have heard. They explore such questions as: Where can money best be spent to develop the knowledge which will contribute to the public welfare?

When you put all this together, and meld it, through the Board discussions—which Dr. Hackerman correctly reported as being rather vigorous at times—the end result is a pretty good mix.

For example, my priorities might be in the area of studies of the movement of continents and the possibility of mineral deposits in certain areas, whereas somebody else's priority could be in astronomy or biology. But we try to bring all these together in the interest of what is best for the Nation and what will maintain its strength and viability.

Senator KENNEDY. Senator Williams, I just have a few more questions.

The CHAIRMAN. I would like to listen.

Senator KENNEDY. I was listening to Dr. Mac Lane, who has done extensive writings in establishing of priorities. We have talked a

little bit about some of the ways that we have been reaching these decisions.

On an entirely different subject, Dr. Cobb, I was interested in what you had found to be the interest of women in science and technology.

What should we be doing, or what can the Board do in terms of bringing women into more important roles, both on the Board, and in our Nation. I would be interested also in any comments you would like to make about what can be done to make this whole area of science policy more interesting to minorities.

Dr. COBB. First of all, I would like to reemphasize the concept of scientists and science as a positive moral ethic in terms of understanding that its whole process has been and is operative for the development of the future of mankind that makes everyone accessible to the best things in life. With that particular goal, there are, of course, areas in basic research and applied research to be emphasized.

I see a policy group having the facility to look at basic research and to encourage it because it has implications for directions that we cannot predict at this moment in time.

In relation to the two oppressed groups, women and minorities, I would say that we certainly have to look at what programs can be mounted to increase the numbers of women moving into the sciences, and, in general, having access to higher education. The socialization process begins very early, not only for women, but for minorities. Early on they are not expected to go too far in the hard sciences. This has been very clearly indicated. Mathematics, for example, physics, and engineering are underrepresented.

We talked about this 2 years ago. Women in science and engineering met at the invitation of Dr. Philip Handler at the National Academy of Sciences. We were in fact dismayed to find that the Atomic Energy Commission, for example, has very antiquated ideas about exposure of women to radiation at certain times of the month. Yet a man might have a cut or sore finger and is allowed to be exposed to radiation nevertheless.

The point is, we have missions given to us from social scientists as well as from people involved in science education to look at: (a) programs on the early education and the desocialization of women; and (b) the new access routes for the encouragement of minorities to enter science.

However, there has certainly been little done for encouraging women in science. We know at the moment that only 20 percent of the faculty teaching in colleges in any field are women. And the same percentage was true in the 1920's. We have made no progress there.

So I see these as very important issues. I am going to be the conscience for the women and minorities on the Board, but will be very aware of the total picture, I assure you.

Senator KENNEDY. Very good.

I note, Dr. Shields, you have been interested in this, too, at your University.

Going on from what Dr. Cobb has said, do you think some of the experiences you have had could be applicable nationally?

Can you draw on your experience to try to meet some of the problems Dr. Cobb has mentioned?

Dr. SHIELDS. I think so, Senator.

One of the critical concerns we have had is to attempt to stimulate and develop the interest, particularly within ethnic minorities, in science at a much earlier stage than we have been able to in the past. In that sense, there have been several more programs mounted in recent years to try to develop better expertise in getting right into the elementary schools and secondary schools where there is a large ethnic minority population to create science teaching approaches to the present science curricula that would be of more interest to ethnic minorities, and get them involved in an earlier stage in some of the excitement of science.

I think this is an area that we can improve on, and I am certainly interested in looking into it more.

Senator KENNEDY. Very good.

Dr. RICE. May I comment on that subject?

Senator KENNEDY. Certainly.

Dr. RICE. Just thinking from the point of view of our experience at Rand, where we have been trying to increase the numbers of women and minorities with real success in the past few years, but not nearly enough, I would say it is necessary to work that problem from both the supply and the demand sides. We do need programs that make it possible for women and minorities to get involved in areas of science to begin with, and then be able to stay in school as long as necessary. We do not have enough of that sort of program.

On the other hand, we do not have policies today which permit minorities and women to develop their skills on the job to the extent that I think necessary.

Money is short everywhere, so money is squeezed on every project. That means that every project manager throughout the Government has an incentive to encourage the institution doing the work he or she is funding to put only the best people on it, only the people who have already demonstrated their qualifications. The whole process works to make it difficult to provide development opportunities for people who have not already demonstrated their abilities.

I think that is an area that we could well look into.

Senator KENNEDY. That is a good observation.

As a former OMB official, and recognizing the actual decrease from fiscal 1973 to 1974 in Federal expenditures in science and technology, do you think we can afford to reduce that spending any more in the future?

Dr. RICE. I do not know if I am familiar with just exactly what figures you are referring to, Senator. In my view, the decrease is not the direction to go in.

Senator KENNEDY. In constant dollars, as I understand it, there has been a decrease.

Dr. RICE. Yes, I think that is a very valid point; absolutely the correct way to look at the problem is in terms of constant dollars.

With respect to the National Science Foundation itself, if you look at the figures there in terms of, say, about a 4- or 5-year, in the most recent years, the funds available for research in the Foundation have gone up at a somewhat faster rate than inflation. But there has been a decline in nondefense areas elsewhere in the Government, and the increase in NSF has not been enough to offset the declines in other places.

I think that is the problem we have to look into. I would prefer to see some real growth, certainly not a decline.

Senator KENNEDY. If we saw a further decline in constant dollars, how do you see that as affecting the mandate of the Science Foundation?

Dr. RICE. The most important impact it would seem to me to have on the Foundation would be to increase the pressures on the Foundation to pick up the slack in areas that would be dropped out by other agencies.

The Foundation has already had a lot of difficult problems of that sort to deal with over the past several years, as strictly basic research activities have been reduced by the Department of Defense, by NASA, and the AEC.

It would increase pressures on the National Science Foundation if that trend continued in other agencies.

Senator KENNEDY. Dr. Rice, do you have any feeling for what is happening in other countries in terms of total expenditures for science and technology?

What are they doing, say, in Western Europe?

Dr. RICE. I do not have Western European figures at my fingertips. I do recall that the best estimate that we were able to put together—there is a lot of uncertainty about them, to be sure—indicates that Soviet Union spending on R. & D. has been rising steadily in real terms.

Senator KENNEDY. Could you provide a little information for us on that, Dr. Stever?

It is my information that they have been spending significant amounts for science education and research.

Dr. STEVER. The Board will have out in the near future a second report on science indicators, and there will be more data on that.

I think that as far as the fraction of the gross national product is concerned, we peaked in 1966 or something like that, and have gone down one-tenth per year, or a tenth of a percent per year, from 3 percent down to 2.3 percent.

The Soviet Union is harder to pin down on statistics because of the difference in the systems, but it appears to continue to go up.

West Germany has come up with a strong area, although it is not certain whether they are continuing to grow, but they are in the same range that they were.

Japan has been growing. I do not know whether the energy problem has cut back their growth concepts. There will be new statistics out soon, and we will certainly keep you informed of them.

I do think in toto we still have the largest and the most powerful program, but our relative advantage is nowhere near what it was.

Senator KENNEDY. I know that you served, Dr. Rice, on Dr. Killian's committee which made recommendations for improving the science advisory mechanism in the executive branch.[1]

Is this something you will continue to support?

Dr. RICE. Yes, Senator.

I was honored to be a part of that committee. I do have a personal view reflected quite well, I think, in the report in many ways, that it is

[1] Ad hoc Committee on Science and Technology of the National Academy of Sciences; report entitled *Science and Technology in Presidential Policymaking: A Proposal.*

desirable to strengthen the arrangements that provide science and technology information into the staff processes that serve the President. I think it is more desirable to have an entity which can cover the full range of problems. The arrangement that we have today—all of us believe Dr. Stever has done a magnificent job in this assignment—does not cover the whole range of problems. It covers problems in a most piecemeal way.

The council that was proposed by Dr. Killian's committee is certainly one such option that could be pursued.

I think it is most important in that same context to recognize that many of the problems, and therefore the staff processes that are needed to serve the Office of the President, must be concerned with the full range of talents and information that have to be brought to bear on these problems.

Many of the problems that need to be dealt with are not wholly science problems and technology problems and not even dominated by the science and technology considerations.

I am sure you are grappling with that in the case of the Office of Technology Assessment (OTA).

I think we have to find a better way of providing a broad-based interdisciplinary and analytical staff to serve the President, as well as to strengthen the science advisory mechanism.

Senator KENNEDY. Dr. Zumberge, I know that your university has participated extensively in the Foundation's programs over a period of time.

Do you have some ideas in terms of the relationship of the Foundation to universities that might be helpful?

Do you have any suggestions or comments?

Dr. ZUMBERGE. Senator, the Foundation has always enjoyed a very close relationship with universities and university people in the conduct of research from the earliest stages onward.

I think that that has been one of the strengths of this country, that there are so many universities, so widely dispersed, and of such diverse character, that the Foundation has almost unlimited numbers of groups in different fields to draw upon for the conduct of research.

Even in the area of the new emphasis on applied research, we find universities, such as the University of Nebraska and other land-grant institutions, having the expertise to solve some of these problems of basic interest for the future of mankind.

One of the good examples is in agriculture where so many problems with science relate to the quality of food, its transportation, its availability to people, not only in this country but all over the world.

The one thing that makes the United States quite different from other countries is that the Foundation itself does not engage in research, but that it finds out where the research can be done, which it does in a number of ways, and responds to proposals that are submitted.

I think the proposals submitted by universities to the Foundation are one of the great strengths of science in our country. This method should be continued and strengthened, not only as it has been, but in new areas that are developing. We have many colleges and universities at all levels in the post-secondary educational field which have a great number of people who are on the cutting edge of many of the areas of basic as well as applied research.

My simple answer to your question, sir, is that this relationship has allowed us to reap great rewards, and I see no reason to do anything but continue it and strengthen it.

Senator KENNEDY. It is good and should be strengthened; is that it?

Dr. ZUMBERGE. Yes.

Senator KENNEDY. Dr. Murray, could you give us your evaluation of the effectiveness the energy research programs have which are being undertaken?

I know that you have a very distinguished background in this area.

Dr. MURRAY. I think the energy crisis in many respects is more financial and political than it is scientific, certainly in respect to the petroleum industry in this country. This industry is one of the critical industries in this Nation. Probably no other substance, other than food, air, and water, is more essential to our continued growth as a major nation and to our maintenance and survival. We could not possibly go to work in the mornings, or return home at night without crossing or utilizing a single petroleum product.

Private industry, in this instance, has done an outstanding job of finding reserves, both in this Nation and abroad and in the exportation of expertise and know-how in the search for, and the production of, petroleum products, not without some mistakes, however, as is understandable.

The Foundation programs in support of solar energy, wind energy, geothermal energy, the use of hydrogen, and so forth, are in their infancy. I think it may be a little premature to attempt to evaluate them at the moment.

However, it seems to me that it is incumbent upon the Foundation, the U.S. Geological Survey, or the Atomic Energy Commission—whatever the group may be—to push ahead in energy research at maximum speed.

This may not be the most efficient system, but I believe they should push ahead at maximum speed to insure self-sufficiency, whatever that may be.

Senator KENNEDY. Do you think we ought to push ahead in all of them?

Dr. MURRAY. Yes.

Senator KENNEDY. You do not think we ought to try to take a look at the different alternatives and find out what the scientific problems are, what the technological problems are, what are the costs relative to each?

Dr. MURRAY. If we tend to push ahead in all of them these problems would come to light.

Senator KENNEDY. I am sure the problems will come to light, but will that not mean we have spent a lot more in resources if we are pressing ahead in all of these efforts, rather than trying to move ahead first to the point where at least we get some projection as to what it is going to cost in terms of financial investment, what it is going to cost in terms of technological investment, and what the secondary effects are going to be, for example, in terms of the use of water out in the Rocky Mountain States, as well as other public policy issues?

Dr. MURRAY. We need to go ahead as rapidly and as strongly as we can on all of them, because they tend to complement each other. I be-

lieve solar and wind energy can reduce the dependence on oil and the natural gases; for example, in certain areas of the country.

Utilization of hydrogen as a fuel must be explored because, if we can convert to hydrogen-propulsion systems, we are certainly going to be able to preserve our petroleum and natural gases for other important uses.

As we learn to complement the various energy sources, we will achieve a balance in the energy picture in this country, as well as a balance in the distribution of energy, which we do not have at the present time.

Senator KENNEDY. I hope you will give some more thought to wind energy. As someone who spends a lot of time close to the sea, it seems incredible that a sail about a quarter the size of this wall can drive a 15-ton boat through mountainous spray. One just cannot help but think there are all kinds of marvelous things that can be done through the use of wind energy.

We have talked about that before with the Foundation. Unlike health care, wind energy research is not heavily funded.

Dr. STEVER. We accept your bias.

Senator KENNEDY. We have just touched on some of the things which concern the committee. I hope we have a chance to go through them in more depth at another time. I want to thank all of you very much for coming up here.

This is a very outstanding group, Mr. Chairman, and I think that with the responsiveness they have displayed this afternoon in answering our questions, and their interest in being aware of some of the concerns we have up here, there is reason for encouragement and hopefulness.

I think this group will be very useful and helpful to us in trying to find ways for us to better support their work.

So, I want to thank all of the nominees, and you, Dr. Stever, for your appearance here this afternoon.

The CHAIRMAN. There are just one or two things that I have, ladies and gentlemen.

It seems with fluctuating national needs and demands we see certain areas of scientific resources removed from certain activities.

For instance, aeronautical engineering is an area that is much reduced relative to what it was 4 years ago.

I have been told that at one of our great universities, Georgia Tech, some of the people working in aeronautical engineering are not sponsored in research in solar energy.

I just wonder if that is one of the Foundation's activities.

Dr. STEVER. Yes, it is.

The CHAIRMAN. It would seem to me that the Foundation would obviously be alerted to this reservoir of talent that might be otherwise not fully occupied and could be put to use for some of your purposes.

Dr. STEVER. In the energy field, for example, in the areas where at the present time we have a lead responsibility, we are in fact transferring money to certain NASA laboratories.

The Lewis Laboratory, of course, is a leader in wind energy. We have discovered many people who are in the aerospace business con-

verting to other national needs, and our RANN program caused us to help considerably in that conversion.

Dr. MURRAY. Mr. Chairman, I would like to introduce a relative point in this regard.

One of the problems with the utilization of wind energy and solar energy is the storage of the energy once it is produced. I call your attention to the fact that the Foundation is supporting research in this area of storage of energy.

Dr. STEVER. Yes.

The CHAIRMAN. Are all the members of the Board from what you call the hard sciences?

Dr. STEVER. No, sir. I think I should answer that. Representatives of the social sciences are on the current Board. We have four members: Dr. W. Glenn Campbell of Stanford University, who is an economist; Dr. Roger W. Heyns, who is a phychologist; Dr. William H. Meckling, from the Graduate School of Management at Rochester, who is an economist; and Dr. Frederick P. Thieme from the University of Colorado, who is an physical anthropologist.

Of the new nominees here today, Dr. Rice is in the social sciences in economics, so we will have, if this group is confirmed, 5 out of 25 members of the Board who will be in some form of the social sciences.

We have had a few people come to us and say that we do not do very much with social sciences as far as Board membership is concerned, and when we tell them we have 5 out of 25, they say, maybe they are overrepresented.

The CHAIRMAN. Would there be room for a sociologist?

Dr. STEVER. Yes. We have had former Board members in that field: Dr. Chester I. Barnard, Dr. Rufus E. Clement, the very Reverend Theodore M. Hesburgh. Dr. James G. March, one of the retiring Board members, was in this field. We lost Jim March's services, but we will probably pick up others of his kind later. A list of former members of the Board is hereby inserted into the record, with your permission.

[The list of former members of the National Science Board referred to follows:]

NSB-74-176

FORMER MEMBERS
NATIONAL SCIENCE BOARD

Dr. Sophie D. Aberle
Special Research Director
University of New Mexico

*Dr. Roger Adams
Research Professor
Department of Chemistry and
Chemical Engineering
University of Illinois

Dr. W. O. Baker
Vice President - Research
Bell Telephone Laboratories, Inc.
Murray Hill, New Jersey

#*Dr. Chester I. Barnard
President
The Rockefeller Foundation

Dr. Robert P. Barnes
Professor of Chemistry
Howard University

Dr. R. H. Bing
Rudolph E. Langer Professor
of Mathematics
The University of Wisconsin

+#Dr. Detlev W. Bronk
President, The Rockefeller
University and
President, National Academy of
Sciences

Dr. Harvey Brooks
Gordon McKay Professor of
Applied Physics and
Dean of Engineering and
Applied Physics
Harvard University

Dr. Mary I. Bunting
President
Radcliffe College

*Dr. Rufus E. Clement
President
Atlanta University

#Dr. James B. Conant
President
Harvard University

*Dr. Gerty T. Cori
Professor
Biological Chemistry
School of Medicine
Washington University
(St. Louis)

Dr. John W. Davis
President
West Virginia State College

Mr. Charles Dollard
President
Carnegie Corporation of
New York

+Dr. Lee A. DuBridge
President
California Institute of
Technology

*Dr. Conrad A. Elvehjem
President
The University of Wisconsin

NOTE: Position is that when appointed to Board or major affiliation during service on Board.

* Deceased.

\# Former Chairman, National Science Board.

\+ Former Vice Chairman, National Science Board.

Dr. Henry Eyring
Dean
Graduate School
University of Utah

Dr. William A. Fowler
Institute Professor of Physics
California Institute of Technology

+Dr. Edwin B. Fred
President
The University of Wisconsin

Dr. T. Keith Glennan
President
Case University

Dr. Julian R. Goldsmith
Associate Dean
Division of the Physical Sciences
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The CHAIRMAN. I find that encouraging.

Senator Kennedy raised the one point that I wanted to raise before we recess, and that is on science personnel, manpower, so-called.

A few weeks ago I was at a conference of engineers, and the mission there was to explore ways to excite minorities to an interest in engineering.

They had very stark statistics of 40,000-plus graduates in engineering last year or the year before, of which there were 400 blacks. This conference was sponsored by one of our great national corporations.

They are fully aware of their responsibility, and they have been aided by some of the work of this committee, particularly the equal employment opportunity legislation that came from here. They are really thirsting for qualified people.

Again, as you mentioned, it starts early in the educational life of an individual. Many of them are corporately launching programs of educational interest at the elementary and secondary levels.

Is there any role for your Foundation in this?

Dr. STEVER. Yes, sir, and we participate in many different ways.

First of all, the National Academy of Engineering here in town has a Commission on Minorities in Engineering. It is chaired by Mr. Reginald H. Jones, who is chairman of the Board of General Education. Many corporations and schools have representatives on this. It is quite an active group.

I am a Government representative. The Secretary of HEW is also a Government representative. One of the NSF people in minority education, Dr. James Mayo, is helping that committee.

We have a program for minorities in science—a small program, but it is quite a good one. The Board has shown intense interest in doing better in this area.

We have just learned that our consciousness is going to be expanded on this. Dr. Cobb, you will find several other members who have similar objectives.

We do have a role, we are conscious of it, and we are trying to do something with it.

The CHAIRMAN. I do not know whether there will be an opportunity or not, but I learned another bit of stark information from Dr. Gallegos—he comes from a Spanish background in Denver—and said not only is there not an effort to stimulate interest, there is an absolutely depressing attitude at the lower levels of discouragement, that there is no room in some of the areas. He was talking about science and engineering.

So I think you might find an ally in Dr. Gallegos at OEO.

Dr. STEVER. We find allies in very interesting places. The Los Alamos Laboratory of the AEC has, I think, the only native American Indian Ph. D. in physics on its payroll. It is located in an area with lots of Indian tribes and reservations. It has worked with one of the major reservations there, and volunteered science services to help them in some of their early education programs in science.

The National Science Foundation is funding AEC's laboratory to do this program.

The CHAIRMAN. Fine.

Dr. STEVER. We are trying as often as we can to broaden the spread to where the problems are on the support for minority education in science and technology.

The CHAIRMAN. I gather this is a historic occasion, a hearing on confirmation. It is good for us here to have this opportunity to meet you and hear from you.

I think our committee is strongly in support of the Foundation. We are very pleased with this meeting, and certainly will do our job as efficiently as we can, so we will clear this process of nominations as rapidly as possible.

At this point I order printed a letter from Senator Hart, of Michigan, endorsing Dr. Hubbard and other pertinent material submitted for the record.

[The material referred to follows:]

PHILIP A. HART
MICHIGAN

COMMITTEES:
COMMERCE
JUDICIARY

United States Senate
WASHINGTON, D.C. 20510

September 5, 1974

The Honorable Harrison A. Williams
Labor and Public Welfare Committee
4230 Dirksen Senate Office Building
Washington, D. C. 20510

Dear Senator:

Next week you are scheduled to hear the nominees to the National Science Board. One nominee is Dr. W. N. Hubbard, Jr., President of The Upjohn Company - and the world.

His distinguished career would recommend him highly as one who could provide effective and thoughtful service on the Board. Your judgment with respect to his nomination will be based upon your own impression of him and his background, but I hope you will not think it inappropriate for me to express my own endorsement of Dr. Hubbard.

Sincerely,

Philip A. Hart

SCIENCE & GOVERNMENT REPORT

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NSF's Research Budget: An Inside View of the Grant Process

First of a series of non-official renditions concerning how the major federal granting agencies decide yes or no on grant applications.

Over the next year, some 15,000 researchers will seek to share the $275 million that the National Science Foundation plans to dispense for its traditional program of individual project research. Perhaps 5000 will be successful; of these, almost all will receive less than half the money they sought, and in many cases, as little as 30 percent.

Who makes the decisions, what are the criteria that separate the blessed from the disappointed, and are there, as folklore holds, tricks of "grantmanship" that can make a difference? SGR has spent the last several weeks trying to find out by chatting, on a non-attributable basis to encourage candor, with some of the people who staff the innards of the NSF bureaucracy. Our conclusion is that the present system, though honestly administered and brimming with good intentions, is surprisingly uneven and often arbitrary in its criteria and methods, and that it would be desirable for Congress or perhaps the National Academy of Sciences to undertake a diligent inquiry into this vital aspect of the economy of science. And, yes, a shrewdly composed application does hold an edge over a less polished competitor, even though their substance and the quality of the applicants may be similar. (See Grantsmanship," p. 2).

NSF's $275 million in project research money, as distinguished from funds provided for national research centers, oceanography, Research Applied to National Needs, and other of the Foundation's many activities, is distributed through a Research Directorate that is divided into six disciplinary divisions: environmental sciences, biological and medical sciences, engineering, social sciences, mathematical and physical sciences, and materials research.

The Directorate is headed by one of NSF's six assistant directors, Edward C. Creutz, who previously was director of research of the General Atomic Division of the General Dynamics Corporation, and before that head of the physics department and nuclear research center at the Carnegie Institute of Technology. The six divisions under Creutz are each headed by a director, and then, varying from case to case, they are subdivided into sections and individual programs that report directly to the division director.

However, within this complex and varying table of organization, the key figures in all cases are the program directors, associates and assistants, of whom there are 75 within the 1200-member staff of the Foundation. To an extent that is not widely recognized, they are the ones who in reality decide yes or no and how much, and rarely at all are their decisions altered by the staff structure above, though major—but not binding—influences are exerted by outsiders whose opinions are routinely solicited.

How do the program directors operate? Well, as one top NSF official explained to SGR, "There's not much uniformity. We let them use their judgment." Applications are routed to the program directors by NSF's central processing office, which, two years ago, confronted by a 10-20 per cent growth rate that now annually adds up to 25,000 applications, active grants and contracts, took to

(Continued on page 2)

And Ask if He'd Like an Appointment

Stapled in the centerfold of the latest NSF staff telephone directory is a form titled, "Record of Telephone Threat," including a section inquiring: "If a bomb threat, when will it explode? Location of bomb. Reason for placing bomb. Name of caller."

In Brief

Some elders of science recall with dismay that Nixon's new economic czar and main input for science policy affairs, Treasury Secretary George P. Shultz, has sometimes spoken of the "arrogance" that he encountered among scientists when he was a young economics teacher at MIT after World War II. . .

With the White House Office of Science and Technology lacking a director or deputy director and due to expire in July, the man in charge is David Beckler, a veteran staffer, who says, "I'm organizing an orderly retreat." . . .

Some recent departees from federal service are expressing shock over the gap between public and private salary scales, but it's the public pay they now find at the upper end of the scale. One ex-Washington official noted that his government assistant drew $21,000 a year. "We couldn't possibly match that in the private sector," he said.

NSF RESEARCH BUDGET *(Cont'd from page 1)*

the computer to provide continuous "tracking" of all that paper.

Since all the program directors work either alone or at most with a few fulltime professional colleagues, they personally examine every arriving application—no small task, considering that the numbers total 300 to 600 per year for each program, and that an average application is in the neighborhood of 25 pages. If the application looks anywhere near "reasonable"—as many program directors put it—the next step is to solicit through the mail confidential opinions, consisting of essay-style comments on the proposal, plus an "overall rating" that runs from "excellent," through "very good, good, fair, poor," with it being generally agreed that anything below the top two has very little chance. As for what the reviewers are supposed to comment on, that, too, varies somewhat from program to program, but in general, the directors want their thoughts on the scientific validity of the proposal, its importance for "advancing the field," the "reasonableness" of the budget, and the relationship between the applicant's past performance and the ambitiousness of the project.

How many appraisers and who are they? That, too, turns out to be a matter of individual discretion, with the numbers varying from three or four in most cases to as many as a dozen in others. One commonly expressed opinion was that in the "hard" sciences, it's easier to size up a proposal and the ratings tend to be fairly consistent; hence fewer mail reviews. In the social sciences and in newly developing interdisciplinary fields, the score-keeping was said to vary widely, and the tendency was to collect a greater number of opinions.

In general, the "mail reviewers" are people in whom the directors have confidence, either from personal acquaintance, professional reputation, or because they have been recommended by the members of another major element in the granting system: the program advisory panel, of which there are 24, one for each program, with some overlap, usually consisting of 12 members per panel who meet with the program director for three two-day sessions per year. (Remuneration, $75 per day,

(Continued on page 6)

Program Directors: At the Center of NSF's Grant System

What are some of the major professional characteristics of the program directors who occupy so important a position in NSF's support of project research?

Almost all hold Ph.D's in the disciplines they supervise or in a nearby field. About one-third are on leave to NSF for a year or two from research or administrative posts. The others are considered permanent appointees, and of these at present, about half have served with NSF for at least 5 years. In almost all cases, their financial rewards are substantially superior to the prevailing rates of the academic world. Depending on length of government service and whether they bear the title of program director, associate, or assistant, their salaries range from $19,700 to $34,900, with most in the vicinity of $30,000. Fairly representative is a program director who came to NSF three years ago from an associate professorship at a major university, and is now receiving a salary of slightly over $30,000.

Having operated on essentially level budgets for the past three years, most directors radiate a sense of feeling squeezed between their NSF superiors, who listen to their requests and then hand them a budget to distribute more or less at their own discretion, and their wailing colleagues in the field, who demand to know why more money isn't forthcoming.

"Grantsmanship" & Other Matters

NSF officials specify scientific merit as the key determinant in awarding research project grants, but privately some concede that generally unspoken of elements can affect the balance. Following are examples from conversations with Foundation executives:

"It helps if there's some evidence of frugality, like saying that a certain piece of equipment is absolutely essential, but that you'll borrow rather than buy."

"It's good for a youngster to list some big shot as co-principal investigator, but you've got to be careful with that. We'll check to see what his other commitments are. If he's serving just as a front, it won't help at all."

"Relevance? We have no formal requirement for stating anything about it in an application, but it's significant in borderline cases—and more and more cases are borderline these days."

"Anyone who can come up with something that you can put to work right away has an inside track."

"We get doubtful if a guy with a good but ordinary research record proposes to solve some colossal scientific problem. It's better to have a reasonable match between past performance and what you're planning."

Congressional intervention in behalf of an applicant? "Absolutely worthless and may even do harm. We kiss it off with a courteous reply about the normal reviewing process, and if we ask for data from the program director, we never tell him that it's for a congressman."

NSF RESEARCH BUDGET *(Cont'd from page 2)*

plus a free trip to Washington, a chance to meet with colleagues, and, of no small importance, an opportunity to keep abreast of what others in the field are planning.)

But unlike at the National Institutes of Health, where outside scrutiny for funding of grant applications is required by law, the role and authority of NSF's advisory panels are discretionary with the program director. Some submit every application, with the mail reviews and their own comments, for consideration by the panel, and wholly or in large part abide by the panel's decisions. Others, usually claiming that the application load is too great to be sensibly disposed of in six days of meetings a year, use their panels simply to keep them abreast of scientific, administrative and financial matters in the discipline. Some, according to a top NSF official, "make the decisions themselves, maybe with just a mail review or two in cases where they're doubtful."

When all the appraisals, of whatever sort, have been made, there's the program director with desk piled high. What happens next tends to vary from program to program.

According to one NSF official, when William D. McElroy directed NSF, his guiding rule was "take care of the proven performers"—and that, it is said, still guides some program directors. McElroy's successor, H. Guyford Stever, according to this same official, has neither rescinded that dictum nor approved it. "I doubt if anyone in the house has any idea of what Stever thinks about this matter," said the official.

So, the program directors tend to go their own way. One of them, presiding over several million dollars a year, said that he feels "uneasy if the young people aren't getting a good share"—"young" being under 35—but he added that there is no proportion specifically earmarked for the young. Others said that age did not figure in their decisions.

Another explained that since her program can provide only about 30 percent of the funds requested, "my rule of thumb" is that "young investigators can get along without a technician. The important thing is simply to get them started on research. In considering applications from older applicants, we generally cut them down to one technician for every three requested." One director said that he tends to be "particularly hard on the older, established researchers. Some of them think their name alone can swing the matter. I think otherwise."

After an application has been approved by a program director, formal approval is required from two higher levels, but, with few exceptions that's simply a formality. "It's rare for even one in a hundred to be bucked back," a director explained.

For the rejected applicant there is a channel for appeal. He can resubmit his application for another run through the review process.—D.S.G.

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National Science Board: Its Place in National Policy

Eric A. Walker

The recent article on "Federal science policy," by Philip Handler (3 March, p. 1063), in which he discusses the role of the President's Science Advisory Committee and of the National Science Board, raises some interesting questions. Among other things it suggests a very careful reconsideration of the mechanisms by which the National Science Board can most effectively make its contributions to federal science policy. This same matter has in the past received considerable attention from the House Subcommittee on Science, Research, and Development (the "Daddario committee"), and a bill proposing changes in the status of the Board is once again before the Congress. Indeed, the whole question of the nation's scientific and technological progress, particularly in terms of the useful application of our accumulated scientific knowledge and its relation to the national economy, has become a matter of general concern. And the operations of the National Science Board clearly play an important part in this larger picture.

These considerations have prompted me to put on paper some of the impressions and opinions I gained during a term on the Board.

Throughout the history of the National Science Foundation, and indeed even before its formal establishment, the question of how much responsibility and authority the National Science Board should have has been a matter of contention and uncertainty. The original enabling act, after 5 years of congressional debate on the subject, was vetoed by President Truman on the grounds that it granted too much authority to the Board and thus infringed on the constitutional duties of the Chief Executive. The act which was finally signed in 1950 was far from clear with respect to the Board's role. And subsequent legislation, designed to resolve some of the initial uncertainties, has actually had the effect of making the Board's position more, rather than less, anomalous.

The Foundation, as originally conceived, was very largely the brainchild of Vannevar Bush, the director of the World War II Office of Scientific Research and Development. To him and to the other founding fathers, the concept was paramount that the nation's science policies should be determined by responsible leaders in science, education, and public affairs—men representative of the best scientific thinking in the country. To achieve this end, Bush, in his original report proposed an organizational structure for the new agency which provided for an unusual degree of autonomy and a very clear-cut pattern of authority and responsibility (*1*):

> Responsibility to the people, through the President and Congress, should be placed in the hands of . . . [the] Members, who should be . . . selected by the President on the basis of their interest in and capacity to promote the purposes of the Foundation. . . . The Members should elect their own chairman annually. . . . The chief executive officer of the Foundation should be a director *appointed by the Members*. Subject to the direction and supervision of the Members (acting as a board), the director should discharge all the fiscal, legal, and administrative functions of the Foundation.

Thus, as Bush and his committee conceived the Foundation, its organizational structure was to be modeled after the pattern of the large private foundations of the country rather than that of a typical government agency. The Board was to run the show, and the director was to be, in effect, the Board's employee. It was a simple and straightforward arrangement. The members of the Board, free both from external political pressures and from internal administrative duties, could apply their talents and exercise their collective judgment in the development of a meaningful science policy for the nation. Both the responsibility for establishing programs and the authority for carrying them out would rest clearly with the Board, with the director serving as its executive officer.

It was too much to hope, of course, that such an idealistic arrangement would meet with either congressional or presidential approval. Thus the enabling act, as finally passed, included complications and anomalies that made the Board's role in the operations of the Foundation cumbersome from the outset and almost assured the defeat of the founding fathers' intentions.

In the manner of compromise legislation, the act was too specific in some respects and too vague in others. The director of the Foundation, rather than being chosen by the Board, was to be appointed directly by the President (with the advice and consent of the Senate) and was to be a nonvoting ex officio member of the Board. These provisions seemed reasonable enough in the light of the Foundation's governmental character, but the act went on to enumerate specific responsibilities for the director which served to complicate his relationship to the Board. He was authorized to "exercise the powers of the Foundation" with respect to awarding scholarships, granting fellowships, and entering into contracts. Thus he was to be the agency's "contracting officer." But he was to perform this function "in accordance with the policies established by the Board" and with the express provision that no final action was to be taken in these matters "unless *in each instance* the Board has reviewed and approved the action proposed to be taken."

The Board was given the privilege of making recommendations to the President with respect to the appointment of the director and was granted the power to create its own executive committee (of which the director was also to be a nonvoting ex officio member), but was prohibited from assigning to its executive committee "the function of establishing policies, or the function of review and approval" of contracts and awards. The Board was to elect its own chairman. And it was specifically stated that the Board "shall, except as otherwise provided by this Act, exercise the authority granted to the Foundation by this Act."

It was an unusual and cumbersome arrangement. The Board, it is true, was free to determine overall policy, but it was the director who reported to the President. On the other hand, the Board was saddled with what actually

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amounted to a large part of the organization's administration, while the administrative control of personnel rested with the director. And although the Board was charged with the development and pursuit of a national science policy, no mechanism was provided for the implementation of whatever decisions might be made in this respect.

Moreover, it was not at all clear just what was meant by a national science policy. Did this mean simply determining the overall needs of the nation as far as scientific research and education were concerned, or did it involve a composite of specific policies for the scientific affairs of Congress and the various executive agencies? Did it include an investigation and evaluation of the programs of other—frequently larger and more influential—federal agencies, and if so, by what means? In the light of these anomalies, it is understandable that, during the early years of the Foundation, little attention was paid to large-scale policy matters. Uncertain of the Foundation's place among the many federal agencies supporting research, limited by inadequate funds, and burdened with operational duties, the Board devoted most of its energies to working out practical arrangements for carrying out its own programs. The determination of overall policy, even for the Foundation itself, was by no means a simple matter. In this respect the act had provided for a troika-like arrangement which did not make for easy sledding. Three groups clearly played a direct part in policy guidance and control of the agency—the Congress, the Executive Branch, and the Board itself, each of which had, and still has, some measure of veto power over the Foundation's activities. As long as all three are in favor of a given policy or project, there is no problem. But if one of them wishes to exercise a veto, it can do so. Either the Congress or the Administration can thus negate a policy promulgated by the Board.

In 1958, an executive order clarified to some extent the Foundation's external responsibilities by instructing it "to recommend to the President policies for the Federal government which will strengthen the national scientific effort and furnish guidance toward defining the responsibility of the Federal government in the conduct and support of Federal research." And in 1959, the internal situation was improved by amendments to the National Science Act which permitted the Board to delegate authority to the director and to its executive committee to approve grants and contracts in certain situations. Yet in spite of these attempts to overcome some of the difficulties inherent in the original act, the Foundation seemed unable to fulfill the expectations of its founders.

To many the trouble appeared to lie in the Foundation's unusual structure. Complaints were heard that the NSF was "not like other Federal agencies," that it was not sufficiently responsible to or controlled by the executive branch, that it was too directly responsible to the Board. Suggestions were made that the Foundation should be put into the more regular pattern of other government agencies. For this and other reasons, the Foundation was reorganized by an act of Congress in 1962. What the reorganization plan did in effect was to push the Foundation further away from the concept which had been of prime importance to its founders—that of providing a workable mechanism by which the best scientific thinking of the country could be brought to bear on the development and pursuit of a sound science policy for the nation. By the 1962 reorganization, the Board—supposedly the representative of the nation's top scientists and educators—was placed in a curiously restricted position, both in relation to the Foundation's own operations and to its broader influence in the government's scientific affairs.

The tendency to strengthen the director's position vis-à-vis the Board had been evident in a 1959 executive order which designated him as a member of the Federal Council for Science and Technology. The act of 1962 further strengthened his position at the expense of the Board. First, he was made a full voting member of the Board. Since such an arrangement is fairly common in many universities and industrial corporations, this step was not seriously resisted by the Board. But the really curious provision of the 1962 act was that, in overhauling the executive committee to give it a more effective role in the Foundation's operations, it was specified that the director, rather than the Board chairman, should be chairman of the Board's executive committee!

The 1962 act also removed from the Foundation "so much of the function conferred upon" it by the original act —"to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences . . . as would enable [the director of the Office of Science and Technology] to advise and assist the President in achieving coordinated Federal policies" for this purpose. In addition, the act removed the Foundation's charge "to evaluate scientific research projects undertaken by agencies of the Federal Government" and transferred this function as well to the Office of Science and Technology. Thus the Board's opportunity for influencing federal science policy was further and severely restricted. As a matter of fact, if it had not been for the vigilance of some alert Board members, the Board would, at that time, have been stripped of all real authority and reduced to an advisory function. Discussions then took place and a compromise "truce" which lasted 3 years was the result.

The fate of the advisory committees under the provisions of the reorganization act is also significant. These committees, made up of scientists in separate disciplines, such as mathematics, astronomy, engineering, and others, had been an important communication link between the scientific fraternity and the Board. By making them responsible to the director, the 1962 act removed them from direct contact with the Board. And a later reorganization act (1965) abolished completely the statutory requirement for these committees. Since the committees had been removed earlier from the jurisdiction of the Board, the Board had no chance in 1965 to vote on the desirability of their statutory position.

What it all adds up to is that gradually, by successive steps, the National Science Board—originally envisioned as a largely autonomous group of leaders who were to have a powerful voice in the conduct of the scientific affairs of the nation—has become what amounts to little more than a routine committee for determining the specific awards and contracts of the National Science Foundation, with little power to enforce policy decisions. This is not to say, of course, that the larger purposes of the Foundation have, over the years, been unsuccessful. The present strength of United States science speaks to the Foundation's overall achievements. Nor does it mean that there has been serious contention or bickering between the Board and the director. It is to the credit of both the director and the members of the Board that they have been able to work effectively together

in spite of the curious organizational pattern forced upon them. What it does indicate, however, is that the Board, in its efforts to carry out its responsibilities, has found itself constantly hamstrung by operational restrictions and bureaucratic encumbrances.

It is not strange therefore that the Board has been regarded in some quarters as an ineffective body, nor that it has been charged with neglecting some of its basic duties. No reports have been separately issued by the Board, although until the last few years the Board chairman has contributed statements to the annual report of the director. But the Board's neglect in this respect can be at least partially explained by the fact that it has never been empowered to have a staff of its own, and although the suggestion has been made that it depend for its staff work on the regular Foundation personnel, this has not proved very practical. These people are part of a line organization headed by the director, and work for the Board is regarded by them as temporary additional duty, with a low priority. They have other duties and cannot be expected to serve two masters. Thus on many occasions, the Board's effectiveness has been seriously limited by its inability to get the facts on which it can base the policies it is responsible for.

On other occasions, where the facts are available and a policy has been formulated, the suggestions or directions of the Board have not been implemented. For example, the problem of what percentage of the cost of the research projects supported by the Foundation should be paid by the colleges or universities concerned has long been under discussion. On this question, there has never been, to all appearances, a firm Board policy. Yet the Board did direct that some fraction of the support of these projects should come from the university, and when the matter was discussed in Congress, it was suggested that this fraction be of the order of 5 percent. But this, as one of our congressmen has pointed out, is far too simple, and instead the country's research effort finds itself entangled in provisions which are complex, inequitable, and whose reasons for existence seem to be such a dark secret that they cannot be shared with the universities (*2*).

As mentioned before, the suggestion has been made on a number of occasions that, since the Board's position is so obviously an anomalous one, it might be advisable to simply make it, by legislative action, a purely advisory body. This suggestion has been vigorously resisted, on what appear to me to be very solid grounds. It seems to me that the original purposes of the Board are at least as important today as they were when the Foundation was established. Indeed, the nation's expanding research activity seems today to be more in need of capable direction than ever before. And it seems eminently desirable that this direction should come from the men whose technical competence and rational judgment have fitted them to make the decisions necessary for a sound science policy—men who are intimately familiar with the discovery and application of knowledge and who are willing to contribute a substantial portion of their time to the performance of an important public service.

Indeed it seems to me very likely that, if the National Science Board were to be further stripped of its authority and be made a purely advisory body, it would be impossible to get the same calibre of men to serve on it. As an advisory board, it would lose even the vestige of influence in national affairs that has been left to it. I cannot help but feel that whatever steps are taken by Congress to reorganize the National Science Foundation, they should be taken in the direction of strengthening the Board's role rather than diminishing it. The national policymaking role of the Board should be clarified not only in relation to the Foundation itself, but also in relation to the Office of Science and Technology, the Office of the Special Assistant to the President for Science and Technology, the President's Science Advisory Committee, the Federal Council for Science and Technology, the National Academy of Sciences, and the National Academy of Engineering. All of these groups can play an effective part in a national science program, but they can do so only with well-defined responsibilities and clearly understood assignments.

And there would be real advantages in restoring to the National Science Board some of the authority that, either by default or intent, it has gradually lost. The National Science Board has been made up, over the years, of men who to a large extent are as objective in their judgment and as conscientious in their decision-making as could be found anywhere. Their essential loyalty is not to the Congress, or to the Administration, but to science itself. Moreover, they are appointed by the President, with the consent of the Senate, for 6-year terms, which means that at least six of them span a 4-year presidential term. They are, in short, better qualified to carry out the task that men like Vannevar Bush envisioned for them than almost any other group that could be named. What they need is a clarification of their duties, an assurance of adequate authority, and as much freedom as possible from bureaucratic pressures and entanglements.

The legislation currently being considered for revamping the Foundation is a short step in the right direction; at least, it leans the right way. To some extent it supports the Board's own suggestion that the Board should "establish and be responsible for the policies and programs of the Foundation." At least it states specifically that the Board should "determine policy."

Yet it seems to me that many of the problems of the past could be alleviated if the Board were given a more clear-cut mandate, not only to establish policies but to determine programs as well, and to be made responsible for seeing that the programs really carry out the policies. It is for this reason that the Board by unanimous vote proposed the wording referred to above, wording which in my opinion was intended to mean (i) that the Board should establish the purpose and nature of the various individual programs supported by the Foundation; (ii) that the Board should exercise a continuing general surveillance of the awards made under such programs; (iii) that the Board should be empowered to modify or terminate such programs when in its judgment they no longer appear to serve the national interest adequately; and (iv) that the director bring to the Board those applications for grant or contract funds which raise matters of policy or of the interpretation of policy. In addition, the Board should obviously choose its own chairman, operate its own executive committee, appoint its own functional committees on the basis of practical needs, and be assigned a small staff to aid in necessary research and report-writing.

Yet even if all this were done, the question still arises as to who really runs the Foundation. The matter of administrative discipline is sometimes raised. Should Board members be permitted to raise questions publicly without approval of the Executive Branch, the Bureau of the Budget, or the President's Scientific Adviser? Or if

the Board promulgates a policy which it thinks is in the best interests of the country, should approval be obtained from the Executive Branch before such a policy is announced?

Some Board members object to the constraints of this sort of administrative discipline, and at least in the past have felt that prior approval of this type should not be required. It might be reasoned that the director—who is a presidential appointee, who is on the federal payroll, and who is making a career of federal service—is obviously subject to administrative discipline. But does the same reasoning apply to Board members? In fact, the question of giving testimony before a congressional committee itself has been raised. Must Board members offer only "approved" testimony? If so, this would seem to seriously weaken the Board's voice in terms of the purposes for which it was established. In my opinion, the nation would best be served by making that voice stronger. Unless some provisions are made to really strengthen the National Science Board, we are likely to witness a gradual shift of the control of national science policies and programs from the scientific community to the bureaucracy—with a consequent weakening and distortion of the whole scientific effort.

Reference and Note

1. V. Bush, *Science—The Endless Frontier*, 1945, reprinted by the National Science Foundation, Washington, D.C. (1960).
2. I have commented more fully on this matter in my letter to *Science* 155, 1489 (1967).

The CHAIRMAN. The committee will now stand in adjournment subject to the call of the Chair.

[Whereupon, at 5:30 p.m., the committee adjourned subject to the call of the Chair.]

NOMINATIONS

THURSDAY, OCTOBER 3, 1974

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON THE NATIONAL SCIENCE FOUNDATION, COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 431, Russell Office Building, Hon. Edward M. Kennedy, presiding.

Present: Senator Kennedy.

Senator KENNEDY. The subcommittee will now come to order.

First of all I want to extend a word of congratulations, Dr. Hubbard, for your nomination to the Board.

As you well understand, our subcommittee is a small subcommittee. These hearings are indicative of the continued and increasing interest that the Congress has in working with the National Science Foundation in the development of science policy.

The members are extremely active and interested, and increasingly so, in working with the Board in the development of scientific priorities, in trying also to interact with the Board and in responding to their interest in what Congress is thinking.

I think there has been an increasing beneficial relationship that has been developing over the period of recent years, and it is really in that spirit that we wanted to meet with you here this morning.

First of all, I would appreciate it if you would express your interest in the Board and what you feel to be the areas in which you can make the greatest contribution, and really what you hope to be able to achieve by service on the Board.

At the outset I will make your complete biographical data a part of the record. It is indeed impressive. You have been a distinguished dean of one of the great medical schools, an extremely successful businessman in the private sector, presently president of the Upjohn Co. and one who has been active in community and civic affairs.

A copy of Dr. Hubbard's biographical sketch will be included in the record at this point.

[The information referred to follows:]

CURRICULUM VITAE

William Neill Hubbard, Jr., M.D.

Born: October 15, 1919 in Fairmont, North Carolina

Marital Status: Married Elizabeth Terleski, December 28, 1945

Children:
William N., III
Michael James
Mary Emma
Elizabeth Anne
Susan Ellen

Education:

Premedical: Columbia College, Columbia University, 1937-41 -- A.B.

Medical: University of North Carolina School of Medicine, 1941-43
New York University College of Medicine, 1943-44 -- M.D.

Postgraduate: Bellevue Hospital

Intern, Third Medical Division, 1944
Assistant Resident, Third Medical Division, 1945

Schenectady County Tuberculosis Hospital

Resident, 1946

Bellevue Hospital

Intern, Department of Pathology, 1947
Assistant Resident, Third Medical Division, 1948
Resident, Third Medical Division, 1949

University Appointments:

New York University College of Medicine

Assistant in Medicine, 1949-50
John Wyckoff Fellow in Medicine, 1950-51
Instructor in Medicine, 1950-53
Assistant Professor of Medicine, 1953-59

Assistant Dean, August 1, 1951 to June 30, 1953
Associate Dean, July 1, 1953 to June 30, 1959

University Appointments, cont'd.

University of Michigan

July 1, 1959-June 30, 1964:	Dean of the Medical School and Associate Professor of Internal Medicine
July 1, 1964-June 30, 1969:	Dean of the Medical School and Professor of Internal Medicine
July 1, 1969-March 31, 1970:	Dean of the Medical School, Director of the Medical Center and Professor of Internal Medicine

The Upjohn Company

April 1, 1970 - Sept. 30, 1972:	Vice President & General Manager Pharmaceutical Division
Oct. 1, 1972 - Apr. 16, 1974:	Executive Vice President
Apr. 16, 1974 -	President

Hospital Appointments:

Bellevue Hospital Third Medical Division

Clinical Assistant Visiting Physician, 1950-52
Assistant Visiting Physician, 1952-59

University Hospital of New York University

Assistant Attending Physician in the Department of Medicine, 1952-59

University Hospital of The University of Michigan

Senior Medical Staff in the Department of Internal Medicine, 1959-70

Membership in Societies:

Alpha Kappa Kappa
Alpha Omega Alpha
American Association for the Advancement of Science
American College of Physicians: Fellow
American Medical Association
Association of American Medical Colleges
Harvey Society
Michigan State Medical Society
Member of the Council, 1960-62
New York Academy of Medicine
Phi Kappa Phi
Sigma Xi
Society of Alumni of Bellevue Hospital
Kalamazoo Academy of Medicine
Michigan Academy of Science, Arts, and Letters

United States Government Agency Appointments:

Member of the Study Section, Heart Program Project Committee of the National Institutes of Health, 1960-64
Regent of the National Library of Medicine, 1963-67; 1972 -76
Chairman of the Board of Regents, 1965-67; 1974-75
Member, Ad Hoc Advisory Committee to the Surgeon General on Dental Research Centers, 1964-67
Consultant to the Public Health Service Division of Hospitals and Medical Facilities, 1964-66
Member, Ad Hoc Advisory Committee on National Networks of Data Processing Systems, Office of Science and Technology, 1965
Consultant, National Institute of Dental Research, 1965-66, 1970-
Member, Dental Research Institutes Special Programs Advisory Committee, 1966-69; Chairman, 1968-69
Member, National Advisory Commission on Libraries, 1966-68
Member, Special Medical Advisory Group of the Veterans Administration, 1969-70

Appointments:

Association of American Medical Colleges
Associate Secretary, part-time, 1954-56
Member, Editorial Board, Journal of Medical Education, 1960-65
Member, Executive Council, 1962-68
Vice-Chairman of the Committee for Planning for Medical Progress Through Education, 1964-65
President, 1966-67
Chairman, Federal Health Program Committee, 1966-68
Chairman, AAMC Institute on Medical School Curriculum, 1968
Member, Medical Advisory Committee, The W. K. Kellogg Foundation, 1959-67
Member, Board of Directors, National Society for Medical Research, 1962-64
Member, Board of Directors, National Fund for Medical Education, 1962- (Vice-Pres. 1968)
Member, AMA Task Force on Animal Care, 1962-65
Chairman of the Council and Treasurer, EDUCOM, 1964-66
Member, Board of Trustees, Detroit Annual Conference Retirement Homes of the United Methodist Church, Inc. 1965- ; Board of Health and Welfare, 1968-
Member, Governor's Advisory Council on Heart Disease, Cancer and Stroke, 1965-66
President, Michigan Association for Regional Medical Programs, Inc.; Chairman, Board of Directors; Chairman, Regional Advisory Group, 1966-68; Member, Board of Directors, 1968-69
Member, Committee on Health Manpower, Michigan State Board of Education, 1966-68
Member-at-Large, Board of Directors, National Board of

Appointments, cont'd:

Member, Committee for a Study of the Governance of Medical Schools, Macy Foundation, 1967-69
Member, Advisory Board on Medical Education of the Citizens Committee on Education for Health Care, 1967-69
Member, Committee on Health and Human Values, 1968-70
Member, Executive Panel for the Study on Biomedical Education for the Future, National Academy of Science Board on Medicine, 1968-69; Chairman, Panel on the Relationships of Medical Schools to the Universities and Higher Education, 1968-69
Member, Board of Directors, The Upjohn Company, 1969-
Member, Board of Directors, Greater Detroit Area Hospital Council, Inc., 1969-70
Member, Areawide Health Planning Operating Committee, 1969-70
Member, Advisory Committee of the Inter-Society Commission for Heart Disease Resources, 1969-70
Member, Board of Directors, National Intern and Resident Matching Program, 1969-70
Member, Commission for the Study of Nursing and Nursing Education, 1970-73
Member, Board of Trustees, Bronson Methodist Hospital, 1970-
Chairman Governor's Action Committee on Corrections 1972-
Member, Panel of Educational Consultants to Commission on Education for Health Administration, 1973-
Member, Board of Trustees, Kalamazoo College, 1973-
Member, Board of Directors, National Medical Fellowships, Inc. 1973-
Member, Brown University Committee on Medical Education, 1974-
Member, Board of Directors, First National Financial Corporation 1974-

Awards and Honors:

Distinguished Alumni Service Award, University of North Carolina, March 31, 1962
Sc.D. (Hon.) conferred by Hillsdale College, Hillsdale, Michigan, May 28, 1967
Special Award, Michigan State Medical Society, September 27, 1967; February 24, 1968
Sc.D. (Hon.) conferred by the Albany Medical College, Albany, New York, June 1, 1968

BIBLIOGRAPHY

1. Terramycin in the treatment of pneumococcal pneumonia. (With W. S. Tillett.) Ann. N. Y. Acad. Sci., 1950, 53, 429-432 (Sept. 15).

2. Systemic toxic responses of patients to treatment with streptokinese-dornase. J. Clin. Investigation, 1951, 30, 1171-1174.

3. Research orientation and methods. Contribution to educational objectives of the basic medical sciences. J.A.M.A., 1959, 170, 432-435 (May 23).

4. The university phase of medical education. Scalpel, 1959, 29, No. 3, 4 pp.

5. Medical education at The University of Michigan. Guest editorial. Washtenaw Co. M. Soc. Bull., 1960, 11, No. 6, p. 12.

6. Mental health research in the Medical School. U. M. Med. Bull., 1960, 26, 32-35 (Feb.).

7. The 110th Medical School convocation: introductory remarks. U. M. Med. Bull., 1960, 26, 325-332 (Oct.).

8. The future of geriatrics education. Guest editorial. New Physician, 1961, A-15 to A-16 (July).

9. Medicine and dentistry must someday merge. New Med. Materia, 1962 4, No. 3, p. 40 (Mar.).

10. Changing patterns in medicine: education and practice. U. M. Med. Bull., 1962, 28, 7-13 (Jan.-Feb.).

11. The dean and the hospital administrator. J. Med. Educ., 1962, 37, No. 4, 270-272 (Apr.).

12. The changing role of the physician. Scalpel, 1962, 32, No. 4, 6 pp.

13. New physician. Editorial. J. Mich. State M. Soc., 1963, 62, 201-202.

14. Professional obligation. U. M. Med. Bull., 1963, 29, No. 4, 195-200 (July-Aug.).

15. Problems of discipline in medical schools. Fed. Bull., 1964, 51, No. 11, 341-351 (Nov.).

16. Grants management and the scientific community. U. M. Med. Center J., 1965, 31, 1-3 (Jan.-Feb.).

17. An institution's individuality. Guest editorial. Internat. Med. Digest, 1965, 81, No. 3, p. 89 (Mar.); Internat. Surg. Digest, 1965, 74, No. 3, p. 97 (Mar.).

BIBLIOGRAPHY (p. 2)

18. The Hippocratic oath. Mich. Med., 1965, 64, 247-250 (Apr.).

19. Viewpoint of the scientific community. Pub. Health Rep., 1965, 80, No. 8, 677-680 (Aug.).

20. One hundred years and hence. Mich. Med., 1965, 64, 684-686 (Sept.).

21. The revolution in science and the response of the church. Mich. Med., 1966, 65, 179-182 (Mar.).

22. The educational functions of the university medical center. Universiteit en Hogeschool, 1967, 13, 205-219 (Jan.). (In: Functions of the future university medical center. Proceedings of the Boerhaave Conference, University of Leiden, The Netherlands, December 15-17, 1966).

23. The sequicentennial of The University of Michigan's role in health. Mich. Med., 1967, 66, 163-167 (Feb.).

24. Human biology and medical ethics. U. M. Med. Center J., 1967, 33, 49-53 (Mar.-Apr.).

25. The educational environment in the large medical school. (With Robert B. Howard). J. Med. Educ., 1967, 42, No. 7, 633-641 (July).

26. The Tricentennial. U. M. Med. Center J., 1967, 33, 156-157 (July-Aug.).

27. Continuing Education and revaluation of the physician. Fed. Bull., October, 1967, pp. 318-325.

28. Janus revisited. J. Med. Educ., 1967, 42, No. 12, 1071-1080 (Dec.).

29. A report from the September, 1968 AAMC Workshop on the Medical Curriculum. J. Med. Educ., 1969, 44, No. 1, 58-61 (Jan.).

30. The implications for licensure of changes in medical education. Fed. Bull., 1969, 56, No. 3, 53-64 (Mar.).

31. University of Michigan health team geared for extensive expansion. Mich. Med., 1969, 68, No. 9, 475-476 (May).

32. The health manpower shortage: the physician. U. M. Med. Center J., 1969, 35, No. 2, 98-100 (Apr.-June).

33. Health Knowledge. The Health of Americans, Prentice-Hall, Inc. 1970, 4, 93-120. (Report of the 37th American Assembly, Apr. 23-26, 1970).

BIBLIOGRAPHY (p. 3)

34. Curriculum changes. ACMC Newsletter, June 1970 (Annual Meeting Assn. Canadian Med. Colleges, Oct. 1969).

35. Introduction - the medical school curriculum. J. Med. Educ., 1970 45, No. 11, Part 2, 3-6 (Nov.).

36. Compassion and competence. Honors Convocation Address, The Univ. of Ala. School of Med., Birmingham, Ala. The Alabama Journal of Med. Sciences, July, 1970.

37. Book Review. Financing Medical Education: An Analysis of Alternative Policies and Mechanisms. Rashi Fein and Gerald I. Weber. Jour. Med. Ed. Vol. 46, No. 10, October, 1971.

38. Editorial Comment regarding question of departments of family medicine in Michigan medical schools. Mich. Med., 1972, 71, No. 11, 333 (Apr.).

39. Preclinical Problems of New Drug Developments. Conference on "The Regulation of the Introduction of New Pharmaceuticals" Dec. 4-5, 1972.

MAJOR ADDRESSES

1. "Medical Education -- for What?" Sigma Xi Lecture, Ann Arbor, March 9, 1960.

2. "The Responsiveness of Medical Education to Changes in Medical Practice." Wayne County Medical Society, Detroit, April 4, 1960.

3. "Economic Dilemma of Doctor in Training." Panel: Michigan Clinical Institute, Detroit, March 9, 1961.

4. "Professional Obligation." Commencement address, Fifty-Ninth Annual Commencement, Baylor University College of Medicine, Houston, Texas, May 27, 1961.

5. "Private Medicine." Symposium: Michigan Tuberculosis Association, Kellogg Center, East Lansing, September 20, 1961.

6. "Changing Patterns in Medicine: Education and Practice." Michigan Society of Obstetrics and Gynecology, Grand Rapids, Sept. 27, 1961.

7. "The Dean and the Hospital Administrator." Annual Meeting, The Association of American Medical Colleges, November 12, 1961.

8. "Changing Patterns in Medical Education." Milwaukee Academy of Medicine, January 16, 1962.

9. "The Changing Role of the Physician." Alpha Epsilon Delta Convention, Toledo, April 27, 1962.

10. "The Needs of Medical Education." National Fund for Medical Education, Detroit, November 28, 1962.

11. "New Medical Schools -- Why and Where?" Edward and Susan Lowe Lecture, Butterworth Hospital, Grand Rapids, March 26, 1963.

12. "Influence of the Judaic-Christian Ethic on Western Civilization." Hillel Foundation, Ann Arbor, March 27, 1963.

13. "Educational Values in Medical Writing." American Writers Association, Ann Arbor, May 15, 1963.

14. "Undergraduate Medical Training." Panel: Wisconsin Academy of General Practice, Fifteenth Annual Scientific Assembly, Milwaukee, September 17, 1963.

15. "The Role of Computers in Medical Diagnosis." Also: "Ambulatory Patient Care in the Hospital Setting." Mecklenberg County Academy of General Practice, Charlotte, N.C., October 2, 1963.

MAJOR ADDRESSES (p.2)

16. "Practices and Procedures for Allocation of Work Effort to Federally Supported Research Programs." Lecture at a DRG Sponsored Seminar for PHS Grants Management Staff, Bethesda, Md., December 2, 1963.

17. "The Rise and Fall of the Medical Specialties." First Annual Memorial Lecture in Honor of Dr. Martin B. Taliak, Berea, Ohio December 11, 1963.

18. "Problems of Discipline in Medical Schools." Federation of State Medical Boards of the United States, Chicago, Feb. 11, 1964.

19. "The Evaluation of Education in the Clinical Sciences." National Board of Medical Examiners' Invitational Conference, Philadelphia, March 13, 1964.

20. "Twenty-Five Years Before and After." University of North Carolina, Chapel Hill, March 20, 1964.

21. "Science and Humanism." Phi Beta Kappa address, Ann Arbor, April 23, 1964.

22. "The Future Dependable Archives." American Medical Writers' Association, Ann Arbor, May 13, 1964.

23. "Medical Care -- Where Have We Been, Where Are We Going?" All Class Dinner, The University of Michigan, Ann Arbor, May 21, 1964.

24. "Historical Background of the Hippocratic Oath." Convocation Address, College of Medicine, Ohio State University, Columbus, September 27, 1964.

25. "Grants Management and the Scientific Community." American Public Health Association, New York City, October 7, 1964.

26. "Munich Memorial Lecture." Commencement Address, University of Kentucky College of Medicine, Lexington, May 10, 1965.

27. "Implications of the Coggeshall Report for Surgical Education." American Surgical Society, Boston, July 9, 1965.

28. "The Revolution in Science and the Response of the Church." Michigan Methodist Pastors' School, Albion College, Albion, August 31, 1965.

29. "Medicine in Modern Society." Markle Scholars, Mont Tremblant, Quebec, September 20, 1965.

MAJOR ADDRESSES (p.3)

30. "Health Manpower Needs." White House Conference on Health, Panel Session on Health Education, Washington, D.C., Nov. 3, 1965.

31. "Human Biology and Medical Ethics." Salem College Symposium on Technopolis--Modern Trends in Society, Winston-Salem, N.C., April 21, 1966.

32. "The Medical School and Psychiatry." Midwest Professors of Psychiatry, Ann Arbor, June 17, 1966.

33. "The Educational Environment in the Large Medical School." (With Robert B. Howard). Annual Meeting, Association of American Medical Colleges, San Francisco, October 23, 1966.

34. "The Educational Functions of the University Medical Center." Boerhaave Conference, Leiden, The Netherlands, December 15, 1966.

35. "What is Happening to Man Emotionally and Spiritually?" "What is Wholeness?" Michigan Pastors' Conference, Ann Arbor, January 16 and 17, 1967.

36. "Continuing Education and Revaluation of the Physician." Annual Meeting, Federation of State Medical Boards of the United States, Chicago, February 12, 1967.

37. "Emerging Patterns of Education and Practice in the Health Professions--Medicine." Pharmacy-Medicine-Nursing Conference on Health Education, The University of Michigan, Ann Arbor, February 16, 1967.

38. "Preparing Physicians to Meet Future Needs for Health Care Services." Twentieth National Conference on Rural Health, Charlotte, N.C., March 10, 1967.

39. "Trends in Medical Education." American Psychiatric Association, Detroit, May 10, 1967.

40. "Science and Human Purpose." Commencement Address, Hillsdale College, Hillsdale, May 28, 1967.

41. "Janus Revisited." Presidential Address, Association of American Medical Colleges, New York, October 28, 1967.

42. "Can We Be Equal and Excellent Too?" Tufts Medical School, Boston, January 9, 1968.

43. "Are National Organizations Worth the Effort? American Association of Chairmen of Medical School Departments of Pathology, Chicago, March 1, 1968.

44. "Trends in Medical Education." American Academy of Physical Medicine and Rehabilitation, Chicago, April 26, 1968.

MAJOR ADDRESSES (p.4)

45. "Flexible Bricks--Building for Change." Fourth North American Conference on Campus Planning and Public Building, Urbana, Ill., April 30, 1968.

46. "Medicine and Humanism." Commencement Address, Albany Medical School, Albany, New York, June 1, 1968.

47. "Human Biology and Humanism." Ministers Conference, New York Union Theological Seminary, New York, N. Y., July 8, 1968; "The Human Race and the Individual." Ibid., July 9, 1968; "For the Good of My Patient." Ibid., July 9, 1968; "Should We, If We Can?" Ibid., July 10, 1968.

48. "Impact of Federal Money on Functions of a Medical Center." College of American Pathologists, Government and Academic Sections, Miami, Florida, October 13, 1968.

49. "Basic Minimal Requirements for the Medical Student in Otorhinolaryngology." American Academy of Opthalmology and Otorhinolaryngology, Chicago, October 27, 1968.

50. Dedication Address, Mt. Holyoke College Library, South Hadley, Mass., November 9, 1968.

51. "Dust." Minnesota State Pastors' Conference, St. Paul, Minn., January 21, 1969; "A Little Lower." Ibid., January 22, 1969.

52. "Implications for Licensure of Curriculum Changes in Medical Education." Fourteenth Annual Walter L. Bierring Lecture, Federation of State Medical Boards of the United States, Chicago, February 8, 1969.

53. "What Is Needed and What May Be Consumed." Conference on National Biomedical Education Communication Network, Bethesda, Maryland, February 25, 1969.

54. "Where Do We Go From Here?" Michigan State Medical Society Health Planning Conference, Kalamazoo, April 16, 1969.

55. "Medical Schools--National as Well as Local Resources." Commencement Address, University of North Carolina School of Medicine, Chapel Hill, N.C., April 24, 1969.

56. "Science Basic to What?" Meeting of Program Directors of Graduate Training in Pharmacology, Clinical Pharmacology, Medicinal Chemistry and Toxicology, San Francisco, October 2, 1969.

57. "Curriculum Changes." Annual Meeting of the Association of Canadian Medical Colleges, Toronto, October 22, 1969.

MAJOR ADDRESSES (p.5)

58. "Compassion and Competence." Honors Convocation Address, The University of Michigan, Ann Arbor, March 20, 1970.

59. "Compassion and Competence." Honors Convocation Address, The University of Alabama School of Medicine, Birmingham, Alabama, May 27, 1970.

60. "National Goals in the Education and Training of Physicians." 14th Conference for Foreign Medical Scholars, Case Western Reserve University School of Medicine, Cleveland, Ohio, June 9, 1970.

61. "A Look Into the Crystal Ball -- The Future of the Drug Industry." Advanced Workshop on the Drug Industry, Practising Law Institute, New York City, July 27, 1970.

62. "Paradox of Useful Knowledge." Keynote address 75th Annual Meeting Michigan Academy of Science, Arts and Letters, Kalamazoo, Michigan April 22, 1971.

63. "The Institutionalized Physician." Commencement Address, University of Michigan Medical School, Ann Arbor, June 2, 1972.

Senator KENNEDY. Perhaps you could tell us a little bit about your interest in the Board and what you hope to achieve.

STATEMENT OF WILLIAM N. HUBBARD JR., M.D., TO BE A MEMBER OF THE NATIONAL SCIENCE BOARD, ACCOMPANIED BY CHARLES F. BROWN, GENERAL COUNSEL OF THE NATIONAL SCIENCE FOUNDATION, AND THEODORE W. WIRTHS, DIRECTOR, OFFICE OF GOVERNMENT AND PUBLIC PROGRAMS OF THE NATIONAL SCIENCE FOUNDATION

Dr. HUBBARD. Let me first thank you for this opportunity to be with you. Recognizing your own interest, not only in the National Science Board, but in broad matters of the application of science, I think it is important that we have this opportunity.

My concern is with interfaces, Senator, the interface between the acquisition of knowledge, which is called basic research, and its development in utilizable forms, which is technology; and then the final social requirement that these should be for the public benefit.

The interface between these three realms is one of high tension, as you well know. The problem is whether we can adequately serve each of these without destroying the vitality of the others. In my view, there is no simple choice between the essential values of basic research on the one hand, and the essential ultimate goal of serving public benefit.

There is no natural relationship between the two. There is nothing in basic research as such which necessarily serves the public benefit except that it be in terms of natural philosophy and general increased understanding, and the very broad and indeterminate kinds of benefit that brings.

So we look first for a linkage between basic research and utility. The RANN program of the Foundation is one in which I am very much interested, because it is designed to take basic knowledge and apply it to national needs.

Then there is the question of public benefit. I do not think I have to elaborate on the problems of validating scientific technology and its innovations as being synonomous with public benefit.

There is today, as we all know, a great question as to whether scientific technology, which represents feasibility, does in fact serve the public benefit. That interface is one where I think the Foundation has a very important role of interchange with the Congress and with the executive branch, so that, of all the possible technological advances that might be undertaken, a common choice is made of the ones that will most likely serve the public benefit.

That is a very general background. As to why I think I have anything to contribute, I have had an opportunity to work with each of these areas, starting off with basic science, working in medicine, which is utilization of science for human purpose par excellence, and now working with another kind of institution, but still one whose future depends ultimately on benefiting the public.

I feel that I have had an opportunity to have direct experience in each of these interfaces, and would share that experience within the Board, hopefully advantageously. That remains to be seen.

Senator KENNEDY. You wrote an article in 1965 in Public Health Reports concerning Federal grant management. At that time you were

dean of the medical school and professor of internal medicine at the University of Michigan, and you were commenting at that time about the loyalty of scientists to their own professions.

I believe you indicated that you felt usually those loyalties exceeded loyalty to the Department or to the university.

How should we view now your own view and attitude as you take on a position on the Board? Where do your loyalties lie?

Dr. HUBBARD. With the public interest as I serve the Board. I do not consider myself, Senator, in any way a representative either of the company I work for or the industry as I serve the Board; let me say, however, specifically the pharmaceutical industry.

It does have an unusual opportunity for experience in taking theoretical knowledge and finally developing it into a technology, usually a medicinal one that serves a need. So it practices the communication between these interfaces to which I referred.

In doing so, I think it has an opportunity to share an experience with other groups that are trying in general terms to manage this same adjustment of interfaces.

The comments in 1965 referred more to disciplinary loyalty than to problems of academic commitment.

Senator KENNEDY. Have you given some thought to various applications that may in any way present conflict of interest problems—you might be asked to express your view on a proposal that might, to some extent, be of interest, or consequence, or importance to your company.

Can you tell us a little bit about what your criteria will be in making any decisions, as to whether you would excuse yourself from participation on any grant application?

Dr. HUBBARD. If I could relate at all a possible benefit either to the company, or I say to the industry in my case, then I would absent myself.

I have asked myself about this. The only program that the Foundation has now that is likely to be a frequent event is one of faculty research support where faculty members or graduate students may go to the laboratories of the pharmaceutical companies for thesis work or advanced work in an area that is advantageous to them.

In this case, the grants are made to the companies. I would absent myself from the decision when any company might be involved.

Other than that, the only relationship that I am aware of would be on contracts that might be negotiated between the Foundation and a commercial laboratory. If the Board were to be involved in such an effort, then I would not participate in any matter affecting my company.

Other than this, I am not aware—but, of course, I have not been on the Board——

Senator KENNEDY. Surely.

Dr. HUBBARD [continuing]. Of actions on the Board that would represent potential conflicts.

Senator KENNEDY. What about Upjohn making grants to universities for certain research, and then other grant applications coming before the Board from such universities?

How closely related would those grants or requests have to be before you would feel that you would excuse yourself?

Dr. HUBBARD. Let me take a specific example, if I may. I think this is public information now, or soon will be.

The company has made a significant grant to Brown University to endow a faculty position in clinical pharmacology in its medical school. If a proposal were to come forward from that department involving that individual, I think I would not consider that a conflict of interest because the company has no continuing relationship with it.

On the other hand, I sit as a member of the advisory committee to the medical school at Brown, and I would not participate.

Similarly, when I was at the University of Michigan, the company made a capital gift to build laboratories when I was there, that were named for the company. Once again, since the company has no continuing relationship at all with those laboratories, on that basis I would not see a conflict; but having spent so long a time at the University of Michigan, I think I would not ever feel I could act objectively if that university were concerned.

Senator KENNEDY. Say rather than just a grant program over a period of time that the company was supporting research at a university, and then the requests came in for grants from those universities at the same time that the company was involved in grants or other research programs. Would you see any potential area here for conflict?

Dr. HUBBARD. I think if the company's name were involved, I would simply, as a matter of discretion, not associate myself with it. That is an operational answer.

A direct answer is that probably there would not be a conflict, because the likelihood of a given investigator asking for support for exactly the same piece of work from a company and from somebody else would be remote.

At the same time, it is true almost without exception that an investigator, being supported by a company which has already established its reputation through grant support in a field, that would not be supported exclusively from a company grant.

Senator KENNEDY. How many universities does the Upjohn Co. contract with for any purpose?

Dr. HUBBARD. I do not have the figure, but it would be a large number. It would be perhaps 40 or 50. I do not know, but it would be a large number.

Senator KENNEDY. Those arrangements vary as to dollar volume, from what to what, just generally? You may amend this.

Dr. HUBBARD. Oh, they would range from very small grants of $1,000 or rarely even less to large ones extending over several years that would be in the order of a small number of hundreds of thousands of dollars.

These would all be specific in Federal Government language, they would have the characteristics of contracts, rather than grants, with rare exceptions.

We also make grants, but that is a different thing.

Senator KENNEDY. In the case of institutions which receive substantial grants from Upjohn and grants or contracts for them come before the Board. Given the fact that Upjohn had either a grant or a contract of a sizable amount of money invested in the institution, do you see any potential area of conflict?

Dr. HUBBARD. Not in fact but, again operationally if I may take a specific example, we have a large undertaking with the department of obstetrics both at Harvard and at North Carolina.

Almost all of our large grants are for clinical research, research involving patients. The Foundation does not handle those. So that I guess the problem would not arise.

But let us assume that it does. If it were the department of obstetrics, then I think I should absent myself just as a matter of prudence, but for other components of the medical school at Harvard or North Carolina, I do not think there would be a conflict at all.

Senator KENNEDY. All right. Have you ever known, or do you know now, individuals who have been on the Board, or have you worked with them?

Dr. HUBBARD. Yes. Roger Heyns, who is president of the American Council on Education, is on the Board. He was vice chairman, dean of the arts the year I became dean of the medical school at Ann Arbor, and so we know each other. We are very close.

Dr. Carter, who is chairman, has been a consultant to the Upjohn Co. for many years. Although I do not know him very well, I do have a passing acquaintance with him.

Senator KENNEDY. Just one final area. We have been, as you know, in the Congress, giving a good deal of thought to the issue of generic drugs, and that has been a matter of public policy question that we have been wrestling with—the administration, and our subcommittee on health have different views on this.

I know you have some very definite views about this particular issue. I expect as we move through a public discussion and debate on this issue we will get the Science Foundation involved.

We had the Academy of Science make some recommendations on people to serve on our bioequivalency panel.

However, on any issue that were to come before the Board on that particular matter, how would you feel about that?

Dr. HUBBARD. I think once one has assured himself of clinical equivalence—I must choose my words carefully.

Senator KENNEDY. Everyone chooses his words carefully.

Dr. HUBBARD. Well, I am not sure what bioequivalence is. Since I started out as a clinician, I think I know what equivalence means, if that can be assured, I think the Federal Government must not pay more than the lowest cost that is commonly available.

To put it another way, I do not see any justification for a Government agency to pay a premium for a truly clinically equivalent material simply because it has a manufacturer's copyrighted name on it.

Senator KENNEDY. Would you be willing to estimate what percent of the marketable drugs could be clinically equivalent today?

Dr. HUBBARD. Again the unit of dimension of marketable drugs is not easily come by. If you take it in dollars, it is a relatively small part of the total because the largest dollar component of all prescribed drugs is not generic. The very largest component in all categories is the psycho-active drugs, the so-called tranquilizers; and these dominate the market.

So the dollar impact would not be large now, but it would accumulate as time went on, as patents run out.

Senator KENNEDY. Right. The purpose of this meeting is not to go through this, but perhaps the staff has questions. Mr. Gordon?

Mr. GORDON. The Small Business Committee for many years has

been concerned with the problem of Government patent policy, that is, what happens to the results of research financed by the public.

Our committee started our hearings on the very same day Kefauver started his hearings in 1959. The National Science Foundation testified before our committee that they were giving everything away to private contractors, including such things as knowledge dealing with weather modification.

How do you feel about this problem of using Government funds, public funds, for research?

Dr. HUBBARD. Mr. Gordon, I am not expert in this area, and I would first admit that it is a terribly complex problem.

My greatest familiarity is on the part of universities trying to decide whether they are going to have a proprietary interest in the patents that come out of the work of the faculty. I do not have a simple, direct answer to that one, either.

Let me speak as clearly as I can. I think, first, there should not be a giveaway, that the proprietary right of the taxpayer represented by the Government that has to be recognized. So the direct giveaway is one extreme.

On the other hand, from a practical point of view, the totally nonexclusive patent license given to as many as seek a license although it has an egalitarian tone that is attractive from a practical point of view will discourage any company from making a significant investment in development. So that one then has to seek an accommodation between these two extremes, and I do not have the wisdom to tell you precisely where it should lie.

Let me suggest, however, that when this kind of question arises in industry there is a licensing pattern where royalties are charged. It would seem to me that experience with that path ought at least to be explored.

I will come back to my first statement. I am not expert in this. I do not even know whether it is legal for the Government to charge royalties, but there is also in the commercial world a requirement that a patent be worked to the point of commercial success in a given period of time.

Mr. GORDON. It does not have to be worked. A patent can be secured and sat on to prevent others from using it.

Dr. HUBBARD. In this case the license fails, and there is a penalty. When we have things in our laboratory that we are not going to develop but we think ought to be developed by somebody, we license them but we license them with strings.

We have to have proof that the patent has been worked. We have a time limit on when it will be made effective, a cost of getting into it in the first place, and we have a royalty agreement.

In my ignorance I do not know whether or not this kind of approach should be utilized by the Government, so that it protects the proprietary rights of the taxpayer, but yet confronts the realities of risk in a free enterprise system in developing inventions.

That is not a very useful answer, but it is the best I have.

Senator KENNEDY. Doctor, I am afraid I have to attend a conference at 10 o'clock. There are just a few other areas that I would like

to ask Mr. Strauss to ask you about it. It would be very much appreciated if you could remain and just continue the record.

Dr. HUBBARD. Fine.

Senator KENNEDY. I think it probably would be useful if we had as a part of the record a list of the 40 universities.

Dr. HUBBARD. Senator, I will be glad to give you the list, but do not hold me to the 40.

Senator KENNEDY. Whatever you have.

Dr. HUBBARD. You will want what we would call unrestricted grants, where we ask for nothing in return, which is in the nature of a philanthropic action.

Senator KENNEDY. Yes.

Dr. HUBBARD. Also those that have to do with product development?

Senator KENNEDY. Yes. We would like this for perhaps the last couple of years.

Dr. HUBBARD. Two years.

Senator KENNEDY. That will be all right.

[The information subsequently supplied follows:]

EXHIBIT A

COLLEGES AND UNIVERSITIES RECEIVING DONATIONS FROM THE UPJOHN CO.—1972 THROUGH SEPTEMBER 30, 1974

Capital grants

Calvin College
Creighton University
Ferris State College School of Pharmacy
University of Colorado
Kalamazoo College
Michigan Technological University
University of Iowa—Health Science Library
University of New Mexico
University of Oklahoma School of Medicine
University of Southern California, School of Pharmacy

Special corporate grant program

University of Chicago
University of California, Los Angeles, Center for the Health Sciences
University of Colorado Medical School
Duke University
University of Michigan Medical School

Fellowship program

California Institute of Technology
University of California, Los Angeles
University of California, San Francisco
Cornell University
University of Illinois
Indiana University Medical School
McGill University
University of Michigan
Michigan State University
Pennsylvania State University
Princeton University
University of Puerto Rico
Stanford University
University of Texas, Medical School
Vanderbilt University School of Medicine
University of Virginia
University of Wisconsin

Other grants

Atlanta University
Auburn University
University of California
University of Chicago
University of Colorado
University of Connecticut
Duke University
Emory University
University of Georgia
University of Guelph
Hahnemann Medical College
University of Hawaii
Howard University
Kalamazoo College
MacMurray College
Meharry Medical College

EXHIBIT A—Continued

COLLEGES AND UNIVERSITIES RECEIVING DONATIONS FROM THE UPJOHN CO.—1972 THROUGH SEPTEMBER 30, 1974—Continued

Other grants—Continued

University of Michigan
Michigan State University
University of Minnesota
Morehouse College
Nazareth College
University of Puerto Rico
University of Southern Florida
Stanford University
Temple University
University of Tennessee
University of Texas
Tulane University
Tuskegee Institute
University of Utah
Medical College of Virginia
Wayne State University
Western Michigan University
Yale University

EXHIBIT B

INSTITUTIONS RECEIVING PHARMACEUTICAL RESEARCH AND DEVELOPMENT GRANTS FROM THE UPJOHN CO.—JANUARY 1, 1973–SEPTEMBER 30, 1974

Research Grants

Albany Medical College
College of Pennsylvania
Harvard University
Illinois Institute of Technology
Indiana University
Princeton University
University of California
University of Georgia
University of Illinois
University of Kansas
University of Manitoba
University of Miami
University of Michigan
University of Oregon
University of Texas
University of Wisconsin
Wayne State University
Western Michigan University

Domestic Pharmaceutical-Clinical

Albany Medical Center
Albany Medical College
Albert Einstein College of Medicine
Baylor College
Baylor College of Medicine
Baylor University
Boston University
Boston University School
Bowman-Gray School of Medicine
Brown University
Case Western Reserve University
Case Western University
Charles R. Drew Postgraduate Medical School
College of Georgia
College of Medicine and Dentistry of New Jersey
Colorado Medical Center
Columbia University
Cornell Medical College
Cornell Medical School
Cornell University
Cornell University Medical College
Creighton University
Duke University
Emory University
George Washington University
Georgetown University
Hahnemann Medical College
Harvard Medical School
Harvard University
Houston University
Indiana University
Johns Hopkins University
Kansas University
Kirksville College
Loma Linda University
Louisiana State University
Loyola University
Maine Medical Center
Mayo Clinic
Medical College of Georgia
Medical College of Pennsylvania
Medical College of Virginia
Medical College of Wisconsin
Meharry Medical College
Miami School of Medicine
Michael Reese Hospital
Michigan State University
Mount Sinai Hospital
Mount Sinai School of Medicine
Mount Zion Hospital
New Jersey Medical School
New York Medical College
North Shore University
Northwestern University
Ohio State University
Roswell Park Memorial Institute

EXHIBIT B—Continued

INSTITUTIONS RECEIVING PHARMACEUTICAL RESEARCH AND DEVELOPMENT GRANTS FROM THE UPJOHN CO.—JANUARY 1, 1973–SEPTEMBER 30, 1974—Continued

Domestic Pharmaceutical-Clinical—Continued

Rush Medical School
Rutgers Medical School
Rutgers University
Southwestern Medical School
St. Louis University
Stanford University
State University of New York
Temple University
Texas Technology University
Thomas Jefferson University
Tufts University
Tulane University
UCLA
Union University
University Hospital
University of Alabama
University of Arizona
University of Arkansas
University of Buffalo
University of California
University of Chicago
University of Cincinnati
University of Cleveland
University of Colorado
University of Connecticut
University of Florida
University of Illinois
University of Indiana
University of Iowa
University of Kansas
University of Kentucky
University of Louisiana
University of Louisville
University of Maryland
University of Massachusetts
University of Miami
University of Michigan
University of Minnesota
University of Mississippi
University of Missouri
University of Nebraska
University of New Mexico
University of North Carolina
University of Oklahoma
University of Oregon
University of Pennsylvania
University of Pittsburgh
University of Puerto Rico
University of Rochester
University of South California
University of South Carolina
University of Southern Alabama
University of Southern California
University of Tennessee
University of Texas
University of Utah
University of Vermont
University of Virginia
University of Washington
University of Western Ontario
University of Wisconsin
Vanderbilt University
Virginia Polytechnical Institute
Washington University
Wayne State University
Yale University

Senator KENNEDY. Some of the things Ms. Strauss will ask will concern my interest in what you saw in the past in your dealing with the NSF, some of the weaknesses, some of the strengths. We asked all the other nominees where they think there might be strengths, and we have asked a little about the RANN program.

Dr. HUBBARD. I have had the privilege of reading that transcript.

Ms. STRAUSS. Dr. Hubbard, there was grant activity between Upjohn and the Foundation over the last couple of years. I don't recall the exact amount.

Dr. HUBBARD. I asked that same question this morning, and in the last 2 years there has only been one single transaction for a faculty research award, I only know what I was told this morning.

Mr. BROWN. I believe the period was since 1969.

Ms. STRAUSS. Did you have occasion to deal with the Foundation directly on the grant so that you would have any experience to evaluate Foundation procedures?

Dr. HUBBARD. No.

Ms. STRAUSS. No.

Dr. HUBBARD. No; our research program is responsible for some $46 million a year in expenditures. We have over 150 full time Ph. D.'s at work, and there is a constant flow of academic people through that laboratory. There would be no way for me to know what each one was.

Ms. STRAUSS. So you are not particularly familiar with the grant Upjohn received from the Foundation.

Dr. HUBBARD. No. It would be completely outside my day-to-day work.

The vice president for research possibly could have known. The probability is that this was all done through the director of one of the units within the research establishment, and I would be surprised if the vice president for research were aware of this particular work.

Ms. STRAUSS. One other question.

In the applied research area, as you know, the Senator has asked for a comprehensive investigation now being conducted by the GAO into the RANN program.

Have you had enough dealings with the RANN program to have any kind of feeling as to how it is doing?

Dr. HUBBARD. I have had no contact at all with the RANN programs, save for one research effort using the Delphi technique, where I was one of the correspondents. That is my only direct contact with the RANN program.

Ms. STRAUSS. Have you looked at the areas in which RANN is funding research, and how they meet national needs, how appropriate the areas are, whether the research does address urgent needs?

Dr. HUBBARD. I have observed reports on the activities of the Foundation, but I would not have you think that I am familiar with all of them at this point.

Ms. STRAUSS. Do you think that is an area that the Board ought to be following—how the RANN program sets its priorities, and how they meet what our needs are?

Dr. HUBBARD. I would assume this to be one of the direct responsibilities of the Board; yes.

Ms. STRAUSS. Does anyone else have any other questions?

Dr. MCMURRAY. I attended the hearings, and Senator Williams asked at the hearings whether it would not be helpful to the Board to have its own staff, and there was testimony that at least at present they felt the present staff that worked both for the executive end of the Foundation and the Board had served them well.

In my own experience in government I do believe that. However, I believe it is the feeling of many Senators that they want to most effectively utilize the genius and the ability of the various Board members to their maximum; therefore since the statute does permit the Board to have its own staff, and the question is how would you look at this.

Would you feel it would be an effective means of helping the Board members individually if you had a staff full time for the Board itself?

Dr. HUBBARD. My first response must be that, since I have not been a member of the Board, or participated in any of its actions, it would be very presumptuous of me to express an opinion about how the Board can best operate.

Dr. MCMURRAY But you have had long experience with boards.

Dr. HUBBARD. I have been involved in the problems of boards for a long time, both at the university and more recently in private industry. Ex-Justice Goldberg has made clear, I think, the arguments for separate staffing. I do not have a doctrinaire view of this.

I am certainly sensitive to the fact that staff in an operating organization is usually fully committed to operating requirements, and that the education and support functions of Board members tend to be in addition to their other duties, and not always welcome.

In that context one could say, there is the question of the obligation of the Board to take independent judgment, and the rational argument that there is a biased commitment to what has in fact been done. Therefore the staff takes, in a sense, the same position as the agency, that it has to speak on behalf of the group judgment.

If you can bear with me, on the other hand, the problem is one of timing. I am not sure that the boards that I have been familiar with have even digested what staff presents for it. I do not speak of the Foundation because I am not familiar with it, but of the several other boards of which I am a member. Most board members, you know, do not read what is sent to them.

I do not think that provision of a staff that would address them separately would be likely to help that problem very much. So from a theoretical point of view I find myself very sympathetic to the idea. From a practical point of view, I am not sure what the contribution would be.

There are surely times when the Board needs work done, data collated, research done, and for that work staff has to be made available.

If there is any problem prying people loose from their day-to-day activities, we would have to bring in somebody on an ad hoc basis.

Mr. ANDREWS. Dr. Hubbard, one of the things I think the Senators were interested in at the hearings is making sure that the nominees present then, and you this morning, are aware of the statute, as Dr. McMurray pointed out, which provides that a staff shall be available to the Board.

Dr. HUBBARD. Let me speak in a generality. I think it is essential that the Board secure the staff that it needs. Whether that is done within a presently appointed staff, or by the appointment of additional staff, I do not consider to be a crucial judgment. I do find it important that the Board should have that degree of independence that it could require that adequate staff work in support of it be done.

From reading the transcript, it is my impression that the present Board members feel that has been accomplished with the present organization. If it has, then I think the function has been served, and it would be redundant to appoint people to serve a purpose that has already been served.

Mr. ANDREWS. I think the point that the Senators were interested in was to insure that the Board did know that these resources were available to them.

Dr. HUBBARD. Good.

Mr. ANDREWS. A point I might add parenthetically—perhaps unnecessarily—but I will state this anyway—Senator Javits made a statement in the previous hearing—I suppose there is no reason that you should be aware of it—that the hearing, and this meeting this morn-

ing, were requested and held with the full concurrence of all of the minority members of the full committee, of which Senator Javits is the ranking minority member.

I did want to express that to you.

Dr. HUBBARD. I appreciate it.

Dr. EBBIN. Dr. Hubbard, I'd like to pick up on the point that Dr. McMurray raised. It seems to us that every year during the authorization hearings the management of the Foundation testifies as to how busy the staff of the Foundation is and how heavy the workload that they have to carry is.

Dr. HUBBARD. With the staff's concurrence, I assume.

Dr. EBBIN. Yes, with the staff's concurrence.

That is indeed one factor, because as you will agree, it is very difficult to imagine how a staff can be expected to undertake additional work when it is already taxed to capacity, to 100 percent of its capacity.

But an additional point that needs to be emphasized in these hearings, it seems to me, is that the NSB is not an advisory board. It is the policymaking Board of the Foundation, and as the policymaking Board of the Foundation it would seem sensible that the Board should be afforded an independent capability to deal with the kinds of science policy issues, and the kinds of national issues that transcend the scope of individual grant or individual program managers.

If we show a continuing concern here, it is, for example, with the applied research office and how such matters as national needs are determined, who makes the determination, is that a matter for determination by the program manager or a project manager?

Is that to be the cumulative judgment of several project managers? Is it to be an ad hoc decision, or is it to be made as a national policy judgment, by a body charged with that responsibility? Should the Board indicate to the Rann Management the areas of priority national need, and instruct them to fund projects in those areas?

There is not, for example, any evidence that one could derive from the record of the Rann program that in areas not designated by the Congress, energy development programs, earthquake engineering programs—possibly one or two others—that Rann has targeted their efforts to deal with priority national problems responding to priority national needs.

Perhaps that is a statement rather than a question, but I would appreciate it if you could respond to it.

Mr. BROWN. May I respond?

I understood that this is a hearing on Dr. Hubbard's qualifications for membership on the National Service Board not an investigation of the Rann program. After all, Dr. Hubbard has not been exposed to the program.

Dr. EBBIN. I believe we are trying to get at—Mr. Andrews, Dr. McMurray, and I—at Dr. Hubbard's views about the relationship of the Board in its policymaking function to the staff and we have come to it from a discussion about the staff needs of the Board.

We believe that the staff question relates to the policymaking function of the Board and its independence from operating programs and program managers.

Dr. HUBBARD. My understanding may be simplistic, but, as I understand it, Rann is a part of the operations of the National Science Foundation, and the Board and the Director are that Foundation.

Therefore, I cannot conceive of the Board being without direct responsibility for the policies and operations of Rann, as well as all other parts of the Foundation's activities.

As I say, that is a simplistic response, but it represents my present level of understanding.

Dr. McMurray. I think your point is well taken, Mr. Brown.

All I want to indicate, as a new member of that Board—and I think that the point is very important—it is a governing board, it is not an advisory board.

One of the things that concerns anyone who looks at the operation is to what extent the Board can get involved in overseeing the project directors, and there are 74 of them, and they are making, I suppose, smaller grants.

This is where it seems to me maybe a staff attached to the Board could do some very valuable work in overseeing, and you would get sort of a separate kind of view of the projects and how they are made.

From my own experience at the other end of it, there are some very good project grants that are not made, for I am sure good reason, but it would be interesting to have the Board get a little bit more involved at the lower level.

I am sure they are too busy, since they only meet—every 2 months, is it?

Mr. Brown. Eight or nine times a year.

Dr. McMurray. To get involved in the smaller parts of the operation; and it seems to me it would be helpful to have staff assistance. This is the only point that I would like to make.

You know that Senator Kennedy is the chairman of the Subcommittee on the Science Foundation, and I am sure they will be interested in what happens in this respect.

I can also say this. I myself was one of the people who contributed to the Reorganization Act, which granted professional staffing for the Congress, which some of us are now members of, but I think the Senators, for example, find they have the same problem that the N.S.F. Board members have.

They have such an avalanche of reading to do that the staffs who become familiar with the Senators and their concerns are able to follow through with this and pick out things that are of particular interest to them and highlight them for the Senators, and follow through.

The Senators could never keep up with their reading. I suppose the Senators are concerned to what extent this Board can really most effectively utilize its knowledge and wisdom to see that the policies of the Board are best determined.

Dr. Hubbard. I understand the purpose that you cite, that the Board be informed so that its judgments can be appropriate, and that this is a staff function. I agree with this entirely.

But I am not prepared to commit myself to how this can best be achieved.

Dr. McMurray. We do not want you to.

Dr. Hubbard. In my own checkered history of positions I have gone both ways. I have in some circumstances created a full staff and, for whatever it is worth, in my present position I have studiously avoided

having any staff, so I suppose my views are what you might call eclectic on this matter, or very pragmatic.

I can assure you I am sensitive, but as to the mechanism for achieving it, I am not prepared to assign validity to an administrative device a priori.

Mr. EBBIN. I think the effort was simply to make the point that that was a concern.

Ms. STRAUSS. Dr. McMurray, I wanted to say one thing before we close, to Dr. Hubbard.

This is the point that Senator Kennedy and Senator Williams emphasized at the earlier hearing about keeping in close touch with both the subcommittee and the full committee, and not just on a formal basis.

As these matters come before the Board, and as discussions get going, as to whether you need staff, or on the priority setting mechanism, whenever you feel it might be helpful or useful, either to the Board or to the Senate Members who are involved here on the Hill on a continuing basis with the Foundation, feel free to just pick up the phone and to call and let us know, so we can be helpful whenever we can.

I think Senator Williams was interested in that as well Dr. McMurray.

Dr. HUBBARD. Yes.

Dr. MCMURRAY. As a final word, I would like to say in regard to questions about staff, both Senator Williams and Senator Kennedy—and other Senators who have expressed a similar kind of interest—indicate no lack of confidence in the staff.

Dr. HUBBARD. I appreciate that.

Dr. MCMURRAY. As far as the staff of the National Science Foundation, it is quite to the contrary. I think they have one of the best staffs in Washington.

Ms. STRAUSS. Thank you very much, Dr. Hubbard. The hearing is now adjourned.

Dr. HUBBARD. Thank you.

[Whereupon, at 10:30 a.m., the subcommittee adjourned.]

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