January 13, 14, 1970

(EXECUTIVE SESSIONS)

COMPUTER SCIENCE AND ENGINEERING BOARD

19th Meeting Washington, D. C.

Twin Bridges Marriott January 13, 1970
*Reading Room January 14, 1970

LIST OF ATTENDEES

Attending

Board Members

Anthony G. Oettinger, Chairman

Dr. Launor F. Carter
Prof. Wesley A. Clark
Dr. Sidney Fernbach
Mr. Jerrier A. Haddad
Dr. Johm R. Meyer
Dr. John R. Pierce
Prof. J. Barkley Rosser
Dr. Alan F. Westin
Dr. Ronald Wigington

Consultants

Mr. Joel Cohen
Dr. Bernhard Romberg

Absent

Members

Dr. Walter S. Baer
Prof. David C. Evans
Dr. J. C. Licklider
Mr. William L. Lurie
Prof. William F. Miller
Mr. Kenneth Olsen
Dr. Alan J. Perlis

Consultants

Mr. John Griffith

*Please note that the Day Session is being held in the Reading Room in the Main Building located at 2101 Constitution Avenue, Washington, D. C.

Executive
Session

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

COMPUTER SCIENCE AND ENGINEERING BOARD

AGENDA

Evening Session January 13, 1970

EXECUTIVE SESSION

The Executive Session of the Board meeting will be held on January 13, 1970, at the Twin Bridges Marriott Hotel, Terrace Room, U. S. Highway 1 (14th Street Bridge), Washington, D. C. Dr. James D. Gallagher and a few associates will attend to participate in an informal discussion of current and possible applications of computer systems and associated technologies to the educational progress and problems with which OEO is primarily concerned. The informal discussions are expected to start during refreshments which will be served at 6:30 p.m. and to continue through dinner, which will be served at 7:30 p.m. Professor Anthony G. Oettinger, Chairman, Computer Science & Engineering Board, will speak briefly to set the theme for the evening's discussions.

Day Session

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

COMPUTER SCIENCE AND ENGINEERING BOARD

AGENDA

Day Session January 14, 1970

Reading Room
at
2101 Constitution Avenue

(1) Discussion of Commerce Department's lack of funds to implement the Data Base Panel's recommendations to provide additional services---Dr. Sidney Fernbach.

(2) Review of the status report of the panels of the Board and the draft report summarizing computer science development in the USA and the activities initialed by the Board since its inception---Dr. Bernhard Romberg (deferred from December, 1968 meeting).

(3) Discussion of appropriateness of distributing the annual report to ARPA to other contributors and supporters---The Chairman.

(4) Discussion of IIA's (Information Industry Association) desire to broaden the base and viewpoint of the national commission on copyrights---The Chairman.

(5) Review of the informal discussions with Dr. Gallagher and associates regarding OEO problems and possible computer systems applications---The Chairman.

(6) Status of the Information Systems Panel effort, and the support by the Council of Library Resources---Dr. Ronald Wigington.

(7) Status of the NSF Survey report which is to have been revised in response to Board comments during the December, 1968, meeting---Dr. William Miller.

(8) Status of the Project on Computer Data Banks (deferred from the December, 1968, meeting).

Computer Science & Engineering Board
Day Session
January 14, 1970
AGENDA

(9) Status of the continuing review of the draft report by the National Programs Panel "A"---Drs. Walter Baer, Sidney Fernbach, et al.

(10) Review of the draft of the report of the Summer Conference on Computers and Higher Education---Dr. Alan Perlis.

Administrative Items

General Academy policy in regard to rental of automobiles---Administrative Secretary.

Attaining copy of NRC brochure "Information for Members of Divisions, Committees, Boards and Panels."---Administrative Secretary.

**Note--All back-up papers will be passed out to each member at the meeting on January 14, 1970.

Back Up Papers

January

THE ASSISTANT SECRETARY OF COMMERCE
WASHINGTON, D.C. 20230

DEC 30 RECD 2:30 a

DEC 29 1969

Dr. Anthony G. Oettinger
Chairman, Computer Science and Engineering Board
National Academy of Sciences
2101 Constitution Avenue
Washington, D. C. 20418

Dear Dr. Oettinger:

We appreciate the opportunity to review the informal study results of the Data Base Panel of the Computer Science and Engineering Board of the National Academy of Sciences, and we share with you the concern for adequate statistical identification of activity in the computer science and engineering field.

In this regard, we note with some satisfaction, that we have representatives of the Department of Commerce serving on your Data Base Panel. We regret, however, that at this time funds for the support of any additional activity at the Department of Commerce, as described in your study, are not available within the Domestic and International Business budget. It, of course, remains to be seen whether the 1971 fiscal budget will permit us to support such an endeavor.

Thus, at this time, we can only encourage you to continue your efforts knowing that you have our full interest, moral support, and the cooperation of our present computer and science activities.

Sincerely,

ROBERT McLELLAN
for

K. N. Davis, Jr.
Assistant Secretary for Domestic
and International Business

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ATTACHMENT 1

December 23, 1969

CS&E PANEL & STATUS

Education Panel, Dr. Alan Perlis (Board Project)

Mission -- to devise ways and means for assuring an adequate flow of expert and skilled manpower to meet the emerging requirements in colleges and universities for teaching, for research, and for applications.

Initial concentration is upon the problems connected with staffing the computer departments of the colleges and universities. A Conference on Computers in Colleges and Universities was held this summer. The conference report is due out within the next two or three months.

This Panel's work should contribute significantly to the development of the computer science and engineering field.

Data Base Panel, Dr. Sidney Fernbach (Board Project)

Mission -- to establish the parameters of and the flow of information relating to the CS&E field, to define critical gaps, and to devise ways and means of filling such gaps, and to monitor generally the adequacy and timeliness of the flow and distribution of such information.

Initial efforts of the Panel are concentrated upon working out programs which the government departments can undertake to fill certain critical gaps.

This Panel's work should contribute substantially to the development of the computer science and engineering field.

Export Panel, Dr. Donald Ling (Board Project)

Mission -- to provide continuing support to the Office of Science and Technology, the Department of State, the DoDR&E and other government activities in the computer export area.

Initial concentration has been upon production of a series of technical evaluations of various aspects of the computers in relation to the export problem. A draft report from the Summer Conference inventories the state of our knowledge

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regarding critical aspects of the computer export problem and defines critical gaps in our knowledge. A follow-up program to be undertaken shortly will concentrate upon ways and means of remedying such gaps.

The work of this Panel contributes directly to expanding the frontiers of our understanding of computer science and engineering.

FCC Interconnections Panel, Mr. Lewis S. Billig (FCC Project)

Mission -- to do a technical analysis and evaluation of the difficulties arising from the attachment of various interconnecting devices to the "common carrier voice communication system".

Inasmuch as this problem area is undefined and unexplored, the initial effort is designed to create the essential literature of the field, to define critical technical and systems problems, and to weigh these in light of both the short and the long-term. The effort will culminate in a report to the FCC.

In the sense that computer science and engineering embraces systems dependent upon data exchanges via common carrier facilities, this effort should contribute significantly to our understanding of computer science and engineering.

Information Systems Panel, Dr. Ronald Wigington (Council on Library Resources Project)

Mission -- (1) to assess the potential for application of computer science and engineering principals to meet national needs for efficient and effective information systems of all kinds; (2) to identify the roadblocks to the more effective and rapid employment of computer science and associated technologies to information handling problems; and, (3) to focus national level attention on the need for appropriate actions arising from (1) and (2).

The initial effort by this Panel is to make a study leading to the identification and development of sound computer science and engineering principals for applying computers, computer systems and related technologies to various information handling problems associated with conventional and special libraries.

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The work of the Panel will contribute directly and significantly to expanding the frontiers of our knowledge in the computer science and engineering field.

National Programs Panel "A", Dr. Launor Carter (Board Project)

Mission -- to examine the general state of the computer science and engineering field, viewed from the national level, as one means of exploring what actions might be taken at various levels to benefit the field.

Initial efforts of the Panel concentrated upon the R&D programs related to computer science and upon various activities in being and being promoted which are concerned with regional and national level laboratories, institutes, and other institutional forms. Report is in draft.

The work of this Panel should contribute directly to our understanding of our "institutional forms" and their processes, and how these relate to the computer science and engineering field.

National Programs Panel "B", Mr. Jerrier Haddad (Board Project)

Mission -- to explore the feasibility of devising a "national level program" designed to further the development of the computer science and engineering field, and to define the appropriate role of the U.S. government and the Private Sector in such a program.

The initial approach is to identify and to evaluate the various existing activities which might be considered important elements in such a national program. The outsome of this effort, as well as the form it might take, are uncertain at this point.

If successful, this Panel's work should contribute critically to assuring the needed momenta and directions to the computer science and engineering field.

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Patterns of Industry Support for Computers in Colleges and Universities
Dr. William F. Miller (NSF Project)

Mission -- to explore the feasibility of divining motivations and future attitudes of both donors and recipients which could affect the trends in industrial support of computing activities in U.S. educational institutions.

Initial efforts are concentrated upon selected companies active in the support of computing activities in colleges and universities. Report is in process which indicates that further effort along the lines followed in the initial study would be of limited value.

This report will contribute only marginally, if at all, to the computer science and engineering field.

Privacy Panel, Dr. Alan Westin (Russell Sage Foundation Project)

Mission -- to survey and assess developments in large, computerized data banks and related activities as they affect the privacy of individuals in our society.

The project will run for about 18 months, and will culminate in a comprehensive report. The first task is to survey selected data banks throughout the country.

This effort will contribute significantly to our understanding of various aspects of computers and their associated processes as they affect our society, our institutions, and the individual.

Standards Planning Group (Chairman is being sought)

In the Planning Group stage. No recommendations have been made to the CS&E Board.

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FIRST ANNUAL PROGRESS REPORT

November 1, 1968 - October 31, 1969

COMPUTER SCIENCE AND ENGINEERING BOARD

ARPA Order Number -- 1215/1

Program Code Number -- P9D30

Contractor -- National Academy of Sciences

Effective Date of Contract -- 68 November 01

Expiration Date of Contract -- 71 October 31

Amount of Contract -- $300,000

Contract Number -- DAHC-15-69-C-0198

CS&E Board Chairman -- Professor A. G. Oettinger

NATIONAL ACADEMY OF SCIENCES

Washington, D. C.

December 1969

COMPUTER SCIENCE AND ENGINEERING BOARD MEMBERS

Chairman

Professor Anthony G. Oettinger
Harvard University

Dr. Walter S. Baer
Laird Systems, Inc.

Dr. Launor F. Carter
System Development Corporation

Professor Wesley A. Clark
Washington University

Professor David C. Evans
University of Utah

Dr. Sidney Fernbach
University of California

Mr. Jerrier A. Haddad
IBM Corporation

Dr. J. C. R. Licklider
Project MAC

Mr. William L. Lurie
General Electric Company

Dr. John R. Meyer
National Bureau of Economic Research

Professor W. F. Miller
Stanford University

Mr. Kenneth Olsen
Digital Equipment Corporation

Dr. Alan J. Perlis
Carnegie-Mellon University

Dr. John R. Pierce
Bell Laboratories

Professor J. Barkley Rosser
University of Wisconsin

Dr. Alan F. Westin
Columbia University

Dr. Ronald Wigington
Ohio State University

Mr. Warren C. House
Executive Secretary

Mr. A. R. Lytle
Project Engineer

First Annual Progress Report
Computer Science and Engineering Board

In this first year of operation the Computer Science and Engineering Board has directed its primary effort to trying to view the computer industry and associated technologies within the framework of (a) the deep involvement and penetration of computer technology into government and private sector operations, (b) the complex technology of the industry and associated use areas, (c) the active R.&D. activities within the industry, (d) the effects of the technology on education and educational methods, and (e) the strong position of the U.S. computer technology in world markets. Within this framework the Board has tried to identify (1) roadblocks to progress, (2) areas in positive need of research and/or development or just much more information, (3) guidelines the government or industry should apply in certain areas such as export controls, standards, etc., (4) areas of interlock with other technologies where sociological or other non-technical problems may arise. In this it has been the purpose to try to recognize the problems, difficulties, etc. that are fairly fundamental as differentiated from those that arise primarily from growing pains.

The operating procedure has been for the Board to raise, discuss and evaluate possible study areas. On their acceptance as proper within the above framework, responsibility for their further definition, development and completion was placed in the hands of a panel or committee. All such panels or committees were chaired by a Board member but the remainder were predominantly non-Board members. In some instances it seemed that the subject was of special concern to another agency so separate individual funding was sought. In this way the primary support from A.R.P.A. has

served to catalyze research studies in broader areas and provided greater freedom to the Board in its planning. Thus a list of panels and committees present a succinct index of decisions made by the Board at this early stage concerning areas in which research, development or other efforts would be worthwhile and needed.

The accompanying chart illustrates the extent and sources of supplemental funding -- showing the support and interest in programs by other agencies.

The following is a list of committees and panels that were set up and became active during the first year:

Study	Topic
I	Study of Patterns of Industry Support of Computers in U. S. Educational Institutions
II	Computer Science and Software Engineering Education
III	National Program Panel A
IV	Data Base Panel
V	Computer Export Panel
VI	Study of Privacy and Due Process Issues in Computer Data Banks
VII	Technical Analysis of Selected Factors in the Computer/Communications Interface Field

Computer Science education and the use of computer technology in educational institutions are items of great importance in assuring an adequate supply of personnel trained to exploit the technology to the optimum level. (For example, the Board feels that lack of manpower restricts by up to five times the utilization of computer technology). Thus, the studies under Study I were aimed at learning the status and trend of industrial support of computers in educational institutions.

In the past this has been very helpful to many schools and colleges. Such information could play a strong role in decisions by universities on their future needs and funding requirements and is expected to be especially helpful to National Science Foundation in its planning for funding of university facilities and curricula. The report on this study will be submitted by December 31, 1969.

A second aspect of computer technology as related to educational institutions is the character and quality of computer technology and related education and training provided by schools of higher education. Particular concern was expressed by the Board that an inadequate number of students were being given even a basic training and education in computer technology but more particularly that there was little provision for encouraging education aimed at effective "software engineering."

The approach to this phase was to hold a week-long working conference, Study II, in July 1969 among concerned representatives of Universities, users and operators of computing systems, Administrators, Manufacturers (soft and hardware) and government. Over 40 attended. The discussions delved deeply into the types of graduate and undergraduate programs that are offered versus what are needed for adequate computer science education at all levels for the near and distant future. Goals for curricula were freely discussed. Much data were presented on the rate of production of trained students and faculty as related to the forecast needs for manpower. The report, which should be available by the end of the year, should be of major assistance to government agencies such as National Science Foundation and Advanced Research Projects Agency who are concerned with

academic support in the computer field.

What might be considered as a third phase in the Board's interest in computer technology as it affects the education field also overflows into the general field of major data processing, information retrieval, research and development, and teaching, and has taken the form of - to use the general expression - "Study of Computer Institutes." These institutes combine the various functions and needs of computer technology in various proportions, some serving primarily as management aids with some teaching and R&D, others being primarily intended for process development with little management application. Most of these proposed institutes were closely tied into groups of universities or within government agencies and government assistance in funding would be necessary. As it was envisioned that considerable difficulty may arise in attempts by the government to evaluate these programs on the basis of present knowledge, the National Program Panel A, Study III was requested to survey these proposals and report its recommendations. During the course of this survey oral presentations and brochures concerning five such "institutes" were reviewed by the Panel.

The Panel discussions growing out of these presentations have raised many questions about the need or justification for some of the planned functions of the large enterprises that are envisioned, also concerning the mode and source of funding. On the other hand there is considerable merit in some of the concepts. The Panel believes that its best contribution would be in the form of criteria for such institutes. Such criteria will ferret out the justification of or need for a particular institute

function versus alternative means of accomplishing the purpose and will provide the basis for judging the adequacy and availability of manpower and funding and the type of organization planned for with Institutes. The report also includes a rough compilation and analysis of funding generally available for this purpose.

Throughout its planning studies the Board was continually made more aware of the general inadequacy, in volume, completeness and scope, of data on the industry; how many computers are there, or will there be at some point in the future, how many of what types of personnel are or will be in the industry, to what uses are computers put and by whom? Knowledge about the large, mostly government-agency owned computing activities was abundant although not always accurate or consistent. Knowledge about all other activities is very inadequate. The Data Base Panel Study IV has been trying to fill or determine how to fill these many gaps. A preliminary draft drawn up around data generally available confirmed that there is a real problem - not only in assembling the data but also in evaluating its reliability consistency, completeness and degree of coverage. For instance, estimates of the number of operators vary by 100,000. Many individual data sources have been examined; some of them are quite comprehensive and complete but limited in scope - such as "Computers in the Federal Government" - "Computers in Higher Education" - yet it is felt that the needed industry data is available or would become available if there were a properly designed and used information retrieval system.

The panel recognized many problems such as how to measure computer power - or to define a computer - what is a programmer - analyst - etc., how to identify computer personnel who normally are classified as physicists,

mathematicians - biologists, etc. Several cataloging and indexing systems are being reviewed for their possible value in serving as adequate data source locators. As an aid in evaluating such systems a list of questions has been prepared to which answers could logically be expected from a competent data bank or library; they cover the range from technology of hardware, through equipment and personnel to economic forecasts. The one probable result of this panel's activities will be recommendations for setting up a library or catalogue of library references for adequately serving this data-and-information need in the computer industry. Supplemental recommendations or suggestions for further steps to coordinate industry usage in common areas such as job definitions may also result. It is believed that this panel is operating in an area essential to the orderly development of the industry.

The summer conference of the Computer Export Panel group, to which a number of other experts as well as interested and concerned government officials were invited, was held from July 14 through July 18, 1969. The purposes of this study were: (a) to develop within the Panel a broader and more detailed information base from which to develop support for the government; (b) in particular, to explore important areas hitherto only lightly touched on by the Panel, e.g., economic considerations, implications of technology transfer, etc.; (c) to educate, through their participation in the conference, the sponsoring or interested agencies in the government, i.e., DOD, State and Commerce; (d) to develop a broader community of people knowledgeable about the problem, and available for help and

consultation; (f) to isolate and explore areas which remain imperfectly understood, so that recommendations can be made for further study and research. The work was carried out through five study groups, with however considerable coordination and liaison across interest areas. These groups were: Computing Equipment, Economic Aspects, Military Applications, Computer Technology and Software. Many of the meetings were classified.

The report draft of this study has been revised twice by the Export Panel and has been approved for content by the CS&E Board. The report is now being given final editing and will be given limited distribution because of the restricted character of the subject matter. The Export Panel plans to devote the first meeting after the report is completed to developing a follow-on research and analysis effort built around the deficiencies and priorities defined in the Summer Conference report.

Soon after the Computer Science and Engineering Board was formed and began its study of the computer field, concern was focused on problems that have arisen and the questions that have been posed for the future in respect to the privacy aspects of the large data banks being instituted by local, state and federal governments and private organizations Study VI. These data banks can be classified as either intelligence systems, regulatory systems or statistical systems, but all contain personally identified information and data, and under the present system there is often little control over widespread access. The resultant potential loss of privacy combined with issues of due process and of public accountability is a matter for real concern. The CS&E Board has recognized the magnitude and

significance of the problem and has prepared a broad outline of the studies that should be undertaken to meet or ameliorate the anticipated problems and has recommended action. The Russell Sage Foundation has funded this 26 month project. Thus CS&E Board in its normal advisory capacity has catalyzed an activity which is entering the picture at a favorable time before intensive problems have arisen, but after the techniques have been developed and potential problem areas are recognized. The results of this and possibly subsequent studies should have a profound influence on the reception and regulation of computer activities into everyday lives. The project is, therefore, felt to be of great importance. Public announcement of this project is expected early in 1970, following the constitution of an outside Advisory Panel.

The value of the immediate availability of CS&E Board for consultative and advisory services in the computer field was evidenced in the project, just getting underway, for the Federal Communications Commission Study VII. This arose from a recent controversy regarding implementation of a Federal Communications Commission decision in the common carrier/interconnections area which in turn focused interest in the need for a technical assessment of the various factors affecting the common carrier/interconnections are of public communications. There are short and long term facets to this problem. As a start, a series of conferences is planned to consolidate and define the issues concerning users' requirements and system capabilities in both data and voice areas. It is the plan that thru these studies technical and background information will be developed that will aid

F.C.C., common carriers, users, and equipment manufacturers in solving immediate, very difficult problems and to provide a framework for advanced planning by all interested parties. Any constructive service that can be developed in this field will be of major assistance in the near-future progress of information transmittal. It is noted that this project is funded separately but was able to get off to a good start because of the presence of CS&E Board.

The operations of the several panels is proceeding according to previous plans. No action on the part of the government is needed at this time. The fiscal status of the contract is attached.

ANNEX I

ARPA Contract DAHC-15-69-C-0198

Fiscal Status

A.	Total three year contract Amount currently funded	$300,000 100,000
B.	Estimated expenditures and commitments to date	100,000
C.	Estimated funds required for remainder of current funded period	---
D.	Estimated date of completion of work This is an incrementally funded three year contract. The projected work will be completed by the end of the final contract period.	

Xerox to Ron Wigington
Warren House

Oct 8 1969

DEC 1 RECD 9:00

IIA Wants to Broaden Base, Viewpoint Of National Commission on Copyrights

WASHINGTON, D.C. – The Information Industry Association has recommended that creators of information systems, products, and services be given membership on the proposed National Commission on New Technological Uses of Copyrighted Works.

The recommendation was among several made by the association to the Senate Judiciary Committee for possible changes to the copyright revision bill. As the bill now stands, a 23-member commission headed by the librarian of Congress would be created with two members from the Senate, two from the House, seven from among authors and other copyright owners, seven from among users of copyrighted works, and four from the general public.

The association has proposed a 21-member commission to be appointed by the President. Five members would be named from each of four groups: authors and copyright owners, users of copyrighted works and information, creators of systems and products, and the general public. No restriction on the chairman was recommended.

The association recommended that the librarian of Congress, the registrar of copyrights, the President's science advisor, and the chairman of the Federal Communications Commission be *ex officio* members.

The association also has proposed a different name, the national commission on effects of advanced technologies on works of authorship.

The association also recommended charter changes that would "help focus the charter . . . on the problems and opportunities created by application of these technologies," said William T. Knox, association president.

The recommendations resulted from an association-sponsored meeting in July on "Copyright and Related Protection for Information Age Products."

The purpose of the commission would be to study the impact of computers and other advanced technologies on copyright concepts.

An Invitation

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WARREN: LET'S PUT THESE QUESTIONS ON DEC. AGENDA

Mark II Prices Will Incr

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Tony – is there any action here? Re CSA2 Board & the copyright problem? Re hearing Bill brief the Board on IIA – the proposed commission? Re getting the NYT papers from their July meeting? Re starting a proceedings Advisory Panel for the CSA2 Bd?

Warren

cc: John Bispham

DEC 31 REC'D
2:30
JAN 2 REC'D

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

December 31, 1969

Dr. Fred C. Cole
Council on Library Resources
One Dupont Circle
Washington, D. C. 20036

Dear Dr. Cole:

Thank you very much for your letter of December 19 advising us of the action of the Council in support of the NAS Computer Science and Engineering Board's proposed program.

The conditions as outlined in your letter are agreeable to the Academy, and I am enclosing the executed conditions of grant as you request.

I am asking Mr. House of the CS&E Board staff to keep you fully informed of the status of this project. Mr. B. L. Kropp our Deputy Business Manager will be responsible for the financial aspects of this program.

We look forward to this opportunity of working with the Council on Library Resources in this joint undertaking.

Sincerely yours,

John S. Coleman
Executive Officer

Enclosure

cc: Mr. W. F. House
Mr. B. L. Kropp
Professor A. G. Oettinger

cc Hardcamera
Baker
Griffith 1/2/70
Oettinger

CLR

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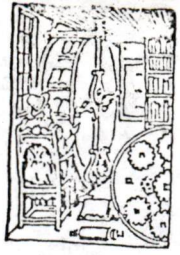

COUNCIL ON LIBRARY RESOURCES
One Dupont Circle • Washington, D.C. • 20036 Tel. 202-296-4757

Office of the President

December 19, 1969

Mr. John S. Coleman
Executive Officer
National Academy of Sciences
2101 Constitution Avenue N.W.
Washington, D.C. 20418

CLR-475

Dear Mr. Coleman:

On Wednesday we had a satisfactory meeting with Professor Oettinger, Mr. House, and Mr. Wigington concerning the NAS Computer Science and Engineering Board's project which will be carried out under a $50,920 grant from this Council over a period of eighteen months.

We agreed that they would notify the Council when they are ready to start and request at that time the initial payment. It is our intention to pay the amount appropriated in five equal installments of $9,000 each, with a sixth and final payment of $5,920 when we are satisfied that the program has been completed. The Council generally makes its payments at the end of March, June, September, and December, upon request accompanied by a progress report covering both substantive and financial matters. Mr. William H. Dodderidge, Treasurer of the Council, will shortly send you forms for use in reporting expenditures. Since we do not yet know the starting date of the NAS project, we shall have to set up the schedule of payments at a later time. Meanwhile, I should appreciate it if you would sign and return to us the enclosed Conditions of Grant.

Twenty-five copies of the final report and any other reports or publications growing out of the project should be furnished us for distribution to our directors and for our records.

We are pleased to be associated with the Academy in this important work.

Sincerely yours,

Fred Cole

Fred C. Cole

cc: Prof. Oettinger
Mr. House
Mr. Kropp

FCC:el
enclosure

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COUNCIL ON LIBRARY RESOURCES, INC.
ONE DUPONT CIRCLE, N.W.
WASHINGTON, D.C. 20036

Telephone 202-296-4757

CLR 475 A Study of Computer Systems Applications & Associated Technologies as They May Relate to the National Library Community

CONDITIONS OF GRANT

All grants made by the Council on Library Resources, Inc., are subject to the following conditions:

1. Expenditure of Grant Funds: A grant is to be used exclusively for the purpose stated in the letter of grant notification. Reallocations or revisions of items in the budget upon which the grant is based must be approved in advance by the Council.

2. Revocation of Grant: A grant may be revoked by the Council at any time, with or without cause.

3. Reversion of Grant Funds: A grantee must return to the Council the unexpended balance of any grant:

a) Not required by the grantee for the purposes of the grant or not expended during the period of the grant.

b) If the grantee at any time ceases to be exempt from Federal income taxation under Section 501(c)(3) of the Internal Revenue Code of 1954 (Section 101(6) of the Internal Revenue Code of 1939 as amended).

In the event a grant is revoked, the Council thereafter has no obligation to make any further payment thereunder, and the grantee shall return to the Council, promptly upon request, the balance of the grant held by the grantee, less any amount necessary to pay or provide for proper and unavoidable commitments already made by the grantee in reliance upon the grant.

4. Reports: The grantee shall furnish the Council with reports of accomplishment under the grant, and reports of expenditures of the grant funds, in accordance with the reporting schedule prescribed in the notification of grant approval.

5. Public Announcement: The Council makes public announcement from time to time of its grant actions, but does not necessarily issue special releases regarding each grant, nor does it ask a grantee to do so. Should a grantee wish to publicize a grant, specific written approval of the nature of the intended publicity must be secured from the Council.

6. Acknowledgment of Support: All reports or publications announcing the results of work supported by a grant from the Council shall acknowledge such support in language approved by the Council.

7. Copyrights or Patents: If patentable discoveries or inventions are made, or if any copyrightable material is produced in the course of work aided by a grant from the Council the grantee shall, in consideration of such grant, refer to the Council for determination of the question whether a patent or copyright shall be sought, in which manner, or what terms, and for what disposition, in order to protect the public interest and in view of the tax-exempt status of the Council.

8. Commitment: Any grant made by the Council is on the understanding that the Council has no obligation to provide additional or any other support to the grantee.

9. Other Terms and Conditions: Each grant is subject to such other terms and conditions as may be required by the Council and set forth in its letter of grant noficiation.

National Academy of Sciences
2101 Constitution Avenue
Washington, D. C. 20418
(Name & Address of Organization)

The above Conditions are Acceptable:

(Signature)
Executive Officer
(Title - Please type)
December 23, 1969
(Date)

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

COMPUTER SCIENCE AND ENGINEERING BOARD
PROJECT ON COMPUTER DATA BANKS
ALAN F. WESTIN, DIRECTOR

PROJECT HEADQUARTERS:
JOSEPH HENRY BUILDING, ROOM 536
2100 PENNSYLVANIA AVENUE, N.W.
PHONE (202) 961-1835

INVITEES TO MEMBERSHIP TO THE NATIONAL ADVISORY PANEL OF THE PROJECT ON COMPUTER DATA BANKS

Ex-Officio Members of Panel*

*1. Professor Anthony G. Oettinger
Chairman, Computer Science and Engineering Board
Aiken Computation Laboratory
Harvard University

*2. Dr. John R. Pierce
Vice Chairman, Computer Science and Engineering Board
Bell Laboratories

3. Dr. Frederick Mosteller
Department of Statistics
Harvard University

4. Dr. Edgar Dunn
Economist
Resources for the Future

5. Mr.Lee Rieser
Director of Personnel Data Bank
Corn Products Co.

6. Mr. George S. Moore
First National City Bank of New York

7. Dr. Robert Weaver
President
Baruch College, City University of New York

8. Dr. John H. Knowles
Physician and Medical Administrator
Massachusetts General Hospital

9. Dr. George A. Miller
Department of Psychology
Rockefeller University

10. Rep. Cornelius E. Gallagher
New Jersey Democrat

11. Mr. Roderick O. Symmes
Director, Data Systems Development, HUD

12. Mr. Arthur Naftalin
Department of Public Affairs
University of Minnesota
Former mayor of Minneapolis, Minnesota

13. Dr. Robert C. Wood
Political Science Department
Massachusetts Institute of Technology
and
Director, Joint Center for Urban Studies
Harvard University

14. Hon. Nathan L. Jacobs
Assocate Justice
New Jersey Supreme Court

15. Professor Arthur R. Miller
University of Michigan Law School

16. Hon. James Farmer
Assistant Secretary, HEW

17. Mr. Ralph Nader
Research Lawyer

18. Mr. Roy Nutt
Vice President
Computer Sciences Corporation

19. Dr. Alain C. Enthoven
Economist
Vice President
Litton Industries

20. Hon. Nicholas DeB. Katzenbach
Vice President
IBM Corporation

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

DEC 3 REC'D

November 26, 1969

MEMORANDUM TO: Heads of Offices

FROM: John P. Gillis
Director of General Services

As you know, it is the general Academy travel policy that rental automobiles are to be used only when more convenient or economical forms of transportation are not available. Whenever rental cars are necessary, you should inform your staff and committee members that the Academy is granted an automatic 20% discount by most of the national car rental agencies, especially Hertz and Avis. Therefore, arrangements of rental cars should be made by using an Academy air travel card to assure that billing includes the discount and is made by the agencies directly to the Academy.

The Avis Corporation will also grant the 20% discount to members of our staff for rental of cars for personal use. Whenever you or any of your staff wish to take advantage of this offer, please request an identification card from this office.

JPG:ss

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

December 23, 1969

MEMORANDUM

TO: Heads of Offices

FROM: John S. Coleman

Enclosed are copies of the 1969 revision of the NRC brochure, "Information for Members of Divisions, Committees, Boards, and Panels." This brochure should be brought to the attention of professional support staff in your units for their own use and also should be distributed to members engaged in committee work for the division.

Additional copies may be obtained from the Office of Information.

Enclosures

John S. Coleman

Olsen

NATIONAL ACADEMY OF SCIENCES

Computer Science and Engineering Board

1/16/70

Dear Ken,

Sorry you could not make the last Board meeting. The attached is in response to some serious concern expressed at the last meeting regarding the time required to produce high quality and customer oriented reports on Board activities. Most of the work will be on items 2&3. If you have any desire to take a whack at rethinking, restructuring and rewriting either of these two, please let me know or just come on down.

Warren

Executive Support Staff, Room 536, Joseph Henry Building
Phone (202) 961-1386

Save for next Meeting

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

January 15, 1970

S P E C I A L B O A R D N O T I C E

Dear Ken,

The Chairman wishes to devote the entire meeting in February to the review, evaluation, customer-orienting, re-drafting and dissemination planning of the following reports:

(1) The Survey of Patterns of Support for Computers and Computation in Universitities (for the NSF)--Dr. William Miller

(2) The National Programs Panel "A" draft report (Board initiated)---Dr. Launor Carter

(3) The draft report of the 1969 Summer Conference on Computers and Higher Education (for the NSF)--Dr. Alan Perlis

The Chairman wishes to establish the following working teams as having primary responsibility for each of the above drafts:

(1) Survey - Dr. William Miller, The Chairman, The Secretary

(2) National Programs Panel "A"--Dr. Walter S. Baer, Dr. Sidney Fernbach, Dr. William Miller, Professor Wesley Clark, Dr. Ronald Wigington

(3) Summer Conference on Computers, etc.,--Dr. Alan Perlis, Dr. John Pierce, Dr. Barkley Rosser, Mr. John Griffith plus all available upon completion of items (1) and (2) above.

The Chairman's plan is to complete the review of the Survey report quickly for delivery to the NSF and then to re-distribute the manpower between the National Programs Panel "A" draft and the Summer Conference on Computers, etc. draft.

The Chairman's desire is to concentrate on (a) sorting out and clearly defining the various reports that the contract/proposal indicate should be provided to the NSF and (b) to revise the initial draft of the Summer Conference report so that it will be ready for review by the Academy. The Chairman may provide additional guidance to the various team members.

Would those listed as team members confirm their attendance. Those not included in the working teams are cordially invited to send written comments or to volunteer for assignment. Please call me or Tony if you have any questions.

Launor

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

January 16, 1970

TO ALL BOARD MEMBERS

Attached are the ~~re~~vised suggested letter of transmittal and conclusions for the National Programs Panel "A" report.

This was done by Drs. Baer, Fernbach and Miller.

Would you please send any comments you may have to them with an information copy to Tony and me.

Warren C. House

JAN 14 RECD
by 9:45

LAIRD
SYSTEMS
INCORPORATED

January 12, 1970

Anthony G. Oettinger
c/o Computer Science and
Engineering Board
National Academy of Science
2100 Constitution Avenue
Washington, D.C.

Dear Tony:

I am sorry that neither Bill Miller nor I will be able to attend the Board meeting this month. During the past two weeks we met in Palo Alto and conferred with Sid Fernbach by phone to discuss the Carter report and to redraft a cover letter from you to Phil Handler.

Our main effort was to rewrite the conclusions which will appear both in the Introduction and in Section VI of the Panel report. While we had some suggestions for changes in the body of the report, on balance we felt that the report could stand as written as long as the conclusions were clearly and positively stated at the front. A copy of our drafting efforts is enclosed.

A redraft of the cover letter also is enclosed, which hopefully includes many of the comments from the last Board meeting. We believe that the Panel report is of sufficient interest and timeliness to warrant its release outside the Academy. In particular, we believe that representatives of the Panel and the Board may want to present the Panel's conclusions to Dr. DuBridge and others in the Executive Office of the President.

I am sure that the suggestion for dissemination outside the Board and our latest redrafting efforts will be discussed thoroughly at this month's Board meeting. I will give you a call later in the week to hear the results.

Sincerely,

Walter S. Baer

1901 BUILDING, CENTURY CITY, LOS ANGELES, CALIFORNIA 90067 — TELEPHONE 213: 277-2900

Dr. Philip Handler
President
National Academy of Science
Washington, D.C.

Dear Dr. Handler:

I am pleased to transmit to you a report by a panel of the Computer Science and Engineering Board on "An Examination of Government Support of Computer Related Research and Development with Particular Reference to Institutes."

The report represents a concensus of the panel and has been reviewed by the Computer Science and Engineering Board. The panel was constituted by the Computer Science and Engineering Board particularly in response to the Board's awareness of a growing number of proposals for the establishment of government supported institutes in the computer field. Several of these proposals were examined in detail. In reviewing them the panel necessarily examined overall support of computer-centered research and computer-related applications.

The panel came to a number of conclusions which are endorsed by the Board and are stated below:

1. The panel concluded that new institutes or special laboratories should be established only when existing institutions and channels of support are inadequate to perform badly needed tasks. The panel does not believe

this to be the case at present for computer-centered research and development. In reaching this conclusion the panel has set down criteria that should be valuable in evaluating requests for new research and development institutes over a wide range of scientific areas.

2. The panel does believe that applications of computing to specific missions (e.g., education, health care, employment) may need increased government support. This support should be recognized as a necessary adjunct to the mission of the agency and is not a substitute for computer-centered research and development.

3. The panel was concerned over the apparent lack of overall federal policy and guidelines for the support of computer-centered research and development. A large fraction of such government sponsored work, and in particular, most large-scale research and advanced development efforts are supported by a single federal agency -- the Advanced Research Projects Agency of the Department of Defense. The panel believes that such concentration of support in one agency is unwise over the long run for both the nation and the field of computer science. On the other hand, it believes strongly that many research activities in computer science require large-scale funding, and that the successful pattern

of support established by ARPA should be continued. The panel recommends that the Federal Government review its policies for the support of computer-centered research and development, with a view towards building comparable programs in other agencies so that a better balance can be maintained.

4. The Panel found it difficult to get precise and satisfactory data on overall support of computer related research and development. This report necessarily presents a first approximation of the external government and non-government funds available for computer related projects.

Besides supporting the above conclusions, the Board would offer these additional comments:

1. The Board believes that the panel has done a very honest and thorough job with the information available to it. The panel has been exceedingly careful not to exaggerate claims for increased funding in computer science. The Board recognizes the potential danger of not shouting as loudly as spokesmen for other fields of science. We, therefore, must state emphatically that the Panel report should not be construed to minimize the very serious effects that decreased funding would have on progress in the field.

2. The Board emphasizes the Panel's conclusion that several mission-oriented agencies, which are consumers of research and talent in the computer area,at present do not support the research and development necessary to advance their own objectives.

3. The Board believes that many important computer-centered research and development projects will be successful only if supported on a relatively large scale. One million-dollar project may accomplish much more than ten projects funded at $100,000 each. The Advanced Research Projects Agency has been the chief source of such large-scale support. The Board considers it likely that, over the next few years,some computer-centered research now funded by ARPA will have to be shifted to other federal agencies whose "style" of research support is quite different. If such transfers take place, preserving the scale of effort in individual projects should be emphasized as well as maintaining the overall level of research support.

The Computer Science and Engineering Board intends to look further into a number of these important issues raised by the panel in the coming months.

Sincerely,

Anthony G. Oettinger

DRAFT CONCLUSIONS

NATIONAL PROGRAMS PANEL A REPORT

These pages would be substituted for the conclusions now summarized on Page 3ff. They would appear also in Section VI along with the original conclusion 6 from the Panel Report.

This report is organized into six major sections, with supporting material in appendices.

The Panel's conclusions are stated in Section VI. Its principal findings are:

1. The highest levels of Government should examine the formal responsibilities for support of computer-related research and development to achieve a clearer delineation of these responsibilities. The Panel believes that the responsibilities and mission of each agency of government should be examined to determine the nature of their need for computer-related research, development and application. Once such an examination has been made, official and unambiguous assignment of responsibilities for

the support of appropriate programs should be made.

2. Having examined a large number of computer-centered research and development problem areas, the Panel believes that most of the important problems are receiving serious attention. Present funding patterns are, in general, appropriate and permit continued progress. However, the panel is concerned over possible cutbacks in research and development support which would seriously impede efforts to solve these problems.

3. At present there is a greater need for new or increased support in the application of computer resources to various specific missions. Proposers of applications should not expect to siphon off money from basic computer science activities. If computer capabilities are to be applied, for example, in the poverty program, in education, in urban development, and other public areas, then it is important that funds from these areas be used to support such new computer-related applications.

4. From time to time it has been proposed that there should be one massive institute to guide much or all of government sponsored work in computer-related research and development. The Panel believes this would be unwise; it believes that pluralistic sources of funding and points of view are desirable. Furthermore, it is essential for each agency having computer-related needs to be directly involved in supporting research and development to meet these needs.

5. New institutes or special laboratories should be established only when existing institutions and patterns of support are inadequate to perform needed tasks. The Panel recommends that agencies requested to fund new computer-related research and development organizations examine such requests in the light of the criteria listed in Section V.

NAS Privileged Information

COMPUTER SCIENCE & ENGINEERING BOARD

20th Meeting — Washington, D. C.

NAS Reading Room — February 18, 1970
NAS Reading Room — February 19, 1970

Mr. Kenneth Olsen

NAS Privileged Information

Staff Note

NATIONAL ACADEMY OF SCIENCES

COMPUTER SCIENCE & ENGINEERING BOARD
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

18 February 1970

20TH MEETING

INFORMAL STAFF NOTE

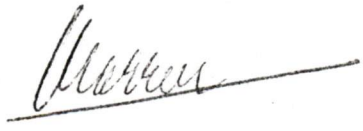
1. Attached are the three reports under review and the Team assignments indicated in the 15 January 1970 Special Board Notice. We will consider these teams to be self-organizing in the finest sense, with only general guidance provided by the Chairman at the outset.

2. Bill Miller will not be able to be present during all of the evening and day sessions. However, his report appears to be well-scrubbed and he is willing to abide by whatever changes the Team decides upon. At NSF's request, I delivered two copies of this report yesterday for internal use.

3. Launor Carter will be unable to attend due to a last-minute company requirement to be on the West Coast. However, the Board has already decided to treat this report as a staff paper delivered to the Chairman and the review and changes should be made with this purpose in mind.

4. We may all end up working on the "conference" report draft by Alan Perlis. One question will be to establish as clearly as possible the context for this report, i.e., the general reporting responsibility of the Board in connection with the Conference and the problems addressed. As soon as this is done, the Chairman plans to get in touch with the appropriate NSF people to explore with them the most useful ways the Board can assist NSF beyond this initial "conference" report.

5. It would be useful to indicate to the Chairman if you cannot be present throughout both evening and day sessions.



NAS PRIVILEGED

NSF

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

January 2, 1970

Informal Staff Note

To: All Board Members

A question arose during the last meeting of the Board regarding just what contractual commitments the Board had made (via the Academy) to produce what kinds of reports for the NSF based upon the Summer Conference on Computer Science Education sponsored by the NSF. This question arose in connection with examining the feasibility of submitting promptly to the NSF a report of the Summer Conference proceedings and preliminary findings without analysis, evaluation or endorsement by the Board. This, in turn, led to some discussion of what additional reports might still be "owed to the NSF."

By way of background, contracts of this sort with the NSF are handled via one-page task orders. The relevant item from the Task Order No. 169 follows:

> "2. Scope of Work: The work under this task order shall be performed in accordance with the Academy's proposal transmitted by letter dated May 1, 1969."

The appropriate pages of the referenced proposal are attached for your information.

Comment--It appears upon a cursory examination that the Board is clearly committed to produce a report outlining the results of a general analysis of computer science education in the U.S. (see Key 1); that this analysis is to contain input-output models relating to the development of programs, the production of trained students and faculty, and the needs of industry and government (see Key 2); and that this report should identify the undergraduate and graduate courses that should properly be considered to be computer science and that these should be evaluated as to their adequacy in relation to computer science needs, both in the immediate future and in the longer-term (see Keys 4 and 5). There is also mention of separate reports for Resource & Function Areas (see Key 6).

In sum, it seems apparent that the Board is committed to turn out a general analytic and evaluative report on the various aspects of computer science and education. At first glance, there seems to be nothing in the agreement that would conflict with the idea that the first phase of the Board's response should be in the form of a report on the conference proceedings, without reflecting necessarily analysis, evaluation or endorsement by the Board of the content and judgments contained in the report.

FOR CS&E BD-STAFF ONLY

NAS PRIVILEGED

Please note that the above deals only with the technical contractual aspects and does not address the quite different aspect of the "appropriateness of such an initial response by the Board." In regards to the latter point, perhaps the conference proceedings could be transmitted informally as an interim draft, with the thought that it was presented for information only, and that it was considered to be grist for the eventual Board report. Also, please note that the consensus of the Board was that Alan Perlis should present a revised draft on the Conference to the Board at the January, 1970, meeting, with options as to how further to proceed to be dealt with by the Board at that time.

Warren

WCH/bla

FOR CS&E BD-STAFF ONLY

NAS PRIVILEGED

February 17, 1969

SUMMER CONFERENCE ON COMPUTER SCIENCE EDUCATION

The objective of the proposed conference is the preparation of a report outlining the results of a general analysis of computer science education in the United States, with particular attention being given to:

1. Graduate Education in Computer Science, and
2. Education in software (and hardware) systems.

Within each of the above areas, detailed analysis will be made of the Resource and Function aspects. By Resource is meant the creation of input-output models relating to the development of programs, production of trained students and faculty, and the needs of industry and government for people so trained. A timetable reflecting the estimated velocity and acceleration rate of these programs will be produced. In accord with the estimated growth rate of these programs, a study will be made of the resources (plant, people and money) required to provide the needed educational development under various response alternatives. Function refers to the undergraduate and graduate courses and programs which should be properly identified as computer science. Also, an evaluation of these programs will be made to provide the basis for determining their adequacy in relation to computer science education needs, both in the immediate future and the longer term. It is not the intent of the meeting to provide detailed curricula, but rather to suggest goals and directions of educational programs.

FOR CS&E BD-STAFF ONLY

NAS PRIVILEGED

The conference is planned to be held from July 21 through July 25, 1969, at the Hilton Hotel in Annapolis, Maryland. A separate report is scheduled for the Resource and the Function areas, and these are then to be combined into one final report. Annex A contains further details on the planned conference proceedings and particular questions to be examined. Annex B is a list of selected professionals who will be invited to participate in the conference. Annex C is an estimated budget for the conference. The cost of producing the copies of record for the National Science Foundation is included in the estimated budget.

(6)

FOR CS&E BD-STAFF ONLY

15 Jan 70 Note

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

January 15, 1970

SPECIAL BOARD NOTICE

Dear

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Would those listed as team members confirm their attendance. Those not included in the working teams are cordially invited to send written comments or to volunteer for assignment. Please call me or Tony if you have any questions.

Miller Report

9.03 Jo

FEB 4 REC'D

February 2, 1970

COPY

Professor Anthony G. Oettinger
Aiken Computation Laboratory
Harvard University
Cambridge, Massachusetts 02138

Dear Tony:

Enclosed is a copy of the revised NSF Survey Panel report. I have also forwarded a copy to Warren House.

Best regards,

W. F. Miller

Encl.

copy to: Warren House (w/encl.)

DRAFT
THE INFORMATION CONTAINED IN THIS DOCUMENT IS IN A PRELIMINARY FORM AND MAY BE SUBJECT TO ERROR, OMISSION OR AMBIGUITY.

Report of NSF Survey Panel

W. F. Miller, Chairman
January 1970

Contents

INTRODUCTION

The Computer Science and Engineering Board was asked to investigate types of support from the computer industry to the colleges and universities in this country.[1] The objective was "to assess the general nature, impact, and trends of industrial support of computers and computer-related activities in educational institutions". It was proposed that the study take place in two phases. The first phase was to be completed in a few months in order to sharpen the questions related to this problem and to determine whether a second phase would be appropriate.

The Board recommended that the panel carrying out the work should try to determine from a limited sample of key officers in computer manufacturing companies, software organizations, and universities what forms of industrial support are now extant and what trends in form and amount might be apparent.

The first phase of the study has been completed and it permits some general qualitative conclusions. A second phase does not appear to be warranted at this time because the general policies of the computer industry are clear from the limited sample.

This study does not attempt to assess anew the needs for or the uses of computers in colleges and universities. There has been a succession of reports[2] which have addressed these problems. They clearly present the need for increasing support to colleges and universities for computer-related teaching and research.

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1. This work was undertaken as part of a proposal to the National Science Foundation.

2. The reports and their principal concerns are:

   (a) The Rosser report, "Digital Computer Needs in Universities and Colleges", Publication No. 1233, National Academy of Sciences, 1967, covered all uses of computing within the universities.

FORMS OF INDUSTRIAL SUPPORT

Industrial support to colleges and universities for computer-related educational and research activities has been given principally in three forms: (1) gifts of or discounts on equipment, (2) grants or contracts for specified activities, and (3) unrestricted gifts.

Until recently the most common form of support from computer manufacturers to educational institutions has been the gift of or discount on purchase (or rental) of equipment. There were a number of reasons why this form of support was a preferred form. The earlier tax law was quite favorable to this form of gift. It was good public relations to have the company's equipment before students. It brought the company into close contact with advanced research and new applications.

A few of the larger computer companies also engaged in giving grants and contracts for specified activities. Policy in this area varied between companies. The grant or contract was usually for the development of software or for the exploitation of computer capabilities in some new area of application.

Unrestricted cash gifts were given by some manufacturers. This form of gift was most advantageous to the receiving institution, but offered the least immediate advantage to the manufacturer making the gift.

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2. (cont'd)

(b) The Pierce report, "Computers in Higher Education", Report of the President's Science Advisory Committee, The White House, Washington, D. C., February 1967, considered principally the use of computers in teaching.

(c) The COSRIMS report, National Academy of Sciences, 1968, addressed the needs for support of research in the mathematical sciences. This report made a special appeal for increased support in the area of research and graduate education in computer science.

TRENDS IN INDUSTRIAL SUPPORT

As a general conclusion we see clear trends toward decreasing at least one form of industrial support (discount on equipment) and we see little inclination toward increasing other forms.

It is clear that support in the form of gifts or discounts on equipment will decrease dramatically in the next few years. This shift arises from changes in corporate attitudes toward gifts to educational institutions, from government auditing rules, and will be strongly influenced by the new tax law. Dr. E. Piore,[3] Vice President and Chief Scientist of IBM, has indicated that IBM is tending toward the unrestricted gift as a form of support for colleges and universities. Mr. James G. Miles,[4] Vice President of Control Data Corporation, has indicated that CDC has eliminated the discount on equipment as a form of educational support.

Computer manufacturers continue to give some support in the form of grants or contracts for specific research programs. Although quantitative data was not made available to the panel, the officers of several computer companies indicated that the total amounts of support in this form was not large.

One company, IBM, has made a clear statement of a trend toward unrestricted gifts to colleges and universities. All other companies contacted (CDC, XDS, DEC) indicated that they have no policy in this area and that they contribute very little in this form. It is not clear whether or not the shift in form of support by IBM will influence other companies toward this form of support. There seems to be little or no evidence that the amount of support in the form of unrestricted grants is likely to equal the amount of support in the form of discounts on equipment.

---

3. Private Communication.

4. Private Communication.

DISCUSSION

Corporate Giving

Corporate giving for education is a relatively recent phenomenon. Corporations, as such, have contributed relatively little to educational institutions before 1950.[5] Pre-1950 support was principally in the form of scholarships and fellowships to students and a limited amount of research of direct special interest to the contributing corporation.

Prior to 1953 the legality of corporate giving was held in question. The case of A. P. Smith Manufacturing Company versus Barlow et al. (1953) established the constitutionality of legislation permitting corporations to make charitable contributions. By 1967 all but three states had adopted legislation that established statutory authority for corporate contributions to charity.

The first year of record by the National Industrial Conference Board for Corporate Support for Education is 1949. Since that time support for education has been increasing steadily, but the bulk of support is still limited to a handful of the largest corporations.[6] Since 1949 we have seen substantial changes in the method of corporate management. These changes toward planning, decentralization of line authority, and delegated responsibility have had an impact on corporate giving to education. They have frequently resulted in the establishment of an office responsible for setting company policy and the coordination of corporate giving to education. These changes have been seen principally in the larger corporations.

---

5. Kenneth G. Patrick and Richard Eels, Education and the Business Dollar, The MacMillan Company (1969), p. 4.

6. Ibid, p. 8.

This short history of corporate giving and the particularly brief history of the computer industry leaves one with little basis for extrapolation into the future.

Discounts on Equipment

One form of support to colleges and universities that has been prevalent until recently has been the discount (or educational allowance) for computing equipment. The usual form of such support has been a discount by the manufacturer for either the purchase or the rental of equipment, or the gift of a particular item of equipment. There were modest restrictions by the donors on the utilization of the equipment so acquired. For example, before 1962 the IBM educational allowance agreement prohibited the use of the discounted machine for "sponsored research". Sponsored research here referred to work done by faculty and/or students on a federal government contract or grant. In 1962 IBM changed the nature of this restriction to prohibit only classified research or research not done as a part of the academic mission of the university or college. A second restriction imposed was that if the equipment is resold within a five-year interval after purchase, the educational institution must rebate to the manufacturer a pro-rated amount of the discount.

In the late 1950's and early 1960's the educational discount played a significant role in helping establish teaching programs. There is little doubt that the colleges and universities who first introduced large teaching programs in computing would not have been able to support their educational courses on such an extensive scale without the educational discount.

The amount of discount made available to the colleges and universities has been decreasing over the last several years. In the mid-1950's the established IBM discount was 60 percent; that is, the college or university would pay 40 percent of the listed price of the equipment. This discount

would apply either to the purchase of equipment and subsequently to the equipment maintenance contract, or to the rental (including maintenance). In the case of the rental contracts it was common for the university or college to pay 40 percent of the first shift rental and be permitted to utilize the equipment on as many other shifts as possible with no additional charge. Discounts have been decreasing in percentage of sale or rental price. Currently IBM offers a maximum of 10 percent educational allowance on new products and the Control Data Corporation discontinued giving an educational allowance. Other smaller computer manufacturers such as Xerox Data Systems and Digital Equipment Corporation make limited use of the educational allowance.

Three events have contributed to changes in the use of the educational discount. These are the Carnegie decision, the anti-trust suit against IBM, and the new tax law.

Before the so-called Carnegie decision[7] the colleges and universities were able to treat the educational discount as a gift and utilize the contribution for support of their educational and unsponsored research programs. Government audit rules eventually disallowed this practice and made it necessary to pro-rate the benefit of the discount to all users including those supported by government sponsored research contracts. This ruling, in turn, had the effect of decreasing the contribution to the teaching program.

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7. Carnegie Institute of Technology (1964) ASBCA No. 4299, 1964 BCA ¶ 4026. Credits against computer rental - A non-profit institution contractor using an IBM 650 computer for sponsored research could not include the full rental for the computer as a research cost under a cost-reimbursement contract since it was allowed a 60-percent deduction in rental payments for a so-called educational contribution regardless of whether or not the prerequisite to the taking of the deduction was fulfilled.

In the anti-trust suit of the U. S. Government against IBM Corporation[8] the IBM Corporation is charged with the utilization of the ecuational discount as a means of effecting a monopolistic position. It seems clear that the recommendation will be to enjoin IBM to cease and desist the offering of the educational discount. This action will certainly encourage IBM in the direction of the elimination of the educational discount whether or not the Justice Department suit is successful.

The new tax law has more restrictions on charitable contributions than formerly. The gift of use (rental) of equipment is now not deductible. Neither can one deduct as a charitable contribution a gift of less than the full price of the equipment.

Grants and Research

As pointed out in letters from Miles of Control Data Corporation, Spinrad of Xerox Data Systems, and Olsen from Digital Equipment Corporation, these companies give support in areas of specific interest to their companies. The support is often in the form of equipment but may also be in the form of a grant that includes the support of personnel as well as the use of equipment. The consequences of these policies is that graduate research in the universities should not look to the computer manufacturers for research support. These policies also leave unsupported an important area of activity outlined in the report of the President's Science Advisory Committee, "Computers in Higher Education",[9] which called attention to a

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8. Civil Action No. 69 CIV. 200, U. S. District Court for the Southern District of New York, Filed: January 17, 1969. See COMPLAINT § 20(d) and PRAYER § 4. Appendix VI, p. 9 and p. 11.

9. "Computers in Higher Education", Report of the President's Science Advisory Committee, The White House, Washington, D. C., February 1967, frequently called the Pierce Report after the panel chairman.

substantial need in the area of teaching both undergraduates and graduates in the use of computers as well as in the subjects necessary to contribute to the development of computers.

THE ROLE OF INDUSTRY AND THE GOVERNMENT

We believe at this time one must conclude that the computer industry is still searching for its role in support of colleges and universities in computer research and education. The larger companies are taking a global view and are considering their role in support of educational institutions quite far beyond computing. The smaller emerging companies are taking a very short-range view of their immediate self-interest, and have not yet developed a long-range policy and attitude toward research and toward support of colleges and universities. A great deal of work must be done by colleges and universities as well as industry in developing understanding as to what are the needs of the universities and how industry can best help them and at the same time serve their own self-interest.

Carter Report

Mr. House
P-M ©

NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

January 16, 1970

TO ALL BOARD MEMBERS

Attached are the revised suggested letter of transmittal and conclusions for the National Programs Panel "A" report.

This was done by Drs. Baer, Fernbach and Miller.

Would you please send any comments you may have to them with an information copy to Tony and me.

Warren C. House

W Gingham

JAN 14 REC'D
by 9:45

LAIRD
SYSTEMS
INCORPORATED

January 12, 1970

Anthony G. Oettinger
c/o Computer Science and
Engineering Board
National Academy of Science
2100 Constitution Avenue
Washington, D.C.

Dear Tony:

I am sorry that neither Bill Miller nor I will be able to attend the Board meeting this month. During the past two weeks we met in Palo Alto and conferred with Sid Fernbach by phone to discuss the Carter report and to redraft a cover letter from you to Phil Handler.

Our main effort was to rewrite the conclusions which will appear both in the Introduction and in Section VI of the Panel report. While we had some suggestions for changes in the body of the report, on balance we felt that the report could stand as written as long as the conclusions were clearly and positively stated at the front. A copy of our drafting efforts is enclosed.

A redraft of the cover letter also is enclosed, which hopefully includes many of the comments from the last Board meeting. We believe that the Panel report is of sufficient interest and timeliness to warrant its release outside the Academy. In particular, we believe that representatives of the Panel and the Board may want to present the Panel's conclusions to Dr. DuBridge and others in the Executive Office of the President.

I am sure that the suggestion for dissemination outside the Board and our latest redrafting efforts will be discussed thoroughly at this month's Board meeting. I will give you a call later in the week to hear the results.

Sincerely,

Walter S. Baer

1901 BUILDING, CENTURY CITY, LOS ANGELES, CALIFORNIA 90067 — TELEPHONE 213: 277-2900

Dr. Philip Handler
President
National Academy of Science
Washington, D.C.

Dear Dr. Handler:

I am pleased to transmit to you a report by a panel of the Computer Science and Engineering Board on "An Examination of Government Support of Computer Related Research and Development with Particular Reference to Institutes."

The report represents a concensus of the panel and has been reviewed by the Computer Science and Engineering Board. The panel was constituted by the Computer Science and Engineering Board particularly in response to the Board's awareness of a growing number of proposals for the establishment of government supported institutes in the computer field. Several of these proposals were examined in detail. In reviewing them the panel necessarily examined overall support of computer-centered research and computer-related applications.

The panel came to a number of conclusions which are endorsed by the Board and are stated below:

1. The panel concluded that new institutes or special laboratories should be established only when existing institutions and channels of support are inadequate to perform badly needed tasks. The panel does not believe

this to be the case at present for computer-centered research and development. ~~In reaching this conclusion~~ In working on this problem the panel has set down criteria that should be valuable in evaluating requests for new research and development institutes over a wide range of scientific areas.

Is it really that serious? Should we explore an expert view on this matter without invitation?

2. The panel does believe that applications of computing to specific missions (e.g., education, health care, employment) may need increased government support. This support should be recognized as a necessary ~~adjunct to~~ part of the mission of the agency and is not a substitute for computer-centered research and development.

3. The panel was concerned over the apparent lack of overall federal policy and guidelines for the support of computer-centered research and development. A large fraction of such government sponsored work, and in particular, most large-scale research and advanced development efforts are now supported by a single federal agency -- the Advanced Research Projects Agency of the Department of Defense. The panel believes that such concentration of support in one agency is unwise over the long run for both the nation and the field of computer science. On the other hand, it believes strongly that many research activities in computer science require large-scale funding, and that the successful pattern

of support established by ARPA should be continued. The panel recommends that the Federal Government review its policies for the support of computer-centered research and development, with a view towards building comparable programs in other agencies so that ~~a better balance~~ stability of prog. can be maintained.

4. The Panel found it difficult to get precise and satisfactory data on overall support of computer related research and development. This report necessarily presents a first approximation of the external government and non-government funds available for computer related projects.

Besides supporting the above conclusions, the Board would offer these additional comments:

1. The Board believes that the panel has done a very honest and thorough job with the information available to it. The panel has been exceedingly careful not to exaggerate claims for increased funding in computer science. The Board recognizes the potential danger of not shouting as loudly as spokesmen for other fields of science. We, therefore, must state emphatically that the Panel report should not be misunderstood so as to cause ~~construed to minimize~~ the very serious effects that decreased funding would have on progress in the field.

2. The Board emphasizes the Panel's conclusion that several mission-oriented agencies, which are consumers of research and talent in the computer area, at present do not support the research and development necessary to advance their own objectives.

3. The Board believes that many important computer-centered research and development projects will be successful only if supported on a relatively large scale. One million-dollar project may accomplish much more than ten projects funded at $100,000 each. The Advanced Research Projects Agency has been the chief source of such large-scale support. The Board considers it likely that, over the next few years, some computer-centered research now funded by ARPA will have to be shifted to other federal agencies whose "style" of research support is quite different. If such transfers take place, preserving the scale of effort in individual projects should be emphasized as well as maintaining the overall level of research support.

The Computer Science and Engineering Board intends to look further into a number of these important issues raised by the panel in the coming months.

Sincerely,

DRAFT CONCLUSIONS

NATIONAL PROGRAMS PANEL A REPORT

These pages would be substituted for the conclusions now summarized on Page 3ff. They would appear also in Section VI along with the original conclusion 6 from the Panel Report.

This report is organized into six major sections, with supporting material in appendices.

The Panel's conclusions are stated in Section VI. Its principal findings are:

1. The highest levels of Government should examine the formal responsibilities for support of computer-related research and development to achieve a clearer delineation of these responsibilities. The Panel believes that the responsibilities and mission of each agency of government should be examined to determine the nature of their need for computer-related research, development and application. Once such an examination has been made, official and unambiguous assignment of responsibilities for

the support of appropriate programs should be made.

2. Having examined a large number of computer-centered research and development problem areas, the Panel believes that most of the important problems are receiving serious and significant attention. Present funding patterns are, in general, appropriate and permit continued progress. However, the panel is concerned ~~over~~ that possible cutbacks in research and development support ~~which~~ would seriously impede efforts to solve these problems.

3. At present there is a greater need for new or increased support in the application of computer resources to various specific missions. Proposers of applications should not expect to siphon off money from basic computer science activities. If computer capabilities are to be applied, for example, in the poverty program, in education, in urban development, and other public areas, then it is important that funds from these areas be used to support such new computer-related applications.

4. From time to time it has been proposed that there should be one massive institute to guide much or all of government sponsored work in computer-related research and development. The Panel believes this would be unwise; it believes that pluralistic sources of funding and points of view are desirable. Furthermore, it is essential for each agency having computer-related needs to be directly involved in supporting research and development to meet these needs.

5. New institutes or special laboratories should be established only when existing institutions and patterns of support are inadequate to perform needed tasks. The Panel recommends that agencies requested to fund new computer-related research and development organizations examine such requests in the light of the criteria listed in Section V.

Perlis Report

TABLE OF CONTENTS

INTRODUCTION

A conference to study computer science education in the United States was held July 21 through 25, 1969 at the Hilton Hotel in Annapolis, Maryland. The conference was sponsored by the National Academy of Science Computer Science and Engineering Board under a grant from the National Science Foundation.

The Computer Science and Engineering Board has been formed to provide a focus for those aspects of the computer field that are important to science in general and the federal government. Attached is a document that describes the purposes of the Board.

The conference was organized to make maximum use of the participant's capabilities in the time available. It is planned to hold all day meetings during the entire week and to focus our attention on two specific topics:

1. Graduate education in computer science
2. Education in software (and hardware) systems

The conference discussions and conclusions may broaden considerably beyond these two areas; nevertheless they seem reasonable for initiating and focusing discussion. With each of these issures there will be two major technical concerns:

B) Content: A thorough study should be made of the content of the undergraduate and graduate programs to be labeled as computer science. Furthermore, an audit of existing programs should be made to gauge what distances exist between what is being done and what should be done. Furthermore the subject of content and standardization should be treated. Similar treatment should be accorded to education in software (and hardware) systems.

It is planned to organize the meeting as a sequence of open plenary sessions with the entire group meeting to discuss the partial results obtained in one of the above areas; and in working sessions divided into working technical groups. A tentative schedule for the two major work groups (Content -- Working Group A and Resources -- Working Group B) follows:

Morning		Afternoon
	Monday	
Introduction		Work
	Tuesday	
Work		Work
	Wednesday	
Report A → B		Report B → A
	Thursday	
Work		Draft
	Friday	
Final Reading		

There are a large number of questions that the conference should attempt to answer. Amont them are:

- Of the reasonably large number of graduate departments of computer science now existing, are these programs producing in kind and in number the graduates that are needed?
- Are there needs, insofar as computer science is concerned, which these programs are not meeting?
- Are these programs separating the mathematical from the engineering too much?
- What alternatives to this mode of educational development can be proposed?
- Does there exist a natural education sequence in the field of computer science like that, e.g., in another mathematical science? Thus, how does one characterize education in computer science through the range of junior college, B.S., B.A., M.S., M.A., Ph.D., and professional degree?

- Does there exist a natural education sequence in the field of computer science like that, e.g., in another mathematical science? Thus, how does one characterize education in computer science through the range of junior college, B.S., B.A., M.S., M.A., Ph.D., and professional degree?
- In the field of computer science what are the goals of the various degrees?
- Is the education program best organized so that students from the lower degree programs provide the major source of the students in the advanced degree programs?
- Will computer science departments become as introverted as has happened, for example, in mathematics?
- How do the programs now in operation compare with those outlined by the study groups such as the ACM Curriculum Committee and COSINE?
- Are the professional societies the appropriate groups to recommend or set curricula? What orderly alternatives are there?
- Are there large problems in software production and use that are largely caused by the lack of well trained software specialists?
- If there are such large problems, should they be solved within a formal education system by educating specialists at various degree levels?
- Or can this matter be best solved by those now responsible for the production of software using on-the-job training?
- Thus, can hardware manufacturers be depended upon to supply the software systems that are needed and also train the personnel to produce and service them?
- Would not software education in a university environment produce technological derelicts since the software problem seems to change so rapidly?
- Put another way, won't the very nature of software make the solutions to these problems be solved by meta software produced by a very small number of specialists?
- If one speaks of software engineering, then why not let the engineering schools and disciplines define and develop the programs?
- Is it possible to meaningfully separate the software problem from the hardware problem?
- How can national institutes of computer science, several of which are now being proposed, contribute to education in computer science?

Other questions will arise during the course of the discussions, but certainly the goal of the conference should be to focus not only on the nature of the problem but to prepare recommended solutions. Naturally, any additional questions that you feel should be discussed will be considered. We would appreciate any feeling you may have concerning the priorities of the various topics which have been raised.

Though it is not required for participation, the attendees would be pleased to receive from you any written comments that you might care to make prior to the meeting. While formal papers are not being asked for, careful organization of your thoughts on these or other related matters would be appreciated. If a working paper can be provided by June 22nd copies will be made available to all the participants to study before the meeting commences. These working papers will undoubtedly provide a strong basis for discussion during the conference.

It is hoped that this conference will provide a reference for the field of computer science -- at least in the two major areas -- that will be a natural first source for information about the field. The conference will be attempting to obtain in one week what the more established sciences have developed over many years -- an overview of the present state, logistics, and future directions of the field. Naturally it could not hope to be complete, but it will provide a first overview of the field that up to now has not existed.

During the conference, duplication and secretarial facilities will be provided for quick preparation of additional working papers and intermediate reports. The goal of the conference will be the preparation of a report outlining the results of the conference. Toward that end, in each of the two areas (resources and content), a chairman and two younger recording secretaries will have the responsibility of preparing the draft of each section, and these two reports will then be coordinated into a final report.

You may be familiar with a report of the National Academy of Science entitled "The Mathematical Sciences: A Report (NAS publication 1681:1968, xiv + 256 pages, paper, $6.00). This report, and preceding reports by the Pierce Committee and the Rosser Committee are the sole widely based surveys conducted under federal auspices on computer science education. It is hoped that the report of this conference will provide a major technical expansion of the requiements and goals of computer science education.

Please let me know as soon as possible, and in no case later than June 9th, if you will participate in this conference. Upon receipt of your willingness to participate in the conference you will be receiving a set of preliminary documents on or about June 15th. These documents will include the full list of attendees, copies of the above mentioned report of the National Academy and the Pierce Committee, a report of the ACM Curriculum Committee, and working papers as they become available. A partial list of attendees and the groups to which we have tentatively assigned them is attached. I would appreciate additional names of people whose presence would materially improve the conference.

Sincerely yours,

Alan J. Perlis (dg)

Dr. Alan J. Perlis, Head
Department of Computer Science
Carnegie-Mellon University

AJP:dg
enc.

LIST OF ATTENDEES

Prof. Richard Andree
Dept. of Mathematics
University of Oklahoma
Norman, Oklahoma 73069

Dr. Bruce W. Arden
Associate Director
Computing Center
University of Michigan
Ann Arbor, Michigan

Dr. C. L. Coates
Electronics Research Center
University of Texas at Austin
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B. H. Colvin
Head, Mathematics Research Laboratory
Boeing Scientific Research Laboratories
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Seattle, Washington 98124

Dr. Ruth Davis
National Institutes for Health
National Library of Medicine
Bethesda, Md.

Dr. George and Alexandra Forsythe
Computer Science Department
Stanford University
Stanford, California 94305

Dr. John Giese
Chief, Applied Mathematics Division
Department of the Army
U.S. Army Ballistic Research Laboratories
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Mr. Bruce Gilchrist
Executive Director
American Federation of Information Processing Societies
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Montvale, N.J. 07645

Prof. J. W. Graham
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Professor John W. Tukey
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Dr. John Carr, III
Moore School of Engineering
Department of Computer Science
University of Pennsylvania
Philadelphia, Pennsylvania

Professor Juris Hartmanis
Department of Computer Science
Cornell University
Ithaca, New York

Professor E. J. McCluskey
Electronics Department
Stanford University
Stanford, California 94305

Mr. Robert Morris
Bell Telephone Laboratories, Inc.
Room 2C-524
Mountain Avenue
Murray Hill, New Jersey 07974

Mr. James Rowe
Union Carbide
270 Park Avenue (41st floor)
New York, New York

Dr. T. L. Jordan
University of California
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87544

RECOMMENDATIONS

1. We support the second recommendation of the COSRIMS report which we repeat here:

> "We recommend that at the national level special priority be given to support of the expansion of research and graduate study in computer science. Appropriate actions would include: special support for developing and updating courses, support for research during the academic year when needed, grants to departments to cover costs of computer usage in research, special attention to needs for space, and expansion of numbers of research assistantships and traineeships to stretch the capacity of all departments of high quality."

2. We recommend that universities, industry and the Federal Government cooperate in the development and support of excellent baccalaureate programs in computer science. While it is recognized that there may be a multiplicity of such programs at a university accenting different aspects of computer science, it is important that the development of the programs be entrusted to one faculty group that, if necessary, cuts across college boundaries.

Furthermore, we recommend that universities take steps to define master's degree programs in computer science that function to award a degree of consolidation built on the content of solid undergraduate programs in computer science and to deaccent master's programs whose major function is the conversion of baccalaureates from other fields to computer scientists.

Furthermore, we recommend that these baccalaureate programs contain strong elements of laboratory training in the development and utilization of computer systems.

The computer industry should be urged and encouraged to make major contributions to the development of computer science education in the universities.

In particular we deplore the recent trend toward the reduction and elimination of discounts to universities by computer manufacturers for the purchase of computing equipment.

We feel that the advantages to the whole computer industry far outweigh possible disadvantages to smaller computer manufacturers.

The computer industry has a strong vested interest in supporting the university programs that are their major source of supply of trained personnel. It is clearly in the interest of the whole industry to support university computer science programs.

3. Many of the existing and new Ph.D programs in computer science (in addition to that group of key institutions supported by large research grants oriented not specifically to educational problems) are drastically limited by the lack of support for competent graduate students.

At present, because of the restrictions of NDEA and NSF traineeships to already existing science and engineering disciplines, there are few fellowships available specifically to computer science graduate students.

It is recommended that new computer science graduate programs, in addition to those already supported by massive research grants, be supported in their initial and continuing stages by (1) graduate teaching and

research fellowships, (2) post-doctoral teaching fellowships to aid in acquisition of new faculty, and (3) support of new and different computer facilities, such as satellite computers and processors for film and TV animation for instructional purposes, hybrid computers, converters to and from other systems, and new up-to-date equipment continuously being developed as a result of the investment of resources in national research and development through the defense, space, and scientific research programs.

4. It will be essential to the universities and colleges to greatly expand their students' opportunities to learn the essentials and principles of all elements in problem formulation to computing realization, and to be aware of the part that computer science wishes to play in offering such opportunities, and the cooperation of individual departments should be encouraged and supported, and departments with competent and interested staff should be encouraged and supported in providing opportunities for students to gain insight and knowledge in part or all of this area, and all reasonable efforts should be made to encourage interdepartmental cooperation in this whole area. And finally, that both research in the general area of application and materials preparation directed toward teaching deserves support, especially when each is planned to support the other.

5. In order to guarantee that the student body in this new undergraduate and graduate education in computer science be spread evenly geographically and economically across the United States, and in order to make sure that the result of this program is not the concentration of computer science

activity and talent in a small number of key prestige institutions, it is recommended that specific techniques be employed in the distribution of resources to guarantee grass-roots growth in this area throughout the United States.

To this purpose, it is recommended that undergraduate support be distributed on a pro rata student population basis throughout the states, similar to but not necessarily as in the National Defense Education Act, to the intent that students in all locales, including inner city and under-supported schools, can participate in this highly important program that will upgrade markedly the performance and productivity of many individual human beings.

6. Even in a relatively stable field like Mathematics, a strong need has been felt for up-to-date information about the nature of education and research in the field, and the amounts and sources of its funding. These needs resulted in the NSF-sponsored Survey of Research Potential and Training in the Mathematical Sciences (c. 1957), and the reports of the Ford Foundation-sponsored Survey Committee of the Conference Board of the Mathematical Sciences (c. 1967). The later committee is apparently to maintain a continuous inventory from now on.

In the rapidly changing field of computing sciences up-to-date information is needed even more, and is harder to get. Under NSF sponsorship, the Southern Regional Education Board has prepared surveys of college and university educational activity in the computing sciences, but apparently no agency is doing anything similar for research in our field. At the same time, graduate departments have a great need for, but possess very little information on what research in computing sciences

is being sponsored; who does the research, who sponsors it, and at what levels.

We recommend that the NAS Computer Science and Engineering Board seek authorization, personnel, and funding for a continuing research survey committee, with some full-time staff, whose mission it would be to maintain a continuous inventory of research in the computing sciences.

7. It is recommended that the Computer Science and Engineering Board of the National Academy of Sciences make definite approaches to Congress to recommend that in the next budget legislation those funds authorized by the Higher Education Act for construction and the funding of computer equipment be made available to the National Science Foundation and the Office of Education so that a Federal program to support recommendations one through five can become operative on an appropriate scale.

National Academy of Science Conference
on Computer Science Education

SCHEDULE FOR THE WEEK OF 21 JULY 1969

Monday

A.M. General Discussion

P.M. Working Groups
Resources - (Gilchrist)
Content - (McCluskey)
What is Good Development- (Arden)
Who will teach and who will do
research in systems development - (Tukey)

Tuesday

A.M. Committee Reports

P.M. Working Groups
Resources (Perlis)
Content (Miller)
Goals and Tools (Morris)

Wednesday

A.M. Working groups
(same as Tuesday P.M.)

P.M. Committee Reports
Resources
Content
Goals and Tools

Evening Working groups
An Undergraduate Program in Computer Science

Thursday

A.M. Final Session

Drafts Prepared During the National Academy of Science Conference on Computer Science Education

1. Report of the Calchrist Committee--What Kinds of Computer People are Needed? (Calchrist)
2. What is Good Development? (Arden)
3. Problem Formulation and Matching--A Vital Segment (Tukey)
4. Reinventing (Forsythe)
5. Hardware and Software Integration (Carr) **(to be added in next draft)**
6. A Potentially Large Manpower Requirement (Carr)
7. The Need for Increased Education in Software Engineering as a Subset of Computer Science (Carr)
8. Software Engineering (Rosen)
9. Purdue Masters Degree Program in Computer Science (Rosen)
10. Need for Links of Computer Sciences to the "Soft Sciences" and Life Sciences and for Continuing Monitoring of the Implications of the Effect of Computer Science on the Future of Civilization (Carr) **(to be added in next draft)**
11. Report of the Resources Committee (Perlis)
12. Education in Computer Science (Spurrad)
13. Computer Systems Laboratories (Miller)
14. A Synthetic Curriculum in the Various Computing Sciences (Andree)
15. Report of the Goals Committee (Harris)
16. A Proposed Undergraduate Curriculum in Computer Science at Carnegie-Mellon University (Perlis)
17. Sub-College Education (A. Forsythe)

Report of the Gilchrist Committee

WHAT KINDS OF COMPUTER PEOPLE ARE NEEDED?

Exclusive of installations involving special purpose equipment, or equipment for specific special purposes (e.g., process control), as well as those involving very small machines, there are on the order of 25,000 installations in this country. Very roughly, they are organized by size and purpose like this:

		Scientific	Commercial
Large	1000:	800	200
Medium	10,000:	5000	5000
Small	14,000:	4000	10 000

The Committee agreed that for purposes of designing college-level training and education programs, the bottom group would have to be disregarded. That group (typically users of 360/20's) has as great a need as the others for competent people, but unfortunately the proper person soon moves up. By default, that section of the computer world becomes staffed by poorly trained people.

For the first two groups, then, the people to be trained fall into these groupings:

Researchers

Systems Analysts

Systems Programmers (Large
(Small

Applications Programmers

User/Programmers

Users

The distinction between large and small in this outline was made by Gilchrist: those who qualify as "large" can modify OS360 to suit their firm's needs; those who are "small" can detect trouble in the operating system and know to whom to turn for help in fixing it. The group labelled "users" are those who also know whether or not the results are correct.

Scott Moore suggested a breakdown of people needs a different way, given in the following outline:

RESEARCH — Devises new tools and applications

Needs specialists in (hardware
(software
(combinations of the two

DEVELOPMENT — Develops those tools and how to use them.

Also needs experts in (hardware
(software
(combination of the two

APPLICATIONS — Requirements (or results) which have to do with data.

How to (select) a system.
(use)

How to measure effectiveness.

→ and all three groups deal with both theory and practical applications.

Computer science as a discipline is concerned with men involved with the theoretical design of tools and applications of them. As an industry (the committee agreed that it is not a profession), some 500,000 people are engaged more or less full time, but it has an abnormally high proportion of very incompetent people.

Attention was turned to a different view again: what sort of person does an employer look for and hire? We listed these specifications:

1) A certain gleam in the eye, vaguely defined as motivation.
2) Some knowledge of the mechanics of computing; e.g., the applicant has run some computer programs.
3) Problem solving adaptibility.
4) Communications skills (in both directions)
5) Ability to be self-critical
6) Elementary knowledge of statistics (this last is weak, or optional)

x————————————x

The balance of the committee's time was spent listening to Prof. Graham's description of the training program at the University of Waterloo. The Committee recommends that he be asked to repeat this description for the entire group.

What is Good System Development?

Committee Report, Bruce Arden, Chairman

In the opening session many of the current problems of computing were related to poor development. Accordingly, the title question was posed. It is predictable in advance that no definitive solution to these problems will be produced but it bears consideration because of its possible educational implications.

First, the committee limited consideration to large systems, and rather arbitrarily designated this to be programs of over 200,000 words. Development can be divided into design and implementation. The design part can be further subdivided into specifications and partitioning. Throughout the discussion an attempt was made to identify those parts which are art as opposed to those where there can be some a priori system of types imposed. By art is meant bringing native ingenuity and experience to bear on the problems. A number of comments were made about the importance of the specification phase. The specifications are difficult in general purpose systems; in general, they have not been handled well. There are a couple of design tools. One of these is analysis. In its simplest form analysis is a very elementary arithmetic attempt to define the loads and processing times and make checks and predictions of system performance. Another specification tool is simulation, and here the aspect of art is apparent. In the extreme a simulation can be as complex as implementing the entire system; if it is too simple, it does not produce insight into the performance of the system which is being designed. Much depends upon the right choice.

Some time was spent on implementation structure. There were several independent estimates that of how many people could be handled by a technical supervisor. The figures ranged from 5 to 20. If this estimate is accepted, then large systems impose a hierarchical structure. Actually there is more than one structure.

Actually there is more than one structure. There is the supervision structure, the system structure, and the documentation structure. It is not necessary that all of these structures be the same. However, for large systems it is certainly advantageous if the three structures are identical. Also, it is certainly clear from experience that if there is a single person that has a good overview of large systems, that this enhances the possibilities of success. When systems get very large this tree-like hierarchical structure may not resolve the difficulties. At every level as one progresses toward the root of the tree, there is some information loss and it is conceivable that, at the root, there cannot be any comprehensive knowledge of the system. During the discussion of very large systems, it was conjectured that the person at the top of this hierarchy could have only statistical knowledge of the details of the system.

In the implementation it is important to have early symbolic binding of the interfaces at the higher levels of the structure. This obviously permits the vital independence for large projects by permitting change within functional modules without perturbing others.

There was some discussion on "upward connectivity." That is, two supervisory groups, should communicate only through their common supervisor. This rule introduces order in the design structure, but it also can introduce, in an absolute sense, inefficiency in the resulting structure. This kind of inefficiency may have to be regarded as an unavoidable result of producing working, large systems.

As mentioned earlier, the documentation hierarchy referred to is very important, and should closely match the structural organization with increasing

detail downward. Here again, there is an aspect of art. If the documentation level is well selected, it is relatively easy to enter at any level in such a tree-like structure and see the local structure. Defining appropriate documentation level well is very difficult. Early workbooks for big systems, illustrate both too much and too little detail. There were also opinions expressed that, although this hierarchical structure is vital, there is probably a need for more communication than can be obtained by staying on the branches of this tree. One suggestion was that a person be responsible for a certain band across this structure; that is, that he know the content of the level above and the level below, as an example.

If the system is not too large, a total group meeting may be workable. Such group or sub-group communication is independent of structure or documentation methods. It is simply a way to extend system understanding beyond the local task. There was discussion of the interchange problem. With computer personnel as dynamic as they are, interchangeability is desirable. It becomes important to be able to integrate personnel into an ongoing, large development.

Certain structural attributes were discussed. One of these is the built-in data acquisition (or instrumentation). It is vital for large systems to provide for such measurement at the design level. This means that the means to accumulate data is incorporated in the program's operation. Also, there should be some flexibility for self-measurement. That is, the overhead involved in such provisions should itself be measurable. Another attribute is that the system should be phase-able. This property was broken into two categories. One category might be called incremental in that at every stage of the development there is a stand-alone system which can operate in a real

environment. As an example, the development of a multi-programming system could proceed by developing first a mixed partition strategy changing it to use virtual storage. It would be operable at every point in the development. Such a strategy is not always possible. The other category is the design of all modules for independent testing. Also important is specification of symbolic interfaces; that is parameterized structures where entities such as sizes and devices appear symbolically. It should be possible for example to simulate devices transparently, that is, simulate by software devices which are not physically available. There was discussion of auditing system development. The hierarchical structure and symbolic interface permit an independent audit procedure which checks documentation as well as function. The system audit group should do this by operating solely from documentation and interface description.

Another often-neglected but desirable process is "post simulation," or design verification. It should be used after the system is operating to measure and refine the system and permit continued development.

Some time was spent on computer aided design of computing systems. Discussion as to whether there is something inherently different in designing computer systems using computers than in some other design areas. The conclusion was that there probably is not. The abstraction of any design process leads ultimately to algorithms which manipulate algorithms. Computers are well suited for such tasks but this does not seem to be unique to computer system design.

PROBLEM FORMULATION AND MATCHING

A VITAL SEGMENT

If we are to realize the potentialities of computing systems at a reasonable rate, we must look forward to the education and development of men and women across a very broad spectrum. It is easy to recognize the inevitable needs for certain kinds of people, such as:

-researchers into the understanding and expansion of what algorithms and computing systems can do.

- systems programmers competent to guide, lead, and do the development of major software systems.

-operators and routine programmers to run tens of thousands of installations.

As we attend to such clearly recognized needs, and, as well, to such crucial needs as increasingly effective attention to "wholeware"-- to the hardware and software of a computing system as a whole -- planned together as well as working together. We must not forget the vital segment of the spectrum associated with matching the problem to the computing system.

Problems do not arise in forms suitable for attack by computing systems. Those that seem to us "just made for a computer" came to that state by much human effort. If we are to tackle new problems -- or new versions of old problems -- effectively, bravely, and pioneeringly, and successfully, it will be because individuals or small groups have done a good job of problem formulation, because individuals or small groups

have used the available computing systems and applications programs to deal effectively with these well and carefully formulated problems.

Neither phase of this task can be done wholly alone:

-Problem formulation often requires both repeated trial and exploration and insightful understanding of what computing facilities are really at hand.

-Bringing a good foundation to successful computing often requires guidance, sometimes repeatedly, from a version of the problem more true to life than the given formulation.

Recommendation:

It will be essential for the universities and colleges to greatly expand their student's opportunities to learn the essentials and principles of all elements from problem formulation to computing realization.

Recommendation:

Where a department of computer science wishes to lead in offering such opportunities, or to cooperate in offering them, that department should be especially encouraged and supported.

We feel it would be quite unrealistic to expect all departments of computer science to commit significant resources to this problem. (Indeed, there may prove to be no one area to which all these departments will, or should, attempt significant contributions). The need is large, all who can and would should help to shoulder the burden.

Recommendation:

Other departments with competent and interested staff should be encouraged and supported in providing opportunities for students to gain insight and knowledge in parts of all of this area. All reasonable efforts should be made to encourage interdepartmental cooperation and co-working.

If opportunities are to become widely available, there will have to be significant investments of time and efforts to develop materials ranging from case studies to organized presentations. Research into the credentials of how these problems are effectively formulated and brought to computation can and should have relation to mutual support with the efforts to develop materials.

Recommendation:

Both research and materials preparation deserve support, especially when each is planned to support the other.

RECOMMENDING

We find that there is a major national crisis of leadership in certain areas of software engineering and computer science. To begin to solve this crisis will require the yearly addition of 3,000 persons at the level of a master's in computer science and 600 at the level of a Ph.D. in computer science.

We also find that each year U.S. universities are now graduating some ~1100 persons with a Ph.D. in physics. Many of these persons have the talent and ability to become faculty members at good universities, or research staff at good research laboratories. Unfortunately, there is little need for these persons in such positions in their own field.

We further note that [illegible] are interested in [illegible] to turn their attention to [illegible] computing. We believe that [illegible] of these talented Ph.D.s in physics could be converted into top class programmers in about a year. [illegible] programmers would [illegible] into computer science faculty members in about [illegible] [illegible] less than [illegible] [illegible] for students [illegible] a Ph.D. in computer science. [illegible] over, the [illegible] by this [illegible] [illegible] to [illegible]

The principal advantage of the retreading approach is the speed-up in creating new computing experts over starting with conventional new graduate work. One cost would be the substantially larger salaries required for post-doctoral students than for graduate students. If there were an overload of, say, 100 post-doctoral students, there would be a substantial cost in finding faculty members to deal with them.

What has been said about physicists may apply also to mathematicians and, with lesser force, to some other fields.

Recommendation:

We therefore recommend that great attention be paid to the opportunity for creating applications programmers, systems programmers, and computer science faculty and research persons by retreading recent Ph.D.s in other fields.

22 July 1969

A POTENTIALLY LARGE MANPOWER REQUIREMENT

The effect of commercial time-sharing on manpower requirements for "professional" computer personnel will be a highly important one. For the first time, highly competent professional help will be given to those 15,000-20,000 small installations around the country using lower cost computers in small data-processing facilities.

For the commercial time-sharing groups to compete effectively, they will have to specialize their services for some segment of the organized technology, for example: machine tool tape preparation, type-setting and hyphenation, wholesale accounting, small-scale inventory control.

Each of these time-sharing organizations must have highly effective computer systems programmers to develop languages, generalized routines, "hand-tooled" algorithms, etc., to satisfy the individual needs of the user.

Users will try competing services against each other for cost, speed and breadth of capability. Those time-sharing commercial groups with the most professional staffs (all other characteristics--management, marketing, etc., being equal) will survive this very intensive competition.

It may be that the 15,000-20,000 small machines, most of which do not have any professional computer staff, will be merged into the commercial time-sharing networks, with this many (15,000-20,000) professionals needed to work for them indirectly. These men and women must be professionally trained in structure of time-sharing systems, managerial processes, data structures, operating systems.

J. W. Carr IV
Monday, July 21, 1969

John W. Carr, III
23 July 1969

The Need for Increased Education in Software Engineering as a Subset of Computer Science

One presently arising class of computer problems differs in both quantity and quality from those that have been most important up until now. Such problems are characterized by:

1. Large size
2. Complexity of structure
3. Lack of formal descriptions
   (here follows one or more further characteristics)

Examples of such problems today include operating systems for large-scale computers; manufacturing systems for large aircraft; construction, retrieval, and analysis of large data bases; air and ground traffic control; management information systems, command and control systems; (here follows a list of other problems)

These problems fall into a category that represents an important area concurrent to and perhaps a part of computer science. The study in and of this technology has been proposed to be called "software engineering"; some of what has been called "systems engineering" or "operations research" falls directly into this problem area.

Such systems have in the past been organized out of groups of human beings as control elements, human-accessed data storages, and direct human communication. The coming of the computers, as well as the expansion of applications of physics and technology, now requires effectuation and automation of systems in which humans can no longer play a detailed part. Where in the older system they served as local control elements, the response time and data rates required no longer allow this participation.

Such systems must now be developed by teams of human beings no one of whom, in general, can view the problem as a whole. The digital computer now serves as data storage, communications device and monitor, control element, and manager of the overall activity. Humans interface the system and must be satisfactorily served. The systems are characterized by large numbers of program steps, complex mappings into present-day computer structures, and need for optimization within a set of complex constraints.

The design of such systems, and their prototype construction via computer programs, is today in its infancy. Examples up until now have ranged from successful special purpose systems for one-problem applications (such as airlines reservations) to less successful general purpose systems for improvement of computer utilization (such as batch and time-sharing operating systems.)

It is in this area of design and development of large computer programs for such large systems that there appears to be a lack of organized instruction in higher education, here or anywhere, at the present time.

Without the educational development of persons who can work on the computer-oriented portions of such problems, the problems will be able to be attacked only on an intuitive ad hoc basis. It is expected that the fundamentals of computer science will serve as a scientific basis for the education of such persons, but

that special areas and tools of application must also be taught.

The products of such an educational curriculum will serve as the cadres of the teams that will construct the computer program portions of such systems. (continue)

One of the requirements of such an educational experience is the availability of an effective laboratory experience. (continue)

"Software engineering" is not a good phrase and its use should be discouraged. The reasons are as follows:

1. Hardware and software are intimately related. Ten years from now many functions that are now handled by software will be either hardware functions or shared hardware software functions. The term "software engineering" emphasizes the distinction. It is very important to emphasize the interrelationships. "Computer Science" is a far better term for this than "software engineering."

2. A curriculum in "software engineering" at a university would of necessity be housed in the School of Engineering. This could create great confusion in schools in which Computer Science is not currently housed in the School of Engineering.

Purdue Masters Degree Program in Computer Sciences

There are 4 major areas:

1. Numerical Analysis
2. Logic and Automata (including formal Languages)
3. Systems
4. Application areas.

Most terminal masters degree students are in the systems area. They generally take one course in Numerical Analysis, one in the area of Logic and Automata and the following Systems courses:

1. Computer Organization
2. Programming Languages
3. Compilers
4. Operating Systems

They will also take 2 or 3 courses in the applications area. Courses in applications include:

1. Information Retrieval
2. Artificial Intelligence
3. Simulation
4. Mathematical Programming
5. Computer Graphics

A total of 33 hours are required. Students entering with a strong undergraduate background in computer science may get the degree with fewer credits. A thesis may replace 9 credit hours but is not currently encouraged because of staffing problems.

The above program leaves room for several electives. Students are encouraged to take courses in Mathematics, Statistics and Electrical Engineering.

Note that there also exists a new joint masters degree program between Computer Science and Industrial Management.

REPORT OF THE RESOURCES COMMITTEE

Dr. Alan Perlis

July 23, 1969

We have a number of figures and tables which have come out which might be of interest. In education, for example, the University of Waterloo has chosen to commence with the Bachelor of Science program in computer science and to develop from that upward to the MS and Ph.D programs. In the United States development in the opposite direction has generally been followed. It is recognized by Waterloo that the first approach, their approach, is a somewhat more difficult path to follow, it being more difficult to upgrade a Bachelor's program than to downgrade a Ph.D program.

However the committee strongly feels, and this is the first recommendation, that major educational efforts should be spent in the development of Bachelor of Science programs in Computer Science in the USA over the next few years. Furthermore, the committee concurs with the Waterloo experience that the program should include significiant amounts of practical, hands-on experience with real computer systems problems. Hence the committee feels, and this is a second recommendation, the BS program will be greatly aided by and should include laboratory courses and/or cooperative ventures with industry and government during the school semesters or over summer periods. The committee does not feel that the development of MS programs has the same priority as the two extremes, BS and Ph.D. Indeed, the MS program contains material only superficially different from the BS program and serves mostly as a springboard for those switching fields and as consolation prizes for those unable to complete Ph.D. programs. The

committee next considered the needs of the non-computer scientist being educated in the universities, since it became clear it would not be feasible to educate as many specialists as one might need in this field in the next 10 years. The first calculation we made we call the Waterloo computation. At Waterloo there is an IBM 360/75, costing 125K per month. Student jobs account for 1/10 of the system time on that machine or if you will costing about 12.5K per month. Considering cost in the support or overhead equal to that of hardware we have a cost of $25,000 a month for student jobs. For that cost the productivity is 5,000 runs a day or 100,000 runs per month. Considering a productivity of four cracks at the machine per problem, this means that that system is capable of absorbing 25,000 problems per month. Consequently, given a student population size and a number of problems one can come up with various estimates as to what it costs to provide undergraduate computer experience for the non-computing specialist, i.e., someone who does problems of a relatively small size. We came up with one figure assuming 25,000 students in the university of one dollar per problem per student per month. The size of those problems is that their programs are limited to one second of cpu time and the students are not charged to disc file time but they generally do not include much file work.

We might at some later time have a few words to say about the overall picture of the way the system flows at Waterloo. In any event over a ten month academic year a system of this kind could support students giving them 10 problems over an academic year at a cost of 10 dollars per student per year in a 25,000 student population which almost reaches the student population of the largest universities we have in the United

States today. Now this figure is substantially below the figure in the Pierce report which runs closer to 50 or 60 dollars per year. That means if we wish to attain the Pierce report figure we could have the student doing 50 problems per year, which is probably much too heavy a load for non-computing specialists!

Now this leads us to make a third recommendation. We recommend that funds be made available so that a cost analysis study can be made of the specification and use of various systems for handling bulk student jobs for the non-computing specialist at different student population levels. It would be hoped to provide a study that would say - at the cost level at which we have spoken, given a student population of 1,000, system A would provide computation at the rate of $50 per year at a level of between 10 and 50 jobs or problems per year. At a student population of 5,000 system B will similarly provide at 10,000 system C, at 30,000 system D, etc. Such a specification of systems is not now available to the educational community. Of course, these systems need not be unique. There can be many systems in each of these four categories. Neverthesless, it is the feeling that at all four of these student population levels, 1,000, 5,000, 10,000 and 30,000, systems can be found which are of economical comparison to the Waterloo system.

We arrived at an estimate that to turn out 300 Ph.Ds per year in computer science, we were talking about an estimated machine cost of $9 million a year. This is the machine cost required to support Ph.D theses and Ph.D education at the level of 300 Ph.Ds per year. Thus: to produce 300 Ph.Ds per year it is estimated that it will take 30,000 dollars per Ph.D in machine time or a total of 9 million dollars in machine time

for the Ph.D production of 300 Ph.Ds.

For the Bachelor of Science program in computer science, assuming six courses in their program that are in the core of computer science, thus not counting auxiliary courses, and an education program that will turn out 15,000 B.S. computer science students per year, a figure of 15 million dollars per year in computer time was arrived at. The calculations will be laid out in more detail in the report.

For the Master of Science program, a figure of 5 million dollars per year in hardware costs was obtained.

The total cost in hardware is 29 million dollars per year. One of the figures that we used was that the EDP industry would be taking in about 100,000 people per year. What percentage of these should be Ph.Ds? Figuring that one percent should be Ph.Ds we get a desirability of producing a thousand Ph.Ds a year. Our feeling on the matter was that by 1975 we might be able to produce 1000 Ph.Ds in computer science, but that we would not be able to produce 1000 Ph.Ds per year by 1975. If you can get up to about 300 by 1975 this would be about what we could expect. It seems to double about every two years.

From whence comes this figure of 15,000 BS students per year? Is it attainable? At the present time in engineering and mathematics the output per year is of the order of 50,000. Now assuming there is no major change within engineering and science schools but that quality computer science undergraduate programs do come into being, how many of the 50,000 per year could we siphon off into computer science? We believe that we could without a great deal of heavy advertising or pressure of any sort get 20-30% of the present undergraduate enrollment that are now in mathematics

and engineering programs diverted into computer science programs, if there were existing quality undergraduate programs in computer science. That means of the 100,000 per year that are required in the EDP area, 85,000 are probably going to have to remain or be non-computer science baccalaureates. We also made an estimate of computer science faculty costs and came up with an estimate of 45 million dollars per year for that part of computer science faculty costs devoted to computer science education alone at the three levels being well aware, of course, that there are other costs associated with their education outside the computer science department. But we're talking now about cost of a faculty of about 1500. Waterloo argues that they are producing 200 Baccalaureates per year to service 1,000 computers in the province of Ontario. There are 67,000 computers in the USA. Consequently, if we assume that the ratios are comparable, this leads to 13,400 output in the USA to service these computers, if we adopt that ratio. This compares reasonably well with our 18,000 figure.

John Giese came up with another set of figures arrived at differently from the figures just cited which tend to corroborate this level by about 1975:

A conservative estimate of the prospective demand for the products of the Computer Science educational system.

A. In the long run the overwhelming majority of computer science graduates at all degree levels will go to non-academic employment. For the estimates we shall make later, we shall need to estimate the number of "computer science" positions which should be filled with computer science trained people if possible at computer

installations in the U.S.

(i) It has been said that there are about 67,000 computers in the U.S. in 1969.

(ii) Let us assume the following distribution of sizes of installations and staff.

SIZE OF INSTALLATION	LARGE	MEDIUM	SMALL
NUMBER OF THIS SIZE	1000	10,000	56,000
AV. CS EMPLOYEES PER INST.	100	30	3
AV. NO. OF PH.Ds PER INST.	5	1	0

Then the desired number of TOTAL "CS" EMPLOYEES

$1000 \times 100 + 10,000 \times 30 + 56,000 \times 3 = 568,000$

and the desired number of TOTAL "CS" PH.Ds = 15,000.

(iii) These positions are not now filled by computer science graduates. We assume it would be desirable to replace them gradually by computer science graduates to upgrade the computing profession

B. Let us assume that the computing profession remains static at about this level, i.e., that increases in efficiency make new people available for an inexhaustible set of new problems. Let us assume that we have a rather rigid slowly varying working population, like the Civil Service. This may not be too unreasonable to assume, since these professionals might become union-organized (as teachers are now). If we assume a working life of about thirty years, then in the steady state we shall have to replace about $\frac{568,000}{30} = 19,000$ "CS" employees per year and about $\frac{15,000}{30} = 500$ "CS" Ph.Ds per year.

C. Composition of 19,000 computer science graduates.

If we assume that about 20% of these graduates seek advanced degrees, this means about 4,000 advanced computer science degrees per year. If we claim 500 PH.Ds per year, this leads to a need for

500 Ph.Ds
3,500 Masters per year
15,000 Bachelors

in the computer science area.

D. Conservatism of this estimate.

(i) The assumed static "CS" employee pool is about $\frac{500,000}{200,000,000} = 0.25\%$ of the total U.S. population.

(ii) 19,000 graduates per year is about half the number of engineering grads (40,000) per year. That doesn't sound unreasonable. Computer technology should be about as widely appliable as engineering.

(iii) For comparative purposes consider the fraction of our manpower resources devoted to medicine and associated subjects. We produce about 9,000 physicians per year. They must be backed up or supplemented by about 18,000 nurses, technicians, dentists, and various forms of physiologists, etc. As a guess, about 27,000 graduates per year are devoted to problems of health.

You might argue that since medicine absorbs a fairly small fraction of our economic output, and since computing is (or will be) involved in all of man's activities, including

medicine, perhaps the output of computer science graduates could safely be increased to the level of medicine (and associated graduates) or 27,000 eventually.

(iv) Some "CS" enthusiasts assert that the growth of "CS" jobs may be 100,000 per year.

In a steady state process, with thirty-year working life, this would lead to a CS employee-pool of

$$30 \times 100{,}000 = 3{,}000{,}000.$$

If the population of the U.S. remains static at 200,000,000, this would mean that the pool would contain about 1.5% of our population.

E. You have Bruce Gilchrist's estimates of staffing requirements to provide faculty for these hordes of computer science students.

F. Nothing has been said about the provision of refresher courses for the people in the pool who will constantly become obsolete. If you provided a "refresher" or updating course once every five years, this comes to 0.2 course (three weeks?) per year. Even if you restricted this updating to the lucky employees at the large and medium installations, somebody would have to provide about

$$0.2 \times 400{,}000 = 80{,}000$$

student courses/year. Even if these things operate at 100 students per section, you would have to run about 800 refresher course-sections per year.

If we aren't so generous and send only 10% of the pool to refreshers, this cuts the total to 80 course sections per year. That ought to be a tolerable burden for the educational system.

G. Nothing has been said about providing computer "service" courses for non-computer science students.

The other computations I performed are very original notes merely paralleled (for very assumed populations) the calculations of Gilchrist. I have therefore not repeated them here.

It may seems ridiculous to staff the small installations with graduates. To handle this I suggest that we reinterpret our imagined program. Let us say that we provide instruction and facilities to produce 190,000 graduates per year. If about a third of these drip out after the first two or three years, they would probably have to be content to work at the small institutions. Actual graduates go to medium or large places.

I would assume that the computer industry would be included as part of the large installations.

One final point. The figure of 15,000 baccalaureates is considerably lower than we would like. Arguing that 100,000 entries into the EDP area a year are needed, we figure that 25,000 come from business schools and industrial administration programs, 25,000 by upgrading from their current positions. This leaves 50,000 coming from colleges, and we're only providing 1/3 of that. That means that 35,000 are going to come from a lower educational level than baccalaureate computer science programs. Jim Rowe mentioned that one of the consequences of providing 15,000 baccalaureates in computer science will be a temporary diminution of the number of people needed in the field. But we all agreed that this diminution would be temporary. The more trained people that you have presumably the less total number you need. However, Rowe felt that he would really prefer

that all 100K came out of baccalaureate programs in computer science.

We merely want to point out that the figure of 15,000 per year is, in our judgment attainable right now, if baccalaureate programs are introduced.

John Giese
J. W. Graham
Bruce Gilchrist
James Rowe
A. J. Perlis

23 July 1969
Spinrad

Education in Computer Science

We see Computer Science as a coherent academic discipline. The educated Computer Scientist will be trained in both hardware and software--the inextricably interwoven elements of his field. Graduate study will, at first, lead to a broader understanding of complex hardware/software systems. Further study, (to the Ph. D. level) will naturally lead to a more penetrating specialization.

We believe that there is a core of knowledge fundamental to the undergraduate's education and independent of his future course of study. For this reason we specifically reject the notion of a "homogenizing" entry year of graduate study whose object is to correct the deficiencies (soft or hard) in the student's previous education (hard or soft). For this same reason we reject the concept of two educational paths-- one leading to a terminal professional degree and the other leading to further graduate study.

We find no compelling reasons that lead us to suggest that Computer Science is appropriately placed within any particular classical academic discipline. Our strong concern is that in a given university, there be only one undergraduate program concerned with the science and engineering of computing. (A student wishing to enter Computer Science from an "adjacent" field will have the traditional academic remedy of "making up" the necessary prerequisites.)

In broad terms, the areas of study we consider essential and at the core of the Computer Science undergraduate program are:

1. Mathematics
2. Physics
3. Hardware Technology
4. Programming
5. Logic Design
6. Software Structures
7. Subsystem Design
8. Computer Organization
9. Compilers
10. Systems Programming
11. Computer Systems Laboratories
12. Systems Applications

These are, of course, in addition to the fundamental education traditional to the undergraduate curriculum.

(Revised)

Miller
23 July 1969

Computer Systems Laboratories

We consider the laboratory-experimental aspect of the training of students in computer science to be vital to their development. We therefore recommend the establishment of computer systems laboratories as part of the curriculum of both undergraduates and graduates in computer science.

There are many substitute plans that could conceivably serve to fulfill the same purpose as the computer systems research laboratories, e.g. summer employment in industry, cooperative work projects with industry, or part-time employment in a computation center on campus. Each of these alternatives was explored by the committee and considered to be difficult for one or more reasons. Principally, these substitute plans lacked the supervised directed planning of an organized laboratory. The success of any of these alternatives is quite personnel dependent.

In the laboratory course the students are expected to work in a team of about six students under close supervision of the faculty member and teaching assistant. The student team is expected to concentrate on design, documentation, scheduling of their work, performance evaluation, efficiency, error recovery, diagnostics, maintainability and other features of a well-engineered system.

It is expected that each student should take the equivalent of two of the below laboratories during the course of his study.

We propose the following computer systems laboratory courses as basic to a graduate computer science curriculum:

C.S. Lab. 1. Construction of Assemblers and Computers

C.S. Lab. 2. Construction of Operating Systems

C.S. Lab. 3. Construction of Terminal Systems
(both typewriter and graphics)

C.S. Lab. 4. Construction of Switching, Communication and Process Control

C.S. Lab. 5. Construction of Large Data Base Systems

In addition, we consider two additional laboratory courses that could be given in addition to or in place of the above five:

C. S. Lab. 6. Management of a Computer Facility

C. S. Lab. 7. Construction of Large Application Systems

The above laboratory courses, particularly the first five, are graduate level courses given concurrently with or following a lecture course covering the subject matter. It is intended that the lecture course cover the theory, models, and formal aspects of the subject matter. The associated laboratory is intended to provide the student an experience that will sharpen his understanding of the theory and, so will, have given him an understanding of the practical problems of implementing large systems.

The companion lecture courses associated with the above listed laboratory courses are given below:

Laboratory Course	Lecture
C. S. Lab. 1.. Construction of Assemblers and Compilers	Lecture course such as I5 and/or A1 from Curriculum 68, A Report of the ACM Curriculum Committee on Computer Science. Includes definition of formal grammars, arithmetic expressions and precedence grammar, algorithms for syntactic analysis, recognizers, semantics of grammar, object code generation, organization of assemblers and compilers, meta-languages and systems.

C. S. Lab. 2. Construction of Operating Systems	Lecture course such as I4 and/or A2 and/or A3 from Curriculum 68. Includes operating systems characteristics, structure of multiprogramming systems, structure of time-sharing systems, addressing structures, interrupted handling, resource management, scheduling, file system design and management, input-output techniques, design of system modules, sub-systems.
C. S. Lab. 3. Construction of Terminal Systems (both typewriter and graphics)	Lecture course such as I4 and A6. Includes text editors, string manipulations, data structures for text editors, job control languages, data structure for pictures, syntax and semantics of terminal and graphics language, control of the console system, meta-languages and systems.
C. S. Lab. 4. Construction of Switching, Communication Systems, and Process Control	Lecture course such as I4 and/or A2 of Curriculum 68. Includes traffic control, interprocess communication, system interfaces, realtime data acquisition, asynchronous and synchronous control, telecommunication, analog-to-digital and digital-to-analog conversion.
C. S. Lab. 5. Construction of Large Data Base Systems	Lecture course such as A5 and A8 of Curriculum 68. Includes organization of large data base systems, data organization and storage structure techniques, data structuring and inquiry languages, searching and matching, automatic retrieval, dictionary systems, question answering.

These laboratories will require a certain amount of "hands on" use of a substantial computer facility. In some installations it may be possible to carry out the entire project in a subsystem or partition of a larger system. In that case the use of the subsystem would have to be dedicated to the project for a substantial portion of time.

We believe that a team of six students can be given a very significant experience for $1,000.00 per student or $6,000.00 for the whole team f one-quarter laboratory.

These laboratories are presented as examples of laboratories that might be given. Each school will have different staff and facilities available and will present variations on this proposal. The important emphasis is the supervised hands on experience with attention to the practical aspects of the system.

Subcommittee
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First Draft
Please [illegible]
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R. Andree [illegible])

A GRADUATE CURRICULUM IN THE VARIOUS COMPUTING SCIENCES

The initials I+CS used in this paper may be read as Information and Computing Sciences or as Information Science or Computer Science or as any other phrases that describe the science and the art concerned with the study of the complex structure that surrounds computers.

The phrase "Computer Science" will continue to have changing meanings as staff interests and abilities change. The committee recognizes that valid graduate programs may differ widely in structure, purpose and implementation, and feels that such diversity should be encouraged, not stifled. We suggest that the following observations merit serious consideration in all graduate programs in the various aspects of I+CS.

1. The core of a graduate program in I+CS should contain a blend of

   Pure theory (Math, Physics, etc.)

   Hardware-software systems

   Laboratory experience involving both hardware and software

   Applications of existing hardware-software systems to realistic problems from various areas

   Administrative management (operations research)

   This should provide an extension (not a repetition) of the students' undergraduate experience.

2. A person who holds a master's degree in I+CS should be able to read and understand (with reasonable effort) more than half of the articles in his area of specialization which are printed in the existing computer related journals. A person with a Ph.D degree

should be able to understand a much higher percentage of the articles in his area and in related areas and should be able to create similar journal articles.

3. A student whose primary interest is in an existing discipline (electrical engineering, chemistry, mathematics, business administration, industrial engineering, economics, etc.) should continue to earn the Ph.D degree in the appropriate department possibly with a minor in Information and/or Computing Sciences rather than creating myriad diverse Ph.D's in the "Applications of I+CS". The Ph.D in I+CS should be primarily for students interested in computing (including hardware-software and abstract theory) rather than in the applications of computers to research and work in other specific areas, vital as this may be.

4. (a) The masters program of the person who will become a "professional practitioner" of the computer art should not differ markedly from that of the pre-Ph.D in I+CS.

   (b) There should be both undergraduate and graduate "service courses" in I+CS which include appreciably more than mere programming in compiler language. They may be the same or different courses from those of 4(a), but should be substantial in nature and include an understanding of the basic concepts of hardware-software interface as well as related elementary theories. Possibly there should be a second, very broad brush masters degree for students from other disciplines who will then return to their own disciplines either for employment or for further training in that discipline.

5. Courses in computer related subject matter which are currently being well taught in existing departments should continue to be taught by those departments (possibly with crosslisting). If new courses are needed, which existing departments are well qualified to teach, they should be urged to do so before the I+CS department undertakes additional teaching duties.

6. A department of I+CS should be aware of the publications related to curriculum including at least

   A.C.M. recommendations in Curriculum 68

   C.U.P.M. recommendations for a curriculum in Computer Science

   D.P.M.A. recommendation for certified Data Process Certificate

   A.C.M. recommendations for a curriculum in Business Data Processing (being prepared by M. Tondow and others)

   COSINE recommendations on Engineering Computer degrees (now being prepared)

7. Students of I+CS at both the undergraduate and the graduate levels should have both theory courses and related laboratory experience (the critical word is related) which will focus their attention on the organization, implementation, and documentation of larger scale computing systems.

8. [Your suggestions are welcome.]

9. The committee hesitates to recommend specific course material other than that suggested in 6 above, but does sincerely recommend the creation of two courses not readily available at present.

   a. Discrete Mathematics (with an awareness of computers)

      To contain material on matrices, probability, logic, graphs, combinatorics; automata theory, computability, linguistics and possibly some simulation theory at a level suitable to build on the students' undergraduate preparation, but not in such depth that a reasonable selection cannot be completed in one or two terms. Suitable references for future reading are essential.

   b. Basic Computer Components (hardware and software)

      To contain current information on hardware-software interphase and their symbiotic relations and hang-ups as well as possible near future changes. Should be possible in one semester.

7/22/69

Morris

REPORT OF THE GOALS COMITTEE

We propose that computer science is going to be the handmaiden of the sciences. We can make models of the external world inside automata such that vital human problems can be solved.

The main goals of progress in computer science apply broadly to computation, computing systems, and computing processes. We can conveniently identify six such goals:

Gaining insight through organization

Gaining factual knowledge

Attaining new feasibilities

Improvement of productivity

Better interaction with people

Export of insight

The character and breadth of these goals can be better appreciated if they are illustrated by short lists of major problems.

Problems were chosen whose scope can easily be understood by persons other than those who are experts in some part of computer science.

Some of the problems overlap other disciplines but their solution would require the development of currently non-existent tools of computer science.

Gaining insight through organization

1. Develop a formal language which can unambiguously and systematically represent the content of natural language sentences.
2. Determine a general procedure for associating semantics and syntactic structure.
3. Develop models for the structure of modern operating systems.
4. Develop a theory of the algebraic structure of computer algorithms.
5. Develop general theories that match both computing structures and language structures to the structure of problems.
6. Develop a deterministic model for machine synthesis by learning.
7. Systematize the methods that human beings use to solve problems.
8. Develop general methods for degarbling data and instructions.
9. Invent new machine organizations for large or novel problems.
10. What are the steps by which metasystems are constructed (e.g., metacompilers, metaalgorithms, metamachines).
11. Understand in adequate detail the requirements placed on large information service systems. These can include speed of access, diversity of access, security against loss or failure, privacy, economic feasibility, need for catastrophe-free changes.
12. Understand how to approach the fulfillment of these requirements through overall system structure and through software architecture and fabric.
13. Develop a more and more adequate theory of large information service systems.

Gaining factual knowledge

1 to 5. Determine the problem solving efficiencies of:

- parallel computers
- associative memories
- distributed logic machines
- memory-centered computer systems
- parallel languages

6. Determine the minimum number of operations to invert a matrix.

7. Find out how to design arbitrarily large nets that function reliably out of faulty elements.

8. How much memory is needed to test whether a given string is a sentence of a given language.

9-10. What is the least amount of work (or storage) required to compute function f.

New feasibilities - internal

(We divide new feasibilities into three parts)

1-4. Develop an adequate language for describing:

- languages
- data
- graphic objects
- machines

5. Develop a good (effective and handy) algebraic symbol manipulation language.

6. Write a very high performance compiler for PL-1 on System 360.
7. Find out how a computer can have very fast access to a memory of 10^9 words or more.
8. Learn how to plan systems and programs that are much more likely to allow easy insertion of unexpected changes.
9. Develop precise descriptions of this and that.

New feasibilities - service

1. Implement good interactive data analysis.
2-4. Develop systems automating:
   - the operations of elementary analysis
   - the solutions of ordinary differential equations
   - the solution of increasingly large classes of partial differential equations
5. Produce an effective algebraic symbol manipulation processor.
6. Produce a program to play championship chess.
7. Learning to effectively instrument computer systems to identify bottlenecks to productivity, and publishing the results. (This may require us to restructure our systems.)
8. Make significant advances in theorem-proving.
9. Find better methods for degarbling data and instructions.
10. Find out how to synthesise high-quality visual images (TV or movie quality).

New feasibilities - external

1. Plan, and show the feasibility of, programs and computing facilities needed to allow a robot to operate effectively in environments hostile to humans (Mars, deep ocean, etc.).
2. Plan, and show the feasibility of, programs and computing facilities sufficient to operate an automobile in ordinary traffic.

3. and 4. Develop techniques for:

- speech recognition
- left-thumbprint recognition (as a substitute for signatures)

5-7. Find automatic methods of interpretation for:

- medical X-rays
- EKG's
- bubble-chamber pictures

8. Implement mechanical translation between natural languages.

IMPROVEMENT OF PRODUCTION

This is a goal of great importance, toward which progress is usually made in smaller steps.

1. Bootstrapping from easy problems to hard problems.
2. When to interpret and when to compile.
3. When to bind and when to leave free.

Impact of insight

1 and 2. Contribute to the development of realistic models of:

- thought processes
- the brain

3 and 4. Contribute to the development of effective

- sensory prostheses
- intellectual prostheses

5. Contribute to learning how to do computer-aided instruction well.

Relationship with people

1 and 2. Learn more about human input/output capabilities, including:

- understanding the potentialities of graphic input to human intuition.
- understanding human output capability as a parallel channel mechanism, and the possibility of exploiting this as a computer input.

One presently arising class of computer problems differs in both quantity and quality from those that have been most important up until now. Such problems are characterized by:

1. Large size
2. Complexity of structure
3. Lack of formal descriptions
4. Possible real-time requirements
5. Requirement for multiple access to programs and data
6. Constantly changing data bases
7. Extremely high penalties for major system failures

Examples of such problems today include operating systems for large-scale computers; manufacturing systems for large aircraft;

construction, retrieval, and analysis of large data bases; air traffic control; management information systems, command and control systems; (here follows a list of other problems)

These problems fall into a category that represents an important area concurrent to and perhaps a part of computer science. Some of what has been called "systems engineering" or "operations research" falls directly into this problem area.

Such systems have in the distant past been organized out of groups of human beings as control elements, human-accessed data storages, and direct human communication. The coming of the computers, as well as the expansion of applications of physics and technology, now requires effectuation (and automation) of systems in which humans can no longer play a detailed part. Where in the older system they served as local control elements, the response time and data rates required no longer allow this participation.

Such systems must now be developed by teams of human beings no one of whom, in general, can view the problem as a whole. The digital computer now serves as data storage, communications device and monitor, control element, and manager of the overall activity. The systems are characterized by complex mappings into present-day computer structures, and need for optimization within a set of complex constraints.

The design of such systems, and their prototype construction via computer programs, is today in its infancy. Examples up until now have ranged from successful special purpose systems for one-problem applications (such as airlines reservations) to less successful general purpose systems for improvement of computer utilization (such as batch and time-sharing operating systems.)

It is in this area that there appears to be a lack of organized instruction in higher education, here or anywhere, at the present time.

Without the educational development of persons who can work on the computer-oriented portions of such problems, the problems will be able to be attacked only on a case by case basis. It is expected that the fundamentals of computer science will serve as a scientific basis for the education of such persons, but that special areas and tools of application must also be taught.

The products of such an educational curriculum will serve as the cadres of the teams that will construct the computer program portions of such systems. (continue)

One of the requirements of such an educational experience is the availability of an effective laboratory experience. (continue)

Conventional undergraduate mathematics

* Important
** Important need more

Mathematics

*Logic

*Algebra (???--

Analysis

Geometry (linear, projective)

*Information/communications theory

**Probability

Mathematical sciences

**Mathematical Statistics

**Data Analysis

**Operations Research {queuing theory, optimization theory,

*Math linguistics {mathematical programming

**Design of experiments

*Numerical analysis - optional control theory

Engineering

Solid state devices — Computer circuits; Computer memories

Mechanical engineering

Philosophy/history of science/mathematics

**"Scientific method" (Polya/Poincare study)

Psychology

Learning theory

Central nervous system

**I/O channels - to/from memory and intuition

**Problem solving

**Perceptual mechanisms--gestalt, etc.

Areas of application

Any/all

Computer Science

Formal languages

Hardware behavior

Computer algorithms

Linguistics

Automata/machines

Descriptive

Error detection/reliability

Semantics

Pattern recognition

Syntactics

Interactive programming

Artificial intelligence

Areas in the mathematical sciences which students with an undergraduate major should give increased attention as certainly useful for research in computer science:

Special attention needed, with certainty:

- More algebra
- Probability
- Mathematical statistics
- Data analysis
- Operations Research (queuing theory, optimalization theory, mathematical programming)
- Design of experiments
- Combinatorial analysis

Special attention deserved, good bets:

- Human I/O channels, including perceptual mechanisms; memory and intuition,
- Scientific method/problem solving (history/philosophy of science, Polya/Poincare, psychology)

Is there similar list for engineering and physical bachelor graduates?

A PROPOSED UNDERGRADUATE COMPUTER SCIENCE PROGRAM

Dr. Alan J. Perlis

	Freshman	Sophomore	Junior	Senior
1st Sem.	1. Anal I	Alg I	Prob & Stat I	OR II
	2. Prog I	Prog III	Comp.Sys. II	Abstr. Sys. III
	3. Phys I	Anal III	Lab II	Elect. II
	4. Hum.	OR I	Abstr. Sys. I	Elect. III
	5. Hum.	Hum.	Hum.	Hum.
2nd Sem.	1. Anal II	Lab I	Prob & Stat II	OR III
	2. Prog II	Alg II	Abstr Sys. II	Comb. Anal.
	3. Phys II	Prog IV	Lab III	Administration and finance
	4. Hum.	Comp. Sys. I	Elect. I	Elect. IV
	5. Hum.	Hum.	Hum.	Hum.

NOTES:

Hum = Humanities
Prob. & Stat. = Probability and Statistics

Programming I - IV

1. Algorithms, programs and language organized by data
2. structures
3. Machines and their programs
4. Problems associated with the management of programs: file systems, libraries; and Proofs of termination and correctness; Verification, representation and documentation of programs

Computer Systems I and II

1. Devices
2. Representation
3. Synthesis
4. System design

Abstract Systems I to III

Logic: Propositional Calculus; 1st order Predicate Calculus
Automata Theory: Finite state machines and regular expressions
Turing machines
Computability
Stages of computability
Math, Linguistics, correspondences (recognizers as machines)

Operations Research

OR I Optimization Techniques
OR II Simulation Techniques and modeling
ORIII Processing requirments of large data systems

Computer Science Laboratory I - III

1. Building, enhancing, auditing a sub-routine library
2. Interfacing two systems
3. Design of a system
4. Completion of a system
5. Managing a system design and construction

Sub college education — A. Forsythe

It seems appropriate that this group give some consideration to pre-college education.

1. The increasing impact of computers on the life of the average American requires that every person understand something about them. Secondary school is a natural place for this. Since schools are pre-organized into departments such as mathematics, science and business which should teach computing? What should be taught?

2. The resources group sees 100,000 persons going into computing each year. All these people go through secondary school--even those who never get to college. Would their education be more relevant if they had had a computing course in highschool? What computing? How?

3. The present trend in highschool mathematics is toward including more and more calculus. Two full semesters of college level calculus are increasingly offered at the secondary school. Should this trend be encouraged? Would a computing course be preferable? Or some other mathematics?

4. Many processes that children learn to execute in elementary and secondary school are easily expressable as algorithms. In fact some children understand and remember an algorithmic expression (by flowchart for example) better than they do the equivalent version of English sentences or mathematical equations. If this type of activity were explicitly encouraged by this group, it might be taken up by more curriculum creators.

Computer literacy activity in secondary schools is growing very rapidly. Guidance and direction on curriculum are urgently needed.

COMPUTER SCIENCE AND ENGINEERING BOARD

MARCH 18, 1970

ATTENDANCE LIST

ATTENDEES

BOARD MEMBERS

Prof. A. G. Oettinger, Chairman

Prof. Wesley A. Clark
Dr. Sidney Fernbach
Dr. Martin Greenberger
Mr. Jerrier Haddad
Mr. William Knox
Prof. W. F. Miller
Mr. Roy Nutt
Dr. Alan J. Perlis
Prof. J. B. Rosser
Dr. Alan F. Westin
Dr. Ronald Wigington

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Dr. Launor F. Carter
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ATTENDEES

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Dr. Madison B. Brown (in lieu of Dr. Edwin L. Crosby)
Mr. W. Melahn

ABSENTEES

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Mr. Harry Heltzer
Mr. William R. Hewlett
Dr. Robert W. Kreuger
Dr. Howard O. McMahon
Mr. William C. Norris
Mr. E. R. Piore
Dr. B. R. Stanerson
Mr. J. C. Wilson
Mr. Sam Wyly

Evening Agenda

NATIONAL ACADEMY OF SCIENCES

Computer Science and Engineering Board

18 March 1970 will be held in The Reading Room of the main National Academy Sciences Building located at 2101 Constitution Avenue, N.W.

Executive Support Staff, Room 536, Joseph Henry Building, Washington, D. C.
Phone (202) 961-1386

NATIONAL ACADEMY OF SCIENCES

COMPUTER SCIENCE & ENGINEERING BOARD
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

17 March 1970

FOR CS&E BD-STAFF ONLY

21ST MEETING

EXECUTIVE SESSION
AGENDA

Evening Session
(1830 hours to 2000 hours)

The Evening Executive Session of the Board will start at 1830 hours and extend to 2000 hours. The meeting will be devoted to discussions of

(a) new business prospects;

(b) possible changes in the NAS organization, operating doctrines and methods, acknowledged responsibilities, etc.

(c) possible changes in the mission and function of the CS&E Board;

(d) possible changes in CS&E Board organization structure, activities and procedures; and,

(e) such other matters as may be properly brought to the Board's attention.

NOTE: Please do not let the generic nature of the topics mislead you. This trip should be well worth the price of the ticket.

FOR CS&E BD-STAFF ONLY

Day Agenda

NATIONAL ACADEMY OF SCIENCES

Computer Science and
Engineering Board

DAY AGENDA - Change in:

Dr. Ling wil present his briefing
at 2:00 p.m. in lieu of the scheduled
time (11:15 a.m.)

Executive Support Staff, Room 536, Joseph Henry Building, Washington, D. C.
Phone (202) 961-1386

NATIONAL ACADEMY OF SCIENCES

COMPUTER SCIENCE & ENGINEERING BOARD
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

18 March 1970

FOR CS&E BD-STAFF ONLY

21ST MEETING

EXECUTIVE SESSION
AGENDA

Day Session
(1000 hours to 1700 hours)

CS&E ANNUAL MEETING FOR PROGRESS REPORTING

10:00 a.m.	Introductory remarks by the Chairman
10:15	Progress and status report by the Chairman of the CS&E Panel on Education and Computer Sciences and Engineering --Dr. Alan Perlis
10:45	Progress and status report by the Chairman of the CS&E Panel on the Data Base Problem --Dr. Sidney Fernbach
11:15	Progress and status report by the Chairman of the CS&E Panel on the Computer Export Problem --Dr. Donald Ling
11:45	Progress and status report by the Chairman of the CS&E Panel on the Data/Communications Problem --Mr. Lewis Billig
12:15	LUNCH -- At local restaurant
1:30 p.m.	Progress and status report by the Chairman of the CS&E Panel on Information Systems. --Dr. Ronald Wigington
2:00	Progress and status report by the Chairman of the CS&E Panel "A" on National Programs --Dr. Launor Carter
2:30	Progress and status report by the Chairman of the CS&E Panel "B" on National Programs --Mr. Jerrier Haddad

FOR CS&E BD-STAFF ONLY

FOR CS&E BD-STAFF ONLY

3:00 Progress and status report by the Chairman of the CS&E Panel for surveying patterns of computer industry support for computing activities in colleges and universities

--Dr. William Miller

3:30 Progress and status report by the Chairman of the CS&E Panel for the inquiry into Privacy and Computerized Data Banks

--Dr. Alan Westin

4:00 Comments by the Chairman as to future undertakings of the Board and environmental trends which may bear on such undertakings.

NOTE: The sequence and timing of the above are arbitrarily chosen. Anyone wishing to make changes to meet his time or travel requirements should negotiate with the holder of the time to be traded. Trades may be made up to the time the meeting starts. Please notify the CS&E Support staff of all such early changes so that an updated agenda may be distributed at the meeting. Last minute changes just prior to the meeting may be made by contacting the Chairman or the Secretary. (Dr. Oettinger - 617-868-6155; Mr. House - 202-961-1386)

Attached for the convenience of the Panel Chairman are:

(a) an updated statement of the basic mission and current task of each of the operating Panels, and

(b) a suggested guide for assuring coverage of the mini-essentials in each of the Panel Chairman's report to the Board.

FOR CS&E BD-STAFE ONLY

Background Papers

FOR CS&E BD-STAFF ONLY

NATIONAL ACADEMY OF SCIENCES

COMPUTER SCIENCE & ENGINEERING BOARD
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

Attachment

NAS PRIVILEGED

Version III
29 February 1970

PANEL MISSION AND STATUS

CS&E Panel for Computer Science & Education, Dr. Alan Perlis

Mission -- to devise ways and means for assuring an adequate flow of expert and skilled manpower to meet the emerging requirements in colleges and universities, in the computer industry, in the computer application areas of both government and the Private Sector.

Initial concentration is upon the problems connected with training manpower needed to staff the computer departments of the colleges and universities. Conference report is due out within the next two or three months. (NSF Project)

Entire result should contribute significantly to the development of computer science and engineering.

Data Base Panel, Dr. Sidney Fernbach

Mission -- to establish the parameters of and the flow of information relating to the CS&E field, to define critical gaps, and to devise ways and means of filling such gaps, and to monitor generally the adequacy of the flow and distribution of such information. (Board Project)

Initial efforts of the Panel are (a) concentrated upon working out specific programs which various government departments can undertake to fill certain critical gaps and (b) providing data in support of other CS&E Panels.

Entire result of this Panel's work should contribute substantially to the development of the computer science and engineering field.

LEND ROOM

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Export Panel, Dr. Donald Ling

Mission -- to provide continuing support to DoDR&E, OST, and the Department of State in the computer export area.

Initial concentration has been upon production of a series of technical evaluations of various aspects of the computer export problem. A draft report from the '69 Summer Conference inventories the state of our knowledge regarding critical aspects of the computer export problem and defines critical gaps in our knowledge. A follow-up program to be undertaken shortly will concentrate upon ways and means of remedying such gaps. (Joint DoDR&E, State, OST Project)

The work of this Panel contributes directly to expanding the frontiers of our understanding of computer science and engineering.

ROUGH DRAFT

Data/Communications Panel, Mr. Lewis S. Billig

Mission -- to continuously monitor developments in this dynamic field, to tentatively define emerging problems warranting the attention of the Board, to take informal initiatives as necessary to test the feasibility of Board actions, to recommend action considered appropriate for the Board and methods for accomplishing the recommended actions.

The initial task of this Panel is to do a technical analysis and evaluation of the difficulties arising from the attachment of various interconnecting devices to the "common carrier voice communications system." Inasmuch as this problem area is undefined and unexplored, the initial effort is designed to create the essential literature of the field, to define critical technical and systems problems, and to weigh these in light of both the short and the long-term. The report is scheduled for delivery to the FCC during or shortly after April, 1970. (FCC Project)

Information Systems Panel, Dr. Ronald Wigington

Mission -- (1) to assess the potential for application of computer science and engineering principals to meet national needs for efficient and effective information systems of all kinds; (2) to identify the roadblocks to the more effective

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and rapid employment of computer science and associated technologies to information handling problems; and, (3) to focus national level attention on the need for appropriate actions arising from (1) and (2).

The initial effort by this Panel is to make a study leading to the identification and development of sound computer science and engineering principals for applying computers, computer systems and related technologies to various information handling problems, with emphasis on the national library system. The Panel has made its first visit in a scheduled field survey of selected developmental or experimental technical information handling systems and major conventional libraries. (Council on Library Resources Project)

The work of the Panel will contribute directly and significantly to expanding the frontiers of our knowledge in the computer science and engineering field.

ROUGH DRAFT

National Programs Panel "A", Dr. Launor Carter

Mission -- to examine the general state of the computer science and engineering field, viewed from the national level, as one means of exploring what actions might be taken at the national or regional levels to benefit the field.

Initial efforts of the Panel concentrated upon the R&D programs in the computer science and engineering field and related non-substantive activities in being and being promoted which are significant in the "national level" context. Report has been submitted to the Board which accepted it as an internal staff paper for use only within the Board. (Board Project)

The work of this Panel should contribute directly to our understanding of our "institutional forms" and their processes, how these relate to the computer science and engineering field and their implications for possible Board actions.

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National Programs Panel "B", Mr. Jerrier Haddad

Mission -- to explore the feasibility of devising a "national level program" designed to further the development of the computer science and engineering field, and to define the appropriate role of elements in the U.S. government and the Private Sector in such a development.

The initial approach is to identify and evaluate the various existing activities which might be considered elements in such a "national level program." The outcome of this effort, as well as the form it might take, are uncertain at this point. (Board Project)

If successful, this Panel's work could contribute critically to assuring the needed goals, momentum and directions to the computer science and engineering field.

ROUGH DRAFT

Survey of Patterns of Computer Industry Support for Computer Activities in Colleges and Universities, Dr. William F. Miller

Mission -- to explore the feasibility of divining motivations and future attitudes of both donors and recipients which could affect the trends in computer industry support of computing activities in U.S. educational institutions.

Initial efforts concentrated upon selected computer companies active in the support of computing activities in colleges and universities. Report has been approved by the Board and is in final stages of editing. The report should be delivered to the National Science Foundation within a week or so from this date. (NSF Project)

This report will contribute only marginally, if at all, to our understanding of the computer science and engineering field.

Privacy Panel, Dr. Alan Westin

Mission -- to monitor developments in the computer science and engineering field and in the closely related fields of communications and information handling, including related technologies, with particular reference to events or trends which may impinge

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upon the privacy of individuals in our society.

The initial task of this Panel is to survey and assess development in large, computerized data banks, related activites and technologies as they may affect the privacy of individuals in our society and due process in law.

The project will run for about 24-30 months from this date, and will culminate in a comprehensive report. The first task is to survey selected data banks throughout the country. Preparatory work is underway and the survey of data banks is scheduled to start within a few months. (Russell Sage Foundation Project).

This effort will contribute significantly to our understanding of various aspects of computers and their associated processes as they affect our society, our institutions and the individual.

ROUGH DRAFT

Standards Planning

In the Planning Group stage. No recommendations have been made to the CS&E Board. A Chairman is being sought.

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NATIONAL ACADEMY OF SCIENCES

COMPUTER SCIENCE & ENGINEERING BOARD
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

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SUGGESTED TERMS OF REFERENCE FOR CS&E PANEL CHAIRMAN'S ANNUAL PROGRESS REPORT TO THE BOARD ON MARCH 18, 1970

Attachment
4 March 1970

I. INTRODUCTION

Statement of the mission and functions of the Panel, its nature and general responsibilities as to: length of life; orientation, i.e., task problem/basic research; substantive focus or area of concentration, i.e., privacy and data banks, basic data flow of CS&E field, etc.; sponsor or customer, i.e., NSF, FCC, Russell Sage Foundation, CS&E Board, etc.; nature of sponsor's interest, i.e., continuous, spaced burst, intermittent burst, waning, rising, etc.; nature of the problem, i.e., speculative, innovative, fact gathering, analytical, action programmatic, tutorial, and the like.

II. BODY OF DISCUSSION

The substantive nature of the problem in somewhat greater depth than above;

The Panel resources and approach to the problem/task;

How much of the job has the Panel completed to date?

How much remains to be done?

Is the task/problem dynamic linearly, prolifertaionally, complicatingly?

Is the problem/task universe expanding at a rate faster than the speed of the Panel's pursuit? Equal to? Slower than?

Is the problem/task relatively static but huge?

How does the Panel plan to respond to this? What does this mean in terms of the Panel's future pursuit? Deceleration? Lighting the afterburner? Increasing troops, money other resources? Closing down?

ROUGH DRAFT

FOR CS&E BD-STAFF ONLY

FOR CS&E BD-STAFF ONLY

III. FUTURE PLANS AND PROGRAM FOR THE PANEL

Does the Panel expect to complete its work during the next 12 months? 18 months? 24 months? Longer?

Does the Panel expect to change its scope and mission? Its area of concentration? Its priority structure?

If so, in what ways? At what times? For what purposes?

Does the Panel expect to develop or use new approaches, techniques or methods?

Are there particular problems that should be noted for the Board's attention?

IV. QUESTIONS AND ANSWERS

ROUGH DRAFT

FOR CS&E BD-STAFF ONLY

FOR CS&E BD-STAFF ONLY

9:00 Jr
MAR 3 RECD

NATIONAL ACADEMY OF SCIENCES

OFFICE OF THE PRESIDENT
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

March 3, 1970

MEMORANDUM

TO: All Professional Staff

FROM: Philip Handler PH

The attached memorandum presents a set of procedures that we will be following to assure more appropriate and effective review of our published reports.

As you know, the Academy publishes reports dealing with a vast array of concerns and having a variety of purposes and audiences. Our objective in developing these procedures is to provide a useful system for giving each report the kind of attention that its particular character requires.

Some reports, exclusively technical or reportorial, require no special evaluative review except editorial. Others should be very carefully considered because their content is directly concerned with matters of great public consequence. And between these extremes are many grades of varying import. We want to be as sure as we can that we handle all cases as appropriately as possible, as well as expeditiously.

One part of the attached material is an informational form, which will be submitted to the Executive Office, through your divisional or major office, in connection with each new work project that involves the creation of a report. As a first order of business, I ask that you complete this form for all work projects now in progress, realizing that for the most part, this will be largely for purposes of information.

I invite your careful attention to the memorandum attached, and request your continued cooperation. Our published reports are our principal tangible means of representing the Academy and its work. I must lean heavily upon the efforts of all our staff for assurance that they are as well done as we can make them.

Enclosures

FOR CS&E BD-STAFF ONLY

FOR CS&E BD-STAFF ONLY

NATIONAL ACADEMY OF SCIENCES

OFFICE OF THE PRESIDENT
2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

March, 1970

MEMORANDUM

TO: All Professional Staff Personnel, National Academy of Sciences-National Research Council

FROM: Philip Handler

SUBJECT: Review of Reports

As you are well aware, the advisory activities of the Academy and the Research Council have, over the past few years, become increasingly significant on very broad technical and political fronts. The principal means of making known the results of the work of our committees, both to those directly concerned and to wider audiences, continues to be our reports. Accordingly, it is increasingly important that we give the most careful attention to the preparation of these documents as representative of the content and quality of all our work. We owe this to the impressive number of individuals who freely commit their time and energies to the projects undertaken by a great variety of Academy and Research Council working groups. We owe it to the membership of the Academy, in whose name our reports are presented. And we owe it to ourselves as the permanent working staff of our organization, as a continuing guarantee of the effectiveness of our efforts.

Because the task of reviewing all reports would overwhelm the Executive Office, because such review frequently requires the collective wisdom of individuals of differing backgrounds and competence, and especially in order to relate the Academy more closely to the work of the Research Council, I have asked a representative committee of members of the Academy, to be known as the Report Review Committee and to be chaired by the Academy's Vice President, Dr. Kistiakowsky, to participate on a continuing basis in the necessary review of our reports. Mr. Robert Green will, in addition to his duties with the Committee on Science and Public Policy, serve as staff officer.

To assure that the Executive Office is kept adequately informed of progress from initiation to completion of all reports, a set of required procedures is outlined below which embraces the essentials of the procedural memorandum issued by Mr. Coleman on April 21, 1969. Those requirements are modified mainly to provide us with earlier information on the initiation and planning of projects, specifically those leading to published reports, and to ensure timely and appropriate review. The intent of this directive is to assure the effectiveness of our procedures for the best possible accomplishment of our tasks.

FOR CS&E BD-STAFF ONLY

As you know, the responsibilities of our Publications Editor, Mr. Robert Hume, include providing necessary advice and assistance in editorial matters to all staff personnel, and keeping the Executive Office informed concerning the development and processing of reports. Mr. Hume, in addition to his continuing responsibility for the general editorial quality of reports, will be responsible for assurance that the procedures described below are followed. We anticipate that these procedures will minimize the time-consuming and frustrating necessities of re-doing and repair of faulty manuscripts after presentation for final approval to the Publications Editor.

General Procedures

Attached is a form, which is to be completed by the responsible staff officer as soon as possible after initiation of work on a new task. With the approval of the executive secretary of the appropriate division, or the director of an office, the form is to be forwarded to the Executive Office. Use of this form will be required whether the new task results from a new contract, amendment to an existing contract, or simple assumption of a new task under the terms of an existing, relatively broad contract. In general, the form would most appropriately be completed after the first meeting of the working group which, later, will draft the report.

1. Title of Project and Tentative Title of Report
   Originating Unit
   Project Staff Officer
   Sponsoring Agency
   Chairman of the Project Committee
2. Tentative identification of scope of the document to be produced as a publication, i.e., what it will contain:

   a. technical information
   b. recommendations concerning federal agency programs and/or policies
   c. recommendations concerning other types of public policy
   d. minutes or reported proceedings of meetings
   e. collection of symposium papers
   f. other

3. Scheduling:
   a. Contract deadline date
   b. Date of availability of draft for review

4. Proposed distribution, i.e.:

   a. by public sale
   b. by free distribution
   c. transmittal to a government agency for public release
   d. transmittal to a government agency for internal government use
   e. transmittal to a congressional committee
   f. transmittal to a private sponsor for internal use
   g. transmittal to a private sponsor for public release
   h. other

5. Proposed review procedure, as approved by division or major office, i.e.:

   a. by parent body of the committee
   b. by outside readers of recognized competence in relevant fields, selected by the parent body
   c. by executive committee or other delegated members of National Research Council division
   d. by Committee on Science and Public Policy
   e. by a panel of the Report Review Committee

If a report is to be security classified, this should be noted so that an appropriately cleared group can be selected for the review.

If, in the course of a project, there are significant modifications of the facts contained in the project information form originally submitted, these changes should be made known to the Executive Office. This should be done by submitting a revised set of the report forms with a covering memorandum stating that this is a follow-up on the earlier set.

All documents to be distributed outside the NAS-NRC will be considered as reports, except business correspondence, Proceedings of the National Academy of Sciences, and documents specifically exempted by the Executive Office. Each will be given a Report Number by the Executive Office upon receipt of the form statement described above; the system of Report Numbers will be used for internal control purposes only. After receipt of the form statement, the Executive Office will inform the project staff officer through his division or other office that the proposed review plan for a report has been approved, or that certain modifications appear necessary. The details of the review procedures are outlined below.

All numbered documents must be submitted, prior to reproduction, to the Publications Editor, accompanied by a written statement of approval by the relevant reviewing body. The Publications Editor will approve a manuscript report for publication when (1) it has been reviewed and certified according to the general requirements outlined here, and (2) it is acceptable in editorial quality. (A rule-of-thumb is that manuscripts must be of such quality as would be acceptable to a reputable professional journal.) If the manuscript does not meet these requirements, it will be returned to the originating office.

Review Procedures

The review process will be most useful and effective, of course, if early drafts of reports are brought under review. Thus, the nature and mechanism of the review of any given report should be decided upon well before preparation of the first draft.

1. Documents of exclusively technical, reportorial, or administrative content, and not including conclusions and recommendations regarding government policy or public policy with any likelihood of being of general public interest require review by the executive committee of the relevant Research Council division, or, where there is one, the parent standing body.

2. Documents with significant policy implications, including all those containing recommendations regarding expenditure of public funds, require review by a group of broadly representative Academy members selected for the purpose by the Report Review Committee, or by the Committee on Science and Public Policy, or by a parent standing body if it is broadly constituted.

3. Minutes or proceedings which contain conclusions and recommendations by the committee involved and are being distributed for other than internal purposes only, must be reviewed in the same manner as are reports of similar scope and purpose.

4. Collections of symposium papers, if they are just that and do not contain conclusions and recommendations by the relevant committee, and include only statements attributed to individuals, need be reviewed only by the Publications Editor.

5. If a document falls into none of the categories referred to above, it should be brought to the attention of the Executive Office of the Academy.

In general, review procedures for any given document will depend upon the scope and proposed distribution of the document. In every case, however, review must be made by a group not directly involved in the preparation of the document. The intent of the review is to provide an in-house test of acceptability and effectiveness of a report for its intended audiences, and to provide some guarantee that the character and purposes of the report will be correctly interpreted by its readers. Another important effect will be to increase the active participation of Academy members in the affairs of the Research Council.

In the event of irreconcilable disagreement between the committee responsible for preparation of a given report and the revieving body, responsibility for final decisions must rest with the President, as in the past. In such instances the President may consult with the Academy Council or the Research Council Governing Board should he consider such procedure desirable.

No report, at any stage of its preparation, should be transmitted to a sponsoring agency or organization until it has been through the appropriate review procedure and approved, unless expressly exempted by the Executive Office.

FOR CS&E BD-STAFF ONLY

REPORT REVIEW FORM

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

1. TITLE OF PROJECT AND TENTATIVE TITLE OF REPORT

SUBMIT IN TRIPLICATE (Retain yellow copy.)

_____

_____

Originating Unit _____ Project Staff Officer _____

Sponsoring Agency _____ Chairman of Project Committee _____

2. TENTATIVE IDENTIFICATION OF SCOPE OF DOCUMENT: (*Check one or more*)

- ☐ **a.** Technical Information.
- ☐ **b.** Recommendations concerning federal agency programs and/or policies.
- ☐ **c.** Recommendations concerning other types of public policy.
- ☐ **d.** Minutes of reported proceedings of meetings.
- ☐ **e.** Collection of symposium papers.
- ☐ **f.** Other (*specify*) _____

3. SCHEDULING:

a. Contract deadline date _____ **b.** Date of availability of draft for review _____

4. PROPOSED DISTRIBUTION: (*Check one or more*)

- ☐ **a.** Public sale.
- ☐ **b.** Free distribution
- ☐ **c.** Transmittal to a government agency for public release.
- ☐ **d.** Transmittal to a government agency for internal government use.
- ☐ **e.** Transmittal to a congressional committee.
- ☐ **f.** Transmittal to a private sponsor for internal use.
- ☐ **g.** Transmittal to a private sponsor for public release.
- ☐ **h.** Other (*specify*) _____

5. PROPOSED REVIEW BY: (*Identify*)

- ☐ **a.** Parent body of the committee: _____
- ☐ **b.** Outside readers of recognized competence in relevant fields, selected by the parent body: _____
- ☐ **c.** Executive committee or other delegated members of National Research Council division: _____
- ☐ **d.** Committee on Science and Public Policy.
- ☐ **e.** Panel of the Report Review Committee.

Date _____ Signature (Staff Officer) _____

Date _____ Approved by Division Executive Secretary, Director of Office _____

REMARKS: (for Executive Office Use)

Signature (Executive Office Approval) _____ Date _____ Executive Office Report Number _____

NATIONAL ACADEMY OF SCIENCES

Computer Science and Engineering Board

The attached revised list of Board Members is to replace the List of Board Members in your SMART Book.

Executive Support Staff, Room 536, Joseph Henry Building, Washington, D. C.
Phone (202) 961-1386

Revised 16 March 1970

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NATIONAL ACADEMY OF SCIENCES

Computer Science and Engineering Board

Attached are two additional items for inclusion in your SMART Book. They are as follows:

1. Revised List of Board Observers
2. List of Panel members for the Computer Data Bank (Privacy) Panel

Executive Support Staff, Room 536, Joseph Henry Building, Washington, D.C.
Phone (202) 961-1386

Revised 17 March 1970

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Notepaper