10/9/69

K. H. OLSEN

CS&E Board Meetings will now start at 6:00 p.m. and end at 4:00 p.m. the next day.

Ken's first choice of hotels is the Watergate, then the Sheraton-Carlton

DIGITAL EQUIPMENT CORPORATION

19 February 1971

Mr. Bruce Henderson
President
The Boston Consulting Group, Inc.
No. 1 Boston Place
Boston, Massachusetts
02106

Dear Mr. Henderson:

In response to a query from us a few days ago regarding various points of expertise on the computer industry in Japan, Ken Olsen, President of Digital Equipment Corporation, indicated that he thought very highly of your organization and that you made a speciality of the Japanese industry. Ken suggested that your views in regard to a study we are undertaking would be of considerable value.

Let me say a word about the Panel and its work. The Computer Technology and Resources Panel is a permanent part of the machinery of the Computer Science and Engineering Board of the National Academy of Sciences. (Attachment 1 shows the current membership of the Board.) Its government sponsors are the Departments of Defense and of State and the President's Office of Science and Technology, but it maintains close contact with Commerce and other government agencies. The Panel's charter is to maintain itself in a position to give timely and informed advice, solicited or unsolicited, to our sponsors on all matters relating to computers and data processing, particularly but not exclusively with respect to questions of export of machines or technology. The Panel is eclectic in its composition, having expertise in economics and political science as well as in the computer arts themselves. (Attachment 2 shows the current membership of the Panel.)

For the next half year the Panel is making a study of the Japanese computer industry and usage in all its aspects, hoping to emerge with a fairly complete picture of what this relatively new and vigorous phenomenon portends for the future in the technical, social, political and mercantile areas.

We have so far conducted a number of meetings and heard many useful and expert briefings, but we have come to feel that we will be unable to do what needs to be done without more or less organized support from the private sector of the U.S. that has technical contacts and experience in Japan. Accordingly, we are asking various U.S. companies if they will individually do in-house studies for us or assist us in some other ways which we can use as the basis for our work. In Attachment 3 I offer a checklist of the topics we would like to see considered in each study. We would hope that each organization would respond to all topics to the best of its capabilities since this would give the panel the benefit of multiple judgments in writing its report and coming to appropriate conclusions and, as warranted, recommendations.

The various individual studies or other forms of assistance would be held completely compartmented under Academy "privilege" and in their totality would be available only to members of the Panel and the Computer Science and Engineering Board chairman. The final report of the Panel will be the property of our three sponsoring agencies, and the decision is theirs as to release of all or part of it. The report would, of course, be free of ascription to the individual industry studies or other forms of assistance. However, each contributing company will be listed as a participant in the study.

As to time scale, we would hope to have our report in hand some six months or so from now, about 1 September. Backtracking from this date suggests that the industry studies should be carried out in approximately the period 1 February to 1 April so that the material might be available to the Panel by about mid-April. I would hope that this schedule plus the checklist would give some idea of the required level of effort. Other forms of assistance, such as expert testimony, review of Panel drafts, etc., would be appropriately timed.

We realize that what we are asking is no small thing, but we feel that a study such as we propose would be in the national interest, and we are convinced that support from organizations such as yours is necessary to assure the required level of quality in the report. We will be most grateful if you are able to help us in any way. We believe that our output might in some small way be of benefit to you and others concerned with computers and their applications.

We would not, of course, presume to indicate the nature or the extent of the contributions that you could make to this study. Professor Oettinger, Chairman of the Computer Science and Engineering Board, or Dr. Donald P. Ling, Chairman of the Computer Technology and Resources Panel will call you in the near future to explore further the feasibility of your participation in this study and the nature and extent of the assistance that you might be able to provide.

Sincerely,

Warren C. House
Executive Secretary
Computer Science and Engineering Board

cc: Prof. A. G. Oettinger
Chairman, Computer Science and Engineering Board

Dr. John R. Pierce
Vice Chairman, Computer Science and Engineering Board

Dr. Donald P. Ling
Chairman, Computer Technology & Resources Panel

Mr. Kenneth Olsen,
President, Digital Equipment Corporation

Attachments:
(1) Current CS&E Board membership
(2) Current Computer Technology & Resources Panel membership
(3) Check list of topics
(4) Press release re CS&E Board
(5) Project List

WCH/laa

NAS

NATIONAL ACADEMY OF SCIENCES

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

7 October 1970

Please note the following change in room location and telephone numbers for this organization.

In the Joseph Henry Building
21st and Pennsylvania Avenue, N. W.
Washington, D. C. 20418

From Room 536 to Rooms 840 A,B,C,& D

Telephone numbers effective 7 October 1970 - Area Code 202
961-1384 (rotary)

JK

Jack F. Kettler
Assistant Executive Secretary

NATIONAL ACADEMY OF SCIENCES

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

NOV 13 1970

9 November 1970

MEMO TO: The Chairman and
Members, Information Systems Panel

FROM: Jack F. Kettler JFK

SUBJECT: December Meeting at Dallas with University Computing Company

Our UCC contact, Richard Coleman, informs me that they have arranged for the Panel to meet with them at 9:15 a.m., 1 December 1970. (We had asked for 2 December.)

Thus, the details are:

1 December 1970 for meeting with University Computing Company
Time: 9:15 a.m.
Address: 1949 Stemmons Freeway, Dallas, Texas 75222 (Fifth floor)

UCC personnel: Dr. Dan Scott, Corporate Staff, John Coleur, Systems Development Division, and Andrew H. Fowler, Computer Utility Network.

2 December 1970 for meeting of the Panel, same location

The motel previously suggested is:
Marriott Motor Hotel
Stemmons Freeway
Dallas, Texas 75222
(214) 748-8551

Please make your own reservations and drop me a note concerning your attendance. It is a foregone conclusion that Terry Baker, and, of course, Gerry Salton will not be present and this is near the end of the field visits, so please give this one priority. (Per Ron W., okay?)

JFK/bla

Al Hanson

[illegible]

[illegible]

NATIONAL ACADEMY OF SCIENCES

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

23 November 1970

Mr. Kenneth Olsen
President
Digital Equipment Corporation
146 Main Street
Maynard, Massachusetts
07154

Dear Ken,

Attached is a statement of Board policy and organization which we have worked out in connection with our efforts to secure funding for the Board during the forthcoming year. These efforts have included ARPA, DoDR&E, and various elements of the government concerned with science and technology in general and with computer science and engineering in particular. There appears to be considerable interest in funding specific tasks in the CS&E area. We should have further information regarding this either before or at the scheduled Board meeting on December 15 and 16, 1970.

The Board Policy draft contains a codification of past Board customs and procedures, some moderately significant shifts in the center of gravity of certain policies, and some different organizational concepts and procedures. In general, the paper contains more detail than any previous one.

Much of the content of this Board policy paper arose directly and indirectly during discussions with the various prospective sponsors/ customers as we explained the nature of the Board's activities and answered specific questions regarding methods of Board operation, access to the Board's deliberations, access to the Board products, and the like. Timely access to the Board products at various stages of their development, if necessary at the sacrifice of polish and formality of the publication vehicle, was a strong interest expressed by all. This consistent concern is reflected on Page Seven in the section of Board Publications. Concern for high quality of the content of the Board's product is reflected on Page Nine in the sections on Board research policy and Board responsibility for report content and integrity.

Your response will be most useful if it arrives here by December 7. The review of the Board policy paper will be on the agenda of the December 15-16 meeting and additional changes may be made then.

Your Chairman, Secretary and other members of the Emergency Funding Task Force will be most grateful for your comments as to content, structure, extent of coverage, language, etc. Please call if you have any questions.

Sincerely,

Warren

Warren C. House
Executive Secretary

Attachment
As stated.

Ken - You might find the side-lined paragraph on 7 g is especially interesting.

cc: Dr. Philip Handler
President, National Academy of Sciences

Mr. John S. Coleman
Executive Officer, National Academy of Sciences

WCH/bla

DRAFT

12 November 1970

POLICY PAPER FOR THE COMPUTER SCIENCE & ENGINEERING BOARD

Introduction -- The activities of the Board are expected to increase substantially during calendar 1971. More requests for support and guidance will probably be made of the Board by government departments and staffs. The Board may also decide to take certain initiatives in areas of concern that are not adequately covered by requests for assistance. The expected increase in Board activities will probably arise, in part, because of past successes by the Board and because of rising interest in making use of computers as a tool for improving on traditional approaches and methods in both the government and the private sectors. The following general policy guides are designed to raise the readiness level of the Board to provide leadership and support at the national level for activities in both the government and the private sectors.

General Policy -- In order to provide the leadership needed in the computer science and engineering field, the Board will keep in close touch with developments in the field and with those organizations and individuals involved in these developments. The purpose will be to continuously review and evaluate those issues/problems/activities in which the Board can play an appropriate and effective leadership role of value to both the government and the private sector.

General Operating Policy -- The operating policy interests of the Board may be divided into two broad groups or activity areas, i.e., those concerned with the substantive content of the computer science and engineering field and those concerned with activities, problems or issues of the field. There is, of course, a large number of people and organizations in both the government and the private sectors which have a continuing interest in both areas. The Board has fairly broad options which it can exercise in its "initiative" inquiries or activities and rather specific obligations to provide support to various government elements when requested.

In exercising initiative, the Board shall address those activities, problems or issues of concern to the largest number of people and organizations in both the government and the private sector. In such initiatives, the Board will first make maximum efforts to utilize the people/organizations/activities already concerned with the problem, issue, or inquiry. The Board will undertake operational responsibility only when existing resources have been made full use of or where such resources do not exist in significant measure. In these latter cases, the prime aim of the Board will be to develop the needed resources and capabilities so as to pass to them as soon as possible the maximum share of the working and leadership role, thus freeing the limited Board resources for other needed initiatives.

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In the Board's response to requests for assistance and support from the government, the policy will be to make every possible effort to select those projects/areas which have high value to the substantive concerns of the computer science and engineering field and to those people and organizations both within and outside the government having related interests.

In the Board's response to requests for assistance from the private sector, the policy will be to select wherever possible those activities/issues/problems which are of broad importance to the nation and which should be or are of current concern to the U.S. government.

The Multi-Layered Problem -- The "problem" which the Board addresses is a bit complex and inclined to shift both its surface characteristics and its center of gravity. The Board's role as an effective instrument to provide national level leadership in the computer science and engineering field requires it to take cognizance of and selected actions in a wide range of activities. Leadership at this level includes: (1) fostering the most beneficial development and application of computer science and engineering in our society; (2) providing guidance and support to national policy level people in the federal government; (3) doing technical, though policy-oriented, studies for operating departments and staffs of the federal government; (4) assisting in the appropriate development of professional societies in the field; (5) supporting Congress in relation to legislation and to operating computer support systems as appropriate; (6) undertaking studies of computer-related issues of broad social or national significance, such as Privacy and National Data Banks, etc. With such rich diversity, the concept of constituencies is helpful. Attached is an excerpt from a paper prepared in April, 1970, for the Special Export/Technology Panel which deals with constituencies and lists some significant ones.

The following Operating Policies will apply to individual aspects of the Board and its activities.

Board Membership -- Members of the Board shall be selected to assure maximum expertise and competence in computer science, computer technology and computer applications, with due consideration for the National Academy of Sciences policy favoring geographic distribution where this can be done without significant sacrifice of competence. In general, appointment to the Board shall be for a three-year term as indicated by the general NAS policy for Boards, Committees, and the like. Membership of the Board may be expanded or altered at any time in order to provide the competence needed to provide expert support in new areas of the field. In general, the Board

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membership will be rotated on a schedule assuring that at any given point in time the majority of the members shall have no less than two years experience.

Exceptions -- Exceptions to the above to meet special circumstances may be made at any time by the Chairman, with the concurrence of the President of the National Academy of Sciences.

Board Organization and Responsibilities -- The Board shall have a Chairman, Vice-Chairman and Executive Secretary to perform the customary leadership and support duties. The Board will have an Executive Committee comprised of the Chairman, Vice-Chairman, the heads of the three major Board areas, and the Executive Secretary. The committee will be supplemented as appropriate by Board members with expertise related to a given issue.

The Board will have a Planning and Programs Committee comprised of the Chairman, Vice-Chairman, the heads of the three basic areas, the Executive Secretary and such other members as the Chairman may select. The Committee will be responsible for developing, continuously reviewing and evaluating the research program and other related activities of the Board, for reporting quarterly and annually on the status of the program, and for recommending appropriate actions to the Board, particularly in regard to changing priorities in the field and to mid- and longer-term prospects of importance to the Board. The Plans & Programming committee may draw upon the expertise of government observers and experts from the private sector. For longer-term or complex problems cutting across the three basic areas and for which there exists a broadly based constituency, such as the on-going interpact between computers and communications, the Chairman may appoint Program Directors.

The Board will have a Product Review and Evaluation committee which will be responsible for pre-Board review and evaluation of papers, reports, etc., being produced for either contract sponsors or initiative distribution to broader constituency areas. "Ad Hoc" panels established by Board initiative or in response to requests for Board action will be headed by a Chairman to be appointed by the Board Chairman. In Board initiative matters, the Panel Chairman will be appointed by the Chairman, with the concurrence of the Board. In the case of panels set up in response to requests for support or assistance, the Panel Chairman, with the concurrence of the Board and the President of the Academy. The appropriate Board area group(s) will have general cognizance of the "ad hoc" panel activities related to its area

will be appointed by the Chairman

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FOR CS&E BD-STAFF ONLY

of responsibility.

The Board will be divided into three comparable groups which will have continuing responsibility for the following three areas: (1) computer science; (2) computer equipments, technologies and associated technologies; and (3) computer applications and associated technologies. These responsibilities will include monitoring the developments in the area, developing a research program for the area, designating priorities for Board initiatives, guiding, evaluating and adapting these initiatives, providing leadership and guidance to the task-oriented "ad hoc" or "standing" Panels concerned with the area, recommending to the Board the establishment of task or problem oriented Panels, making preliminary evaluations of various Board outputs, and acting as the Board's general agent for the area.

All of the above committees may meet separately from the Board meetings, or in conjunction with the Board. All may draw upon Board members, government observers, or experts from the private sector for assistance and guidance in performing their work for the Board. Actions or decisions taken by the Executive Committee for the Board shall be considered to represent the Board, unless the Committee explicitly indicates that the action taken should have subsequent Board review and approval.

Board Meetings -- The Board shall meet once each month or once every two months, depending upon the varying workload. Meetings may be held at various locations to roughly balance the travel burden for the members coming from various parts of the country. Normally, the Board will meet for one full business day, with the option of holding executive sessions on the evening prior to the full-day meeting or at such other times as the Board may desire. As indicated under "Access to Board Meetings" below, the Board shall schedule its regular meetings six months in advance, with notices of individual meetings and agendas being prepared and circulated in advance to interested people within and outside the government. Items may be placed on the agenda by any Board member, either in reflection of his own interests or the interests of one or more of the "constituent groups" concerned with Board activities. Board members may circulate materials to the Board in support of submitted items, as appropriate.

Initiating Board Activities -- Board actions relating to the field fall into two broad categories, i.e., those taken in response to requests and those initiated by the Board. In either case, the Board will discuss the matter under the general guidance of the member-sponsor. Where the issue appears to warrant further and more formal inquiry, the Chairman will appoint an Interim Planning Group with responsibility for further investigation and for recommending actions to the Board. Upon determination

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by the Board that more formal action should be initiated, the Chairman will appoint an Informal Board Planning Group with responsibility for making a more definitive evaluation of the issue or problem, for identifying the options open to the Board in considering the action to be taken, for indicating the prospective benefits for the parties-at-interest and the computer science and engineering field, for exploring possible sources of the necessary expertise and funds, for recommending the appropriate action.

Upon the Board's decision to take action, the Chairman will appoint a formal Board Planning Group made up of members who are expected to stay with the Board effort to completion, either as active participants or as monitors for the Board. This group will be responsible for delineating the problem in actionable terms, for roughing out a written proposal, for seeking out the parties-at-interest to determine their degree of interest, their funding capabilities and their view of what the Board product should be, for working out an estimated budget, for locating and identifying the needed expertise and competences, and for reporting their findings to the Board in written form. The Chairman will appoint no less than one Board member to give interim guidance to the Panel and to keep the Board informed on Panel progress. The Executive Support staff will provide appropriate assistance and guidance throughout the above and liaison and negotiations assistance through the completion of the formal contract with the sponsoring organization(s).

Access to Board Meeting -- As a general policy, as much as possible of the Board's business shall be conducted in open forum. This is based largely upon the nature of the computer science and engineering field, the intense and widespread interest both within and outside the government in the Board's activities, and on the need for the widest possible understanding and support for the Board's activities in order to provide broad leadership at the national level both within and outside the government. In light of the foregoing, and as indicated under "Board Meetings," above, the Board policy shall be to schedule its meeting no less than six months in advance, and to complete and distribute agendas for each meeting no less than two weeks in advance. Copies of the six-month Board meeting schedule and the agendas for each meeting will be provided to the interested parties within and outside the government. A notice of individual meetings will be sent to interested parties about 30 days in advance. Agenda items will be grouped wherever possible to facilitate selective attendance.

Constraints upon the "openness" of Board meetings originate from several basic sources, i.e., government classification requirements, access restrictions placed upon sensitive "proprietary" materials or information by Board sources,

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the NAS "Academy Privilege" system which is designed to provide general protection for a variety of reasons, the sensitivities deriving from the government policy user's concerns for complete confidentiality regarding his activities, and the specifications in many contracts requiring no divulgence beyond the working NAS consultants of the materials being reported to them. All of the applicable restrictions on access will be detailed for the Board on a case-by-case basis and must, of course, be scrupulously respected by both Board members and the NAS "consultants" working on Board assignments. However, in many cases the conventional techniques of progress status, summarization, non-content description, and non-attribution permit a general discussion of some part of the project that is restricted for any reason. Moreover, a large proportion of the Board's work will probably continue to occur in the general public or "open" area and the general policy of the Academy is to keep the public informed to the maximum extent possible regarding its many and varied activities which are of public interest.

A special case exists for maximum access to Board activities and products by government sponsors who have a common interest in much of the Board's work, who possess considerable competence in the computer science and engineering field, who have a current, sometimes unique, understanding of government support needs, and who, in some cases, share the funding of substantial portions of the Board's activities. Part of the rationale for closer liaison with such sponsors is the fact that interim spin-offs during the course of the Board's work on a longer-term problem can be of great value to the government agencies confronted with interim decisions. Such interim assistance can be provided through close liaison with the concerned government agencies, including the Chairman, the Panel head and the Executive Secretary, through informal "notes" addressing a particular point of concern, and through informal briefings by a small, selected group of the Panel membership, as appropriate. The policy of the Board shall be to assure maximum access by government sponsors to the general work of the Board through attendance of Board meetings, through the means listed above, and by whatever other means are appropriate to the moment.

Exceptions -- Exceptions would be based upon the absence of a "need to know" for classified materials; extra-ordinary "sensitivity" of a proprietary or strongly implied policy use nature; and, in the case of "NAS Privileged" materials, upon the decision of the President of the Academy.

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Access to Board Reports -- The general policy of the Board shall be to give maximum distribution to all Board reports for much the same reasons relating to the Board's national level leadership responsibilities that are outlined in the preceding paragraphs on access to Board meetings. The same constraints applying to meeting access also apply to report distribution, with more formality and precision in some cases. For example, in the case of contracted work, NAS policy is that, while in progress, the report and related materials fall within the Academy Privilege system during preparation, and that when delivered to the sponsor the report becomes the property of the sponsor, unless the sponsor in the contract provides for other disposition or distribution of the report in the contract. Once the sponsor has received the report, he may request the Academy to assist in its dissemination. In the case of government classification, controls are more formal and explicit. However, many government sponsors may possess the necessary basic clearances and the "need-to-know" principle does permit certain discretionary control and access by the originating organization within the basic classification level. In the case of unclassified activities, the resulting reports will be given the widest possible distribution consistent with the other constraint considerations that may apply in a given case.

Exceptions -- Exceptions would roughly parallel those indicated for the above section on "Access to Board Meetings."

Multi-Level Publications -- The policy of the Board will be to package the output of the Board's work in the form and content which is most appropriate to the product, the nature of its intended use, the timeliness requirements of the user, the duration of the anticipated use, the level of the requester/recipient and other users, the level of knowledge in a given subject/problem area, etc. To perform effectively in meeting such a blend of user requirements and applications, the Board must establish a range of publications, with individually oriented criteria sets, which permit the most timely and useful packaging of the Board's work to meet each set of customer requirements from one situation to another. For example, the mix of customer-oriented products could range from a one-page summary of the interim results of six months analysis of the rates and directions of computer technologies and associated technologies to the other extreme of a formal NAS publication of the considered results of a 12-month assessment of the factors and forces affecting the movement of computer technologies and related technologies among the high technology nations of the world, and the implications of these results for government policies and programs under way and in contemplation. Form, structure, content coverage, quality and consistency must all be considered to be variables in the Board effort to provide the most timely and effective support to the government. For example, a four-part summary of a Summer Conference on Computers and Associated Technologies which makes a preliminary and highly tentative assessment of these various technologies in relation to government export control problems could be of great value throughout the affected areas of of government even though the content could not even meet the formal requirement for consistency among the four different parts. Such flexibility in all aspects of publications form, content coverage, quality and consistency calls, of course, for equal flexibility and control in the dissemination of a given product, and in the timely updating of such products.

Exceptions -- Not applicable.

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Board Research Policy -- The general policy of the Board shall be to seek out the finest expertise and the most relevant information wherever they may be that are necessary to provide the highest quality support to the U.S. government. In the search for new and directly relevant technological and background information, the sensitivities encountered, and there is little choice but to accept them, appear to be roughly in proportion to the importance and usefulness of the information and access acquired. In an institution dedicated to the free exchange of scientific and technical knowledge, a special burden is placed on an operating component to make every effort to assure the broadest possible use of new and valuable information, insights, concepts, etc. The policy of the Board, in light of the foregoing, shall be to ascertain insofar as is possible the general nature of the restrictions likely to be encountered on a given project and to make advance provisions for assuring maximum dissemination of the results of the Board's work. Where feasible, such provisions should be made during contract discussions with the sponsoring organization(s). In illustration, consideration should be given to producing a de-sensitized version of the report where the general interest and utility warrants.

Board Responsibility Regarding Report Content & Integrity -- The policy of the Board shall be to closely monitor the activities of every "ad hoc" panel working on problems for which contractual committments exist, to carefully review the content and case of each report as to technical accuracy, competence, pertinence and judgments expressed, and to convey frankly and clearly to the contractor in a memo transmitted through the Academy either a full endorsement of the report or specific areas, points or judgments with which the Board is in disagreement, accompanied by gists of the arguments and evidence supporting the Board's views. In the case of interim briefings, notes, etc., as mentioned above in the paragraph on "Access to Board Activities," the Board will defer to the judgment of the Chairman and the Executive Committee pending the opportunity to review such issuances at the next scheduled meeting of the Board.

DRAFT

FOR CS&E BD-STAFF ONLY

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NATIONAL ACADEMY OF SCIENCES

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

20 November 1970

TO: Members, Computer Science & Engineering Board

FROM: J. F. Kettler JK

Your attention is invited to the draft letter of transmittal to Mr. Kent Curtis, National Science Foundation prepared by the Chairman in consonance with instructions of the Board at the September meeting in regard to the account of the conference on higher education, July, 1969 -- the Perlis Report.

Professor Oettinger wishes to have the report made ready to dispatch as soon as reasonably possible. To this end, please review the draft letter and let us have your comments at your early convenience. Please send your comments to us by 7 December 1970.

Your cooperation in this matter will be much appreciated.

Enclosure
As stated.

JFK/laa

DRAFT LETTER -- 19 November 1970

Dr. Kent Curtis
Head, Computer Science & Engineering Section
Office of Computing Activities
National Science Foundation
Washington, D. C. 20550

Dear Dr. Curtis:

I hereby transmit to you an account of the conference on Computer Science Education chaired by Dr. Alan Perlis in Annapolis, Maryland, in July 1969, with the support of the National Science Foundation and under the sponsorship of the Computer Science and Engineering Board.

The purpose of the conference was to prepare for the National Science Foundation a report on a general analysis of computer science education in the United States, with particular attention to graduate education in computer science and to education in software (and hardware) systems. In the process, explicit relations were to be developed among the expected needs for this type of education, the resources required to meet these needs under various response alternatives, and courses and programs responsive to the needs.

The conference proceedings present data, depict an approach to educational planning and illustrate types of analyses which the Board believes can be useful adjuncts to educational planning and management in the computer field. The transmittal of this conference report discharges the Board's obligation to the conference participants.

However, in meeting its contractual commitment to the National Science Foundation, the Board wishes to draw attention to the fact that the conferees chose not to consider needs for education in business data processing, which is the primary concern of "approximately 80 percent of those working with computers". The report points out that "a number of participants regarded this limitation on conference scope as a serious mistake". Indeed, the conferees did strongly urge "the organization of a subsequent conference on the training requirements of those who will work in the business systems environment."

Consequently, the Board regards the "Goals and Guidelines for the Planning of Four-Year College and Graduate Programs in Computer Science" resulting from this conference as only partial at best and therefore potentially misleading.

Sincerely yours,

Anthony G. Oettinger
Chairman
Computer Science & Engineering Board

AGO/bla

SEP 28 1970

NATIONAL ACADEMY OF SCIENCES

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

25 September 1970

TO: Members, Computer Science and Engineering Board

FROM: Warren C. House

RE: The Report on Computers in Higher Education, July 1969

You may recall that at the Board meeting earlier this month, a spot review of progress being attained on the Perlis report on Computers in Higher Education was made. Enclosed is a copy of Draft #6 of that report for the National Science Foundation.

Considerable effort has been spent by several groups to place the report of the conference in final form. Although there is overlap in the groups which have contributed to this version, i.e., conferees, Project Salvage members, and Board members, by and large, the conferees have not entered into the several drafts of the report devised since the meeting was held. A copy of the cover note forwarding the draft to these members is enclosed for your information.

Please let us have your comments on the draft no later than 8 October 1970. This will be much appreciated. The final version will be presented for final Board review.

Please note that this is a report for the National Science Foundation, that the contents are "Academy Privileged," i.e., made available to you only to facilitate your work as an Academy consultant, and that the eventual disposition of the report will be determined by the Foundation.

NATIONAL ACADEMY OF SCIENCES

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

25 September 1970

TO: Members, Project Salvage

FROM: Warren C. House

RE: Draft #6, Report on Computers in Higher Education

We are sending a copy of Draft #6 of the Report on Computers in Higher Education to members of the Computer Science and Engineering Board, the conferees and are enclosing a copy for your comment. In this regard, please refer to the attached copy of the cover note to those personnel who participated in the conference.

We are, of course, anxious to produce a quality product and shepherd it through final CS&E Board review, and the editing and printing process as soon as this can be accomplished.

Your contribution to date is very much appreciated. We now solicit your comments and suggestions to arrive here not later than 8 October so that this might be accomplished.

Please note that this is a report for the National Science Foundation, that the contents are "Academy Privileged," i.e., made available to you only to facilitate your work as an Academy consultant, and that the eventual disposition of the report will be determined by the Foundation.

NATIONAL ACADEMY OF SCIENCES

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

25 September 1970

TO: Members, Conference on Computers in Higher Education, Annapolis Maryland, July, 1969

FROM: Warren C. House

RE: Review of the Conference Report

A number of months have passed since the above-cited conference was held. Since that time, despite some important but a number of time-consuming intervening matters, we have continued to work on the notes of the conference so that we might furnish an account of the meeting to the National Science Foundation, which provided support for the project.

A draft, which we trust will be the final one for revision before the report is sent to the CS&E Board for review and approval, is enclosed. Please review it and provide us with your comments. Use the draft to indicate changes, if you wish, and return it. Comments should be in our hands no later than October 8, 1970.

In this revision the emphasis was placed on content organization, clarification, high-lighting the major themes, achievement of Academy stylization, retention of the flavor of the conference and the addition of source references where appropriate. In short, the purpose was to prepare a succinct, readable (even to those readers outside the computer field) summary of what the conference accomplished . . . vis., call attention to key problems or issues, provide some data and thoughts representing various points of view on these problems/issues, and recommend courses of action.

Please note that this is a report for the National Science Foundation, that the contents are "Academy Privileged," i.e., made available to you only to facilitate your work as an Academy consultant, and that the eventual disposition of the report will be determined by the Foundation.

The Academy deeply appreciates your assistance and participation in the Conference.

DRAFT FIVE
9/15/70

COMPUTER SCIENCE EDUCATION

Goals and Guidelines for

Four-Year College and Graduate Program Planning

NAS PRIVILEGED

A Report on the

Conference on Computer Education in the United States

held in Annapolis, Maryland, July 21—24, 1969,

and sponsored by the

Computer Science and Engineering Board,

National Academy of Sciences

with grant support from the

National Science Foundation

ACKNOWLEDGMENTS

The Conference on Computer Science Education in the United States was funded by the National Science Foundation (NSF C-310, Task Order 169) and sponsored by the Computer Science and Engineering Board of the National Academy of Sciences.

Serving as chairman of the Conference and guiding the development of this report on Conference findings and conclusions was Alan J. Perlis, Head of the Department of Computer Science, Carnegie-Mellon University.

Some months following the Conference a small group who had participated met with the chairman to develop a report. Included in this group were: Bruce Gilchrist, Executive Director of the American Federation of Information Processing Societies; Fred Gruenberger, Department of Accounting, San Fernando Valley State College; John W. Hamblen, Southern Regional Education Board; Juris Hartmanis, Department of Computer Science, Cornell University; E. J. McCluskey, Electronics Department, Stanford University; Scott E. Moore, Manager of SDD Technical Education, IBM Systems Development Division; Robert Morris, Bell Telephone Laboratories, Inc.; James Rowe, Union Carbide (New York, N.Y.); Samuel Seely, Associate Graduate Dean, University of Massachusetts; Robert Spinrad, Xerox Data Systems; and John W. Tukey, Department of Statistics, Princeton University. Without their cooperation and their generous contribution of time and effort in both the preparation of materials for inclusion and the review of successive drafts, this report would not have been possible.

The Board also wishes to acknowledge the assistance of Thomas H. Bredt, Department of Electrical Engineering, Stanford

University, who organized content, incorporated feedback, and produced a complete draft of the Conference report.

Others who contributed data, background material, and guidance were: Richard Andree, Department of Mathematics, University of Oklahoma; C. L. Coates, Electronics Research Center, University of Texas at Austin; Alexandra Forsythe, Computer Science Department, Stanford University; George Forsythe, Computer Science Department, Stanford University; John Giese, Chief, Applied Mathematics Division, Department of the Army; J. W. Graham, Computing Center Director, University of Waterloo; William Miller, Vice President, Stanford University; and J. Barkley Rosser, Mathematics Research Center, U.S. Army, University of Wisconsin. Their participation and assistance are greatly appreciated.

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(continued)

INTRODUCTION

Scope of the Conference

In July 1969, the Computer Science and Engineering Board of the National Academy of Sciences, with grant support from the National Science Foundation, sponsored a conference on Computer Science Education in the United States. Thirty experts from academic institutions, government, and industry (see Appendix A) participated in this Conference, which was chaired by Dr. Alan J. Perlis, Head of the Department of Computer Science, Carnegie-Mellon University.

Conference discussion dealt chiefly with three major topics:

1. The manpower required (a) to operate effectively the number of computer systems expected to be in use by 1975 and (b) to educate a sufficient number of computer scientists

2. The kinds, characteristics, and estimated costs of the four-year college and graduate programs needed to fulfill these manpower requirements

3. The nature and orientation of computer science as a discipline

In considering these topics conference participants limited their attention to that segment of the population in the computer field—an estimated 20 percent in 1969—who, even in the immediate future, should be college trained. However, they recognized that the bulk of the people working with computers in the next five to ten years will not be four-year college graduates but typically will receive their final training in high schools, two-year colleges, or commercial institutes. A reasonable match seems to exist between the level of training offered by these schools and the current requirements of commercial data processing—programming in COBOL and the design, development, and operation of business data processing systems—the type of work done by some 80 percent of computer personnel. Clearly, these types of activities would benefit greatly from an influx of people more thoroughly trained in computer science, but most conference participants felt that the specialized needs of the business applications personnel and the critical problem of their training merited special consideration in a separate conference devoted solely to that topic.

Some participants regarded such a limitation on conference scope as a serious mistake. They suggested that failure to take into account the very significant distinctions between business data processing and scientific computing would undermine the effort to develop a single cohesive educational program. In their view, ignoring the needs of the business-oriented group when planning computer science educational programs would force engineering schools and schools of business to go their own way in their own fashion. The result could well be three types of computer scientists and three paths to their creation—a situation to be avoided in developing a strong unified discipline. These participants also feared that any conclusions reached in discussions that ignored the needs of four-fifths of the computer field would provoke only challenge and dissent rather than widespread adoption.

Nevertheless, a majority of the participants wished to concentrate their attention at this conference on the education of those who will teach computer science in four-year colleges and universities and who will staff the larger, more scientifically oriented installations. (See Appendix B for additional discussion.)

Also excluded from conference consideration at this time was specific curriculum development. Instead, conference participants confined their attention to outlining the goals of recommended bachelor's, master's, and doctoral programs and advocating an approach to educational program planning consistent with projected needs and economic constraints.

Organization of the Report

The following section briefly summarizes the general trend of conference discussions and the conclusions reached. Recommendations for strengthening computer education that evolved from the discussion appear in the third section. The fourth presents in greater detail the rationale and findings that underlie the main points developed in the preceding sections. Additional back-up material appears in Appendixes A through G.

KEYNOTES OF CONFERENCE DISCUSSION

The Numbers Problem

The first issue addressed was the so-called numbers problem: How many people do we need to educate? The two approaches adopted in attacking this problem were (a) extrapolation of equipment-support requirements and (b) reasoning by analogy with other fields.

In employing the first approach we assumed the existence of approximately 100,000 computers in the United States in the 1970—1980 period, a figure somewhat higher than the estimate (80,000) of the American Federation of Information Processing Societies (AFIPS) cited in the 1967 report of the President's Science Advisory Committee, Computers in Higher Education[1]. A second assumption (consistent with

AFIPS projections) was that the number of computers, and of staff needed to support them, would begin to level off after 1980. Based on these assumptions, and taking into consideration the current (i.e., 1969) mixture of large, medium, and small computers (see Findings, pages 12-13), we accepted as a desirable goal a supporting staff of some 500,000 computer scientists. By the time the rapidly accelerating growth rate (1,700 computers in 1958 to >60,000 in 1969[2]) has slowed and the anticipated long-term, relatively steady-state condition is reached (possibly by the year 2000), all these people should be college trained. If we assume a working life of 30 years, the replacement rate of computer scientists would be about 16,000 per year. We estimated that the college-educated professional population in the computer field in 1969 was about 200,000, most of whom had received their college training in disciplines other than computer science. This number is well below that needed to staff the nation's computer installations efficiently. Even a 30,000 per year influx of trained people would not be out of line; however, such a production rate did not seem feasible. We viewed 16,000 per year as a reasonable national goal—one that can be achieved and will not result in an excess of scientifically trained computer personnel.

The second approach entailed estimation of support population in relation to other older disciplines in which trends are clearer and possibly better understood. Compared to the 40,000 engineering graduates per year (from all engineering disciplines)[3], the chosen target of 16,000 computer scientists per year does not seem excessive. Compared to the 9,000 medical doctors[4] and 40,000 nurses[5] produced annually to staff the field of health services, the anticipated production rate of computer scientists retains its plausibility.

We recognize the dangers of offering predictions for periods beyond the next five years. Our chief concern in our forecasting was not to overstate the need. On the basis of the demand imposed by growth trends in the computer industry (as viewed in 1969), and compared with the annual production of trained manpower in other disciplines, we believe that we have not done so.

Having agreed on a goal of 16,000 graduates per year, we next considered the levels of training these 16,000 should represent. Three factors especially influenced assessment:

1. The estimated number of computers in the United States in the period 1970—1980 (i.e., 100,000)

2. The manpower required to operate the projected number of machines effectively

3. Computer science faculty needed to educate four-year college and graduate students in computer science

Details of our analyses of these requirements appear in the section on Findings (pages 11-20). From these analyses we concluded that in the 1975—1980 period some 1,000 large computers, 12,000 medium-sized computers, and 87,000 small computers would be in operation. To meet the staff and training requirements they will pose would necessitate an annual production of the following numbers of graduates in computer science:

1. Ph.D.'s - 170 — 680
2. M.S.'s - 1,100 — 3,700
3. B.S.'s - 4,500 — 14,700

These estimates suggest that some 5,770 to 19,080 computer scientists probably will be required. In terms of our goal of 16,000 computer scientists to be graduated annually, the proportions would be approximately 400 Ph.D.'s, 3,000 M.S.'s, and 12,600 B.S.'s.

Educational Programs and Costs

To meet the existing, well-recognized shortage of trained professionals in computer science that currently (i.e., in 1969) characterizes all types of computer applications will require the prompt development of strong master's and bachelor's programs. By a strong master's program we mean one that will provide sufficient education for those professionals who are to fulfill the need for trained practitioners of computer science in industry and government and who will improve the efficiency and scope of computer operation. A strong bachelor's program should prepare students for employment as working computer professionals or for advanced education in master's as well as doctoral programs in computer science. Of major importance in both bachelor's and master's degree programs is laboratory training in the development and utilization of computer systems (see Findings, pages 25 -29).

The production of doctorates in computer science in 1970 is expected to reach some 200, and existing programs appear capable of producing about 250 Ph.D.'s annually. Therefore, a moderate rate of increase in Ph.D. output should suffice to meet projected needs. Though existing programs should be strengthened and expanded, and new ones created, no crash program seems necessary or advisable (see Findings, pages 24-25).

In the development of educational programs, two areas of particular importance are (a) providing special training opportunities for those doctorates from related disciplines who wish to apply their skills in computer science (see Findings, pages 29-30), and (b) fostering opportunities for all students to become aware of the fundamentals of computer science and the potential applications of computers in their particular subject areas (see Findings, pages 32-33).

Except for the cost of providing computer services, the cost of educating the computer science student is not significantly different from that of educating a physics or chemistry student when laboratory expenses are excluded. But the provision of experience with a computer (or with computer services) is an essential part of computer science training and this necessary laboratory experience is costly. We estimate that the costs for the several types of courses we believe to be required—a fundamental course for students not majoring in computer science, a course designed for engineering students not majoring or minoring in computer science, and courses for undergraduate majors and graduate students in computer science—are as follows:

1. Non-computer science student	$5 to $10 per man per year for one year
2. Engineering student (not majoring or having minor or option in computer science)	$10 to $25 per man per year for one year
3. B.S. degree in computer science	$300 to $1,500 per man per year for two years
4. M.S. degree in computer science	$300 to $1,500 per man per year for two years
5. Ph.D. degree in computer science (years beyond M.S.)	$2,150 to $2,750 per man per year for two years

These estimates taken together represent a total expenditure of from 12 to 74 million dollars per year for computer science education laboratory costs (see Findings, pages 20-23, and Appendix C).

Computer Science as a Discipline

A question that arose repeatedly during the conference was whether computer science should be regarded as a professional or scientific study. The issue was whether a computer science graduate is to design things, as an engineer does, or to illuminate truth, as, for example, a mathematician. We concluded that graduates with varied backgrounds and interests are necessary and that their objectives also should be varied. However, the distinction in their education should be achieved by the extent, depth, and richness of their computer science training rather than by so-called separate tracking or education in different through related disciplines. We view computer science as a coherent discipline that can produce both practitioners and scientifically oriented scholars (see Findings, pages 30-32). We reject the notion that theoretical and practical computer science are so different that they cannot share the same base. Therefore, we strongly advocate the formation in four-year colleges and universities of a single, independent computer science discipline. An undergraduate core curriculum (with electives) should produce a B.S.-level graduate who has a thorough grounding in the fundamentals of this field and a firm basis for further training to extend his grasp of the subject and his assurance and expertise in applying it to theoretical or practical ends.

We are aware that the development of a single coherent discipline creates a number of problems in defining the scope and content of the core curriculum. Within the brief time interval of this conference we did not feel that we could deal comprehensively and meaningfully with these complex problems; therefore, we devoted our attention to suggesting goals and attributes of graduate and undergraduate programs in the hope that these might prove useful to those engaged in specific curriculum development. (Appendixes D, E, and F present examples of curricula that may be helpful to program planners.) We are firmly convinced, however, that the benefits of avoiding a splintered discipline far outweigh the disadvantages caused by the compromises and accommodation that often may be required (see Findings, pages 30-33).

RECOMMENDATIONS

Based upon July 1969 conference discussion and our findings, we offer the following recommendations on computer science education:

1. To meet the recognized pervasive shortage of professionals in computer science, we recommend widespread and vigorous efforts to establish (a) strong master's programs and (b) strong bachelor's programs in computer science in four-year colleges and universities. We further recommend the broadest possible geographic distribution of such programs throughout the United States. (See Keynotes, page 6, and Findings, pages 25-29.)

2. We recommend that the development and expansion of doctoral programs proceed at the present rate. Support for such programs should be continued through (a) graduate teaching and research fellowships, (b) postdoctoral teaching fellowships to aid in the acquisition of new faculty, and (c) development of new and different* computer facilities. (See Keynotes, page 6, and Findings, pages 24-25.)

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*By new and different facilities we mean such types as satellite computers, processers for film and TV animation for instructional purposes, hybrid computers, converters to and from other systems, advanced equipment employed in the research and development programs of federal agencies such as the Department of Defense and the National Aeronautics and Space Administration, and the like.

3. We strongly recommend the recognition of computer science as a separate, unified discipline and the development of a coherent core curriculum, an essential part of which is the provision of laboratory training in the development and utilization of computer systems. (See Keynotes, pages 6-9, and Findings, pages 29 and 30-33.)

4. We recommend the provision of support to implement cooperative programs and projects between computer science departments and various other college and university departments. The goals of such cooperative efforts would be to provide opportunities for students in other departments to gain insight into the essentials of computer science and experience with computer applications in their particular subject areas. This experience should include all steps from problem formulation through obtaining satisfactory output from the computer. (See Findings, pages 32-33.)

5. Consistent with the increased interdisciplinary cooperation that we advocate in the preceding recommendation, we also recommend the fostering and support of research in the general area of applications and in materials preparation directed toward teaching. We strongly urge the planning and conduct of these activities in such a way that they complement and mutually support one another. (See Findings, page 33.)

6. To facilitate educational program planning, as well as the planning and conduct of research, and to foster the interchange of scientific and technical information among computer scientists, we recommend the provision of support for a continuing research and manpower committee whose mission would be maintenance of a national

inventory of research activity and manpower needs in computer science*.

7. To meet the needs of the growing number of highly trained and competent Ph.D.'s from related fields who would like to redirect their talents to computer science, we recommend that special attention be given the development of two-year transdoctoral computer science training programs. This supplementary training should qualify post-doctoral students to hold such positions as applications programmer, systems programmer, or teacher and researcher in computer science. (See Findings, pages 29-30.)

FINDINGS

Manpower Needs and Estimated Costs

Manpower. Two major determinants of manpower needs in computer science are the number of computers in operation and the number and types of educational programs required to train computer science personnel. In arriving at an estimate of the staff complement needed to operate computers efficiently, we found the breakdown in Table 1 helpful. This Table indicates 35,000 computer installations (averaging about two and one half computers per installation) in 1969. (Special purpose and very small machines are not included.) Most of the large installations are used for scientific computing, and most of the small, for commercial applications.

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*As a first step in planning its research inventory, the proposed committee should seek the assistance of the Science Information Exchange of the Smithsonian Institution. This service, funded by the National Science Foundation, maintains an annually updated file of all on-going scientific and technical research funded by government agencies. Many privately funded projects also are registered.

TABLE 1 Size, Number, and Types of Computer Installations[a] in 1969[b]

Size of Installation	Number of Installations	Type of Installation	
		Scientific	Commercial
Large[c]	1,000	800	200
Medium[d]	10,000	5,000	5,000
Small[e]	24,000	7,000	17,000

[a]By installation is meant one or more computers (on the average, two and one half) and the environment in which they are serviced; i.e., the direct support personnel required to maintain the flow of input and output.

[b]The Table does not include installations involving special purpose equipment, or equipment for specific special purposes (e.g., process control), or those involving very small machines (e.g., computers with a purchase price of $20,000 of less).

[c]By large is meant the class of computers of the IBM 7090 type and their third generation successors such as the UNIVAC 1108, CDC 6600, IBM 360/50, 65, 67, 75, etc., GE 635 and 645, PDP 10, and Sigma 7.

[d]By medium is meant the class of computers such as the B5000, GE 235, IBM 360/40 and 44, CDC 3300 and 3400, and the Sigma 5.

[e]By small is meant the class of computers such as the PDP 8 and 9, HP2000A, IBM 1130, 1800, and 360/30, Honeywell 210, Sigma 3, and the like.

Recently published estimates of the number of computer installations in the United States as of July 1, 1970[6], are somewhat higher than but on the whole consistent with the figures presented in Table 1 for 1969. The 1970 counts obtained in the General Purpose Digital Computer Census, as reported in the September 9, 1970 issue of the EDP Industry Report[6] show 48,217 installations in the United States.

Table 2 presents conference estimates of the number of computers (i.e., machines, not installations) in operation in 1970 and 1975. The breakdown is on the basis of size, as defined in Table 1.

TABLE 2 Projected Numbers and Sizes of Computers in 1970 and 1975

	Number of Computers		
Year	Large	Medium	Small
1970	1,000	10,000	56,000
1975	1,000	12,000	87,000

These estimates reflect a leveling off in the numbers of large and medium computers, with growth continuing, though less rapidly, in the small category.

We estimate that for efficient operation a large computer requires a staff of from 20 to 50 persons with B.S.- and M.S.-level training and from two to four Ph.D.'s. Computers in the medium category should be staffed by from five to 20 B.S.- and M.S.-level personnel and one or none at the Ph.D. level. Small machines will require about one to three B.S.- or M.S.-level personnel and no Ph.D.'s. Therefore, the total estimated requirements for computer scientists of the given levels of training are as follows in Table 3.

TABLE 3 Computer Science Manpower Needs by Level of Training and Year

	Number of Computer Scientists Needed	
Degree Level	1970	1975
B.S. and M.S.	126,000 — 418,000	167,000 — 551,000
Ph.D.	2,000 — 14,000	2,000 — 16,000

The Bureau of Labor Statistics indicates that 175,000 programmers and 150,000 analysts were employed in 1968. Many of these would be applications people (with less than a four-year college education); therefore, the lower-bound figure in our estimates—126,000 for B.S.- and M.S.-level personnel—seems reasonable.

We next looked at the second major determinant of manpower needs, the teaching of computer science. We assumed that the training of both majors in computer science and specialists from other disciplines with minors, options, or electives in computer science ultimately will rest with those who have obtained a Ph.D. in computer science. Additionally, those who have obtained a Ph.D. in a related discipline and received supplementary training in computer science would be qualified to teach computer science courses.

Our estimates of the number required to teach computer science in four-year colleges and universities are based on the following assumptions about the nature of current and future educational trends.

1. All undergraduate students will take a one-semester course during their eight-semester program. The lecturer will meet 150 students in such a course.

2. Students majoring in engineering (other than computer science or strong minors or options in computer science) will take one additional course in computer science during eight semesters with a class size of 25.

3. Majors in computer science or those having strong minors or options in computer science will take three classes (other than those described in 1 and 2 above) per semester for four semesters with a class size of 30.

4. Graduate students studying for the M.S. degree in computer science will take three classes per semester for four semesters with a class size of 20.

5. Graduate students studying for the Ph.D. degree will take three classes per semester for two semesters beyond the M.S. degree with a class size of 20.

We further assumed that 20 percent of the graduates who obtain a B.S. degree in computer science will continue their education to obtain an M.S. degree.

In line with these assumptions, we developed estimates of the number of classes in computer science that would be necessary. Such figures, in turn, furnished a basis for predicting the number of Ph.D.'s in computer science who would be needed to fulfill these teaching responsibilities.

The number of classes in computer science that must be met each academic year is the sum of the projected number for the five groups just described—i.e., all undergraduates; engineers (not majoring in or having minors or options in computer science); majors in computer science; candidates for an M.S. degree in computer science; and candidates (beyond the M.S.) for a Ph.D. in computer science. The annual contribution to the total number of classes arising from the first of these groups (all undergraduates, taking one computer science course during their eight semesters, or four years, in college) would be: $\frac{6x10^6}{150x4} = 10,000$ classes. In other words, in an undergraduate population in four-year colleges of six million, with a class size of 150, the number of computer science classes held each year would be 10,000.

Based on a graduation of some 40,000 engineers per year[3] (taking a special computer science course during any of eight semesters), the number of classes needed for this second group can be expressed as follows: $\frac{4x10^4}{25} = 1,600$.

The projected number of classes per year for computer science undergraduate majors, the third grouping, is based on a productivity period of 30 years and an estimated need for from 150,000 to 500,000 B.S.- and M.S.-level computer scientists in industry and government. Computer science majors would take three additional computer science classes per semester for four semesters with a class size of 30. (There are, of course, always two levels—first year and second year—of students taking courses at any one time.) The equation that follows presents these conditions and assumptions: $\frac{2x6}{30} \times \frac{1}{30} \times \binom{500}{150} \times 10^3 = \binom{6,000}{2,000}$ classes.

Those studying for an M.S. degree in computer science also would take three computer science classes per semester for two years, class size being 20. (The same assumptions in regard to a 30-year productivity period and B.S./M.S.-level manpower made for the third group would hold true for this group.) The resulting equation is: $\frac{2x6}{20} \times \frac{1}{5} \times \frac{1}{30} \times \binom{500}{150} \times 10^3 = \binom{2,000}{600}$ classes.

Finally, there is the class load imposed each year by those beyond-M.S.-level students who are studying for a Ph.D. in computer science. To arrive at an estimate for this group, we will let $\binom{u}{v}$ stand for the annual rate of Ph.D. production for university teaching needs. Assuming again a 30-year productivity period, we estimate the annual Ph.D. replacement rate for manning machines as $1/30 \times \binom{16,000}{2,000} = \binom{530}{70}$. Therefore, the number of classes required (Ph.D. students would take three classes per semester for one year beyond the M.S.) would be: $\frac{6}{20} \times \binom{530+u}{70+v} = .3 \binom{530+u}{70+v}$.

The total number of classes, exclusive of those required in Ph.D. production, is $\binom{20,200}{14,200}$.

If we assume an annual load on faculty of four classes and a productive teaching life of 35 years (note that the productivity period for faculty is estimated as five years longer than that for computer science personnel in industry and government), and if we further assume that a relatively steady-state has been attained, then: $1/4 \left[\binom{20,200}{14,200} + .3 \binom{530+u}{70+v}\right] = 35 \binom{u}{v}$; which yields $\binom{u}{v} = \binom{146}{102}$. Therefore, the annual Ph.D. production would range from 170 to 680 and the number of computer science faculty would range from 3,600 to 5,200.

The production of Ph.D.'s in computer science in 1970 probably will reach 200. (This number includes those in information science, mathematics, and electrical engineering whose training, research, employment, and professional interest characterize them as computer scientists.) The Association for Computing Machinery (ACM) listing of assistantship offerings[7] shows some 55 universities and colleges offering the Ph.D.; another 30 offer only the M.S. The faculties listed total about 680, with some 570 in the 55 Ph.D. programs. Since only a few Ph.D. programs do not appear in the list, an estimate of about 600 Ph.D. faculty now engaged in Ph.D. teaching programs in computer science seems reasonable. Thus, between 11 percent and 17 percent of the estimated steady-state requirement for Ph.D. faculty in computer science already is employed.

Two models for achieving faculty and Ph.D. production levels in the next decade have been postulated. Though neither model probably will prove highly accurate, they do suggest possible production rates that support our contention that a crash program in the education of computer science Ph.D.'s is not justified. Rather, we advocate a gradual and continued strengthening of existing Ph.D. training programs and a selective approach to the establishment of new programs (see Keynotes..., page 6 and Findings, pages 23-24).

The two models assume initial values of:

N_0 (number of faculty in 1970) = 600

D_0 (number of doctorates in the 1969-1970 academic year) = 200

Model 1: Fifty percent of the doctorates join the Ph.D.-producing faculty. They begin to produce doctorates three years after joining the faculty and thereafter will produce at a rate of one every two years. The production rate of the initial faculty (i.e., already on the faculty prior to 1970) will be maintained; however, one of every 35 faculty ceases to produce Ph.D.'s. If N_k and D_k are the number of faculty and the number of doctorates in 1970 + k, then:

$$N_k = 34/35\ N_{k-1} - 1/2\ D_{k-1}$$

$$D_k = 1/2\ N_{k-3}$$

By the end of the 1979—1980 year this model would predict some 2125 faculty who would produce some 630 Ph.D.'s that year.

Model 2: The present faculties will be augmented by the output of special two-year transdoctoral programs in which Ph.D.'s from mathematics, physics, and other related fields may enroll. We will assume that 100 transdoctoral students are accepted annually. These transdoctoral students study for two years after which 25 percent of them will join Ph.D. faculties and will produce at the same rate as the Ph.D.'s in computer science depicted in Model 1. (That is to say, they will begin producing doctorates three years after joining the faculty and continue thereafter at a rate of one every two years. Again, one of each 35 can be expected to stop producing Ph.D.'s.) Fifty percent of the transdoctoral students will join faculties of M.S. and B.S. programs, and 25 percent will enter industry.

Model 2 employs a distribution of computer science Ph.D.'s much like that used in Model 1.

$$N_k = 34/35\ N_{k-1} - 1/8\ N_{k-4} - 4$$

$$D_k = 1/2\ N_{k-3} - 85$$

Using this Model we would predict 1,300 Ph.D.-producing faculty at the end of the academic year 1979—1980, who would produce some 450 Ph.D.'s that year. Of the total number of Ph.D.'s graduated over the eleven-year period, some 2,025 could be expected to join B.S.- and M.S.-program faculties, and about 1,010 would enter industry.

To add perspective to our findings we compared our estimates with the production of doctorates in mathematics. At the present time the number of Ph.D.'s produced per year in mathematics is approximately 1,000 (i.e., 1,063 in 1969[8]), most of whom are absorbed (currently with some difficulty) by universities and colleges. If we estimate that in the future two to three times more students will take mathematics than computer science courses, we conclude that we should produce 300 to 400 computer science Ph.D.'s annually to maintain sufficient computer science faculty (see Appendix C, pages 38-39).

Costs. Having arrived at estimates of the manpower needs imposed by computer facilities and by the educational programs that will be necessary, we looked next at the yearly cost to educate students in computer science. Such costs include, in addition to the standard costs of education (faculty, assistants, supplies, and the like), the cost of computers and computer services without which computer science education would not be adequate or meaningful (see Keynotes, pages 6 and 7; and Findings, page 29).

To determine computer costs we used the same five groupings employed in our estimates of classes and faculty requirements—undergraduates taking one required course, a special course for engineers not majoring or having a minor or option in computer science, computer science majors, master's degree candidates in computer science, and Ph.D. degree candidates in computer science.

We assumed that the first group composed of all undergraduates would be assigned ten problems in their one course in computer science. The cost of processing a problem (in FORTRAN, WATFOR, ALGOL etc.) in a batch environment could be about ten to 20 cents a run. Assuming five runs to attain correctness, the cost would be five to ten dollars per student. The total would then be $\$ \binom{10}{5} \times 6{,}000{,}000/4 \approx \$ [7.5—15]$ million.

The second group, engineering students not majoring in or having minors or options in computer science, would have ten problems assigned in their one-semester computer science course. We estimate that the cost for these problems is between 20 and 50 cents per run. Assuming five runs per problem, we get an annual cost between ten and 25 dollars per student. The total cost would be $\$ \binom{25}{10} \times 40{,}000/4 = \$ [.1—.25]$ million.

Undergraduate majors in computer science, who comprise the third group, would use both batch and terminal service and their assigned problems would require considerably more computer time than those assigned the two previously described groups. The cost would be between one and five dollars per run. At ten problems per course and five runs per problem for each of the six courses required for majors in computer science, this cost would total 300 to 1,500 dollars per student per year. The total annual cost would be $\$ \binom{14{,}700}{4{,}500} \times 2 = \$[2.7—44.1]$ million. (The factor 2 takes into account that in any given year there are two levels of students—first year and second year—being educated.)

Those studying for a master's degree in computer science also would be taking six courses in each of which ten problems would be assigned, with five runs per problem. The annual cost per student is estimated at between 300 and 1,500 dollars, the total amounting to $\$ \binom{1{,}500}{300} \times \binom{3{,}200}{1{,}100} \times 2 = \$ [.7—11.1]$ million. (As in the previous example, the factor 2 takes into account two levels of students in the master's program in any given year.)

The fifth grouping is composed of doctoral students in computer science. These students have one year of class work beyond the M.S. degree, that is to say, three courses for each of two semesters. The cost for dissertation work can be immense—e.g., for those investigating problems related to artificial intelligence, software, or numerical analysis—or negligible—for those concerned chiefly with theory. A mean figure of 4,000 dollars for dissertation support was assumed. Total costs would be: $\$ \, [(\genfrac{}{}{0pt}{}{1,500}{300}) + 4,000] \times (\genfrac{}{}{0pt}{}{680}{170}) = \$ \, [.7\text{—}3.7]$ million.

The sum of costs for all five groups taken together would amount to $ [12—74] million per year. (See Appendix C for additional estimates on costs.)

The 1966 report of the Committee on Uses of Computers, National Academy of Sciences-National Research Council[9] predicted an increase in the total annual cost of computers used for research in computer science in universities and colleges from four million dollars in 1963 to 27 million dollars by 1968. The predicted increase in cost for computers used in instruction in computer science in colleges and universities was from 12 million dollars in 1963 to 36 million dollars by 1968. The combined projected cost in 1968 for both these purposes—computer science research and instruction—falls at the upper end of the range we suggest.

The 1967 report of the President's Science Advisory Committee[1] outlined required computer costs for an optimal computer science education program in two-year and four-year colleges; that is to say, the cost of providing "in all our colleges and universities educational computing at a level of a relatively advanced school in 1965-66 (pages 14-15)."[1] Assuming an enrollment of 5.5 million students in four-year baccalaureate degree programs and 1.2 million in two-year college programs in the academic year 1971—1972, and estimating computing costs at 45 dollars per student, consoles at seven dollars per student, and transmission costs at ten dollars per student, the Committee arrived at a projected total cost of 350 million dollars for B.A. programs and 74 million dollars for two-year college programs in 1971—1972. This estimate, very much higher than ours, was based on the capacity and cost of computing provided by large time-shared centers and on one half hour per student per week console time. The Committee, however, went on to say that if one accepts the projection of the NAS-NRC Committee[9] as approximately correct for the academic year 1967—1968 and applies the conservative 20 percent growth rate used in that Committee's report, the cost of 1968—1969 programs would be approximately 72 million dollars, "if no special measures are taken to accelerate the educational use of computing (page 52)."[1] They further state that this amount is only roughly 20 percent of the support level that they recommend for 1971—1972. The less than optimal 72 million dollar figure falls at the upper limit of our own 12 to 74 million dollar cost projection for 1975.

Educational Programs

To realize the potentialities of computer systems our computer science educational programs must yield graduates representing a variety of interests and types of expertise. Perhaps most apparent is the need for:

1. Researchers into the understanding and expansion of what algorithms and computing systems can do

2. Systems programmers competent to lead the development of major software systems

3. Operators and programmers to run tens of thousands of installations

In addition, educational planners must be aware of other less obvious but crucial needs such as increasingly effective attention to the wholeware (hardware and software of a computing system as a whole) aspects of system design. Our educational programs must also produce the qualified teachers to staff newly created and growing departments of computer science.

Doctoral Training. The first graduate programs in computer science were initiated some ten years ago and by the mid-sixties several computer science departments offered the Ph.D. degree. Since then many more computer science programs have come into being so that today more than 50 graduate programs in the United States offer the doctoral degree in computer science, including options in information science, mathematics, electrical engineering, and other related areas (see Appendix G, Table 3).

Progress during the past decade has been impressive and the over-all quality of most programs is very high. Additionally, the quality of the graduate students entering computer science has improved dramatically over the last five years. Computer science currently is attracting some of the brightest young people, a trend already reflected in recent computer science Ph.D.'s.

During 1970 we anticipate the awarding of some 200 Ph.D.'s in research areas of computer science, and present programs appear to be capable of producing annually as many as 250 Ph.D.'s. We predict that by 1975—1980, and in the years thereafter, we will need to graduate some 170—680 computer science doctorates annually (see Keynotes, pages 5-6, Findings, pages 14-19). If we assume the midpoint of this range, 425, we must conclude that Ph.D. output needs to increase at only a moderate rate to attain the desired goal. Therefore, no crash program seems justified at this time; rather, we recommend a continual gradual strengthening of existing programs and selectivity in establishing new ones. We also suggest refinement of our rough estimates as new data become available and appropriate steps to meet Ph.D. manpower needs when these become more clearly defined.

Master's Degree Programs. The manpower needs imposed by computers are varied. A substantial number of people are, and will continue to be, engaged in the design and implementation of large computer systems, each of which consists of an assemblage of equipment (hardware) and a complementary collection of systems* and library programs (software). People engaged in such design and implementation activities discharge professional responsibilities that in a very real sense are similar to those of professional engineers. We believe that professional educational programs should be available that are specifically planned to provide the knowledge necessary to carry out these computer system design activities. By analogy with the engineering situation, it seems clear that these educational programs should:

*For example, time-sharing systems, traffic control systems, command and control systems, management information systems, and the like.

1. Be at the graduate level and lead to a master's degree

2. Build upon a relevant bachelor's level education

3. Be specifically planned as terminal, professional master's programs

4. Consist of courses at the level of scientific generality offered to beginning doctoral candidates (that is to say, not vocational types of courses)

Initially, the student input to this master's program probably will consist of a degree in engineering, physics, mathematics, or some other closely related field, with a minor in computer science. As the number of computer science baccalaureates increases, a larger proportion of incoming master's degree candidates will be more thoroughly grounded in computer science, thus allowing steady improvement in the quality of master's programs. Currently, many M.S. programs contain material only superficially different from B.S. programs and serve typically as a springboard for those switching fields. The emergence of high-quality B.S. programs in computer science will permit M.S. programs to add material that will lead to a higher degree of expertise and knowledgeability in computer practice and science. Some M.S. programs, however, still should be oriented to those switching fields, particularly those changing from science and engineering and requiring preparation for an applied industrial career in computer science (see Appendix E for a brief description of an M.A. degree program).

We recognize that master's programs in other academic areas may accent computers and their application. We believe that such programs should be designed by and manned largely from within these academic areas. However, the computer science faculty should be used to teach the computer science courses included in such applied programs.

Bachelor's Degree Programs. From 1960 through 1968, discussions relative to the desirability and content of an undergraduate degree program in computer science centered about the activities of the Curriculum Committee on Computer Sciences of the Association for Computing Machinery (ACM). Two published reports that had considerable impact on the structure and content of bachelor's degree programs were Preliminary Recommendations for an Undergraduate (Bachelor's) Degree Program in Computer Science, in the May 1964 issue of Communications of the ACM[10], and Curriculum 68: Recommendations for Academic Programs in Computer Science, in the March ____ issue of Communications of the ACM[11]. ? year

By June 30, 1965, estimates indicated 11 bachelor's degree programs in computer science in operation and an additional 81 programs expected to be in operation by the 1967—1968 academic year[12]. By June 30, 1967, 30 bachelor's degree programs in computer science were reported in operation, with 1,727 majors and 175 graduates for the 1966—1967 academic year[13]. In addition, another 53 bachelor's degree programs were reported with nearly 3,000 enrollees and 300 graduates in subject areas variously entitled data processing, information sciences, or computer science option in, for example, mathematics or electrical engineering. Such programs reflected the influence of the preliminary recommendations of the ACM Curriculum Committee[10] though

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not of their final report, Curriculum 68: ... . If we assume a linear increase in the number of degree programs, we arrive at the following estimates for majors and graduates for June 30, 1969:

1. Forty-nine computer science programs
2. Three thousand computer science majors
3. Seven hundred fifty graduates for the 1968—1969 academic year

However, shortages of faculty candidates have no doubt slowed the development and initiation of many planned programs.

Because of one or two very well-advertised bachelor's degree programs in small institutions, some people have begun to believe that many such programs are being attempted at these institutions. This definitely is not the case. Only seven of the estimated bachelor's programs (of all types) in operation by June 30, 1967, were in institutions that did not offer at least a master's degree and had an over-all student enrollment of at least 10,000.

The 30 bachelor's degree programs in computer science that existed by June 30, 1967, represented 23 different states. Approximately two thirds of these programs are housed in a computer science department or a joint department bearing this name, for example, information and computer science. At the present time approximately 40 computer science departments are in existence that, almost without exception, are located at well-known state and private universities.

A major educational effort in the next few years should be directed toward development of adequate B.S. programs in computer science. These programs should include significant amounts of practical, hands-on experience with real computer systems problems.

Therefore, we feel that B.S. programs should include laboratory courses and opportunities for cooperative projects with industry and government. (See Appendixes D and G for further information on bachelor's degree programs.)

Systems Laboratories. We regard the laboratory-experience aspect of the training of all computer science students as vital to their development, a point emphasized by earlier reports on computer science education[1,9]. Therefore, we see the establishment of computer systems laboratories as a key part of the curriculum of both undergraduate and graduate programs in computer science. Substitute plans that can fulfill the same purpose include summer employment in industry or in research laboratories, cooperative work projects with industry, or part-time employment in a computer center on campus. Meaningful experience can be provided for a team of six students for one quarter at a cost of roughly $1,000 per student.

A vigorous effort is necessary to establish strong B.S. and M.S. programs that include laboratory training in the development and utilization of computer systems if we are to meet existing and projected manpower needs. Appendix F provides additional information on the nature and content of systems laboratory courses. (See also Keynotes, pages 6-7.)

Special Two-year Transdoctoral Programs. A potential source of additional manpower is the number of doctorates in related disciplines such as physics and mathematics who would like to pursue a career in computer science. For example, each year United States universities graduate some 1,400 persons with a doctorate in physics[14].

Many of these recent Ph.D.'s in physics can be converted into good computer scientists with about two years supplementary training. In many instances the time required to train these post-doctoral students will be significantly less than the time to train students entering graduate school in computer science. Further, the annual amount of faculty time required to supervise post-doctoral fellows appears to be from about half to two thirds that required for supervising graduate students. Therefore, the provision of a specially designed supplementary training course for these people would speed the production of trained computer science personnel. A possible disadvantage in terms of cost would be the substantially larger stipends required for post-doctoral students as compared to regular graduate students. (See Keynotes, page 6.)

Computer Science: Its Role in Relation to Other Subject Areas

An Approach to Computer Science Education. We view computer science as a coherent academic discipline with a core of knowledge fundamental to an undergraduate's education and independent of his future course of study. The educated computer scientist will be trained in the design, analysis, and construction of computer systems —complex mixtures of both hardware and software. We find no compelling reasons to suggest that computer science is appropriately placed within any particular classical academic department or college. Our strong concern is that in a given university there be only one undergraduate program concerned with the science and engineering of computing, though of course there will be programs of study within other departments that are concerned with exploring the use of computers from differing perspectives. A student wishing to enter computer science from a related field will have the traditional academic remedy of making up the necessary prerequisites. (See Keynotes, pages 8-9.)

Software Engineering vs. Computer Science. The objective of much current programming activity is the construction of large and complex systems in which most of the difficulties arise from these very characteristics—size and complexity. In addition, such systems often are poorly or vaguely specified at the outset and even during development. The term, software engineering, has been proposed for the study of problems of this type. Systems engineering, or operations research, also deals in part with such problems.

We do not regard software engineering as a useful term to identify an academic discipline and suggest that its use for this purpose be discouraged for the following reason. Hardware and software are closely related. Ten years from now many functions currently handled by software will have evolved into either hardware functions or shared hardware-software functions. Use of the term software engineering emphasizes what we believe to be an artificial distinction instead of fostering recognition of the interrelationships and interdependence of hardware and software. We further feel that computer science is a broader and far better term to apply to a discipline; it includes and places in context both the subject matter and the approach that characterize software engineering. In other words, software engineering seems to us an apt description of one set of activities currently studied and taught within the over-all discipline we term computer science. Admittedly, organized instruction in this subfield of computer science too often is lacking. However, we believe that this deficiency can be met through the development of stronger computer science educational programs, and that software engineering will be more meaningful if it evolves as an integral part of computer science rather than as an ostensibly separate discipline. Instead of placing undue emphasis on either software or hardware, we urge increasingly effective attention to so-called wholeware—the hardware and software of a computing system as a whole, planned together as well as working together.

Interdepartmental Cooperation. A wide variety of problem areas undoubtedly will benefit from advances in computer science. Future research is certain to extend the range of problems to which computers can be applied effectively. By no means will most such problems fall within computer science.

Problems do not arise in forms suitable for attack by computer systems. Those apparently made to order for solution through computer manipulation came to that state by much human effort. Therefore, if we are to attack new problems, and new versions of old ones, effectively, boldly, and successfully, individuals or small groups must, first, do a good job or problem formulation, and second, use available computer systems and applications programs to deal meaningfully with these well-formulated problems.

Neither phase of this task can be done entirely apart from the other. Problem formulation often requires repeated trial and exploration as well as insightful understanding of the computing facilities at hand. Successful computing frequently requires repeated comparison and checking with versions of a problem more realistic than a given formulation.

It is essential for universities and colleges to expand greatly all students' opportunities to learn the fundamentals of computer science and the steps from problem formulation to obtaining satisfactory output from a computer. When a department of computer science wishes to take the lead in offering such opportunities, or to cooperate with other departments in offering them, we feel that such a department should be strongly encouraged and supported. To expect all departments of computer science to commit significant resources to this problem would not be realistic, but the need is great and all who can should help to meet it.

In addition, other related departments with competent and interested staff should receive encouragement and support in providing opportunities for their students to gain experience with at least some of the fundamentals of computer science. In short, all reasonable efforts should be made to foster interdepartmental cooperation (see Keynotes, page 6).

If opportunities for this type of cooperation are to become widely available, significant investments of time and the development of materials ranging from case studies to organized presentations will be necessary. Both research and materials preparation merit strong support, especially when each is planned to complement supplement the other.

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Appendix B Educational Program Planning and Business Data Processing Needs

The Curriculum Committee on Computer Sciences of the Association for Computing Machinery (ACM) recently issued its Curriculum 68: Recommendations for Academic Programs in Computer Science[10]. The Committee, however, did not address the problem of how these recommendations could be used to structure a degree program for those who plan to work in the business community. This was deliberate. At the time the Committee felt that the needs of the data processer were incompatible with those of the computer scientist, or at least that the intersection of needs and interests was very small. Many now feel that recent developments that have led to much more complex hardware systems, in turn requiring more complex software systems, have greatly expanded the intersection of interests. Such a feeling was expressed by many who participated in the present Conference. Others maintained that no committees or conferences, including the present one, had yet come to grips with the needs of the large majority of computer personnel working in the business area.

Recognizing the largely ignored needs of the business applications personnel in the computer field, the ACM appointed a committee in 1965 to study and make recommendations for Computer Education for Information Processing Systems in Organizations. This committee, chaired by Daniel Teichroew of the University of Michigan and funded through a National Science Foundation grant to the ACM, is expected to issue a preliminary report in 1970. Possibly this report will mark a turning point and lead to increased attention to the education of business-oriented computer personnel. In particular, computer science degrees would seem desirable for those who manage, or aspire to manage, large business systems.

Appendix C Supplementary Information on Costs and Manpower

Information obtained from the University of Waterloo (Waterloo, Ontario, Canada) provides additional background for the discussion of costs in Findings (pages 20--23). The University of Waterloo uses an IBM 360/75 at a cost of 125,000 dollars per month. Student jobs run in a priority batch system (WATFOR) account for one tenth of the system time on this machine, a cost of 12,500 dollars per month. Adding to this hardware cost an equal amount for personnel support or overhead results in a cost of 25,000 per month for student jobs. The through-put is 5,000 runs per day or 100,000 runs per month. At five runs per problem, the system is capable of absorbing 20,000 problems per month. Consequently, given the size of the student population and the number of problems assigned, one can estimate the cost to provide undergraduate computer experience for the non-computer specialist (i.e., one who does problems of a relatively small size). Assuming that the size of problems is such that their programs are limited to one second of computer time, and further assuming a student user population of 25,000, we arrive at a cost of $1.25 per problem per student per month. Students at Waterloo are not charged for file access time, but they generally do not include much file work. For a ten-month academic year, a system of this kind could support a student population of 25,000, with ten problems per student, at a cost of $12.50 per student per year. This figure is substantially below those suggested in the Pierce report (the 1967 report of the President's Science Advisory Committee[1]), that is, 50 to 60 dollars per year. In other words, we could assign an undergraduate student as many as 50 problems per year and barely exceed the recommendation of the Pierce report[1]. Probably such a load would be far too heavy for non-computer specialists.

A cost analysis study of the specification and use of various systems for handling bulk student jobs for non-computer specialists at different student-population levels would be of immense value. (Of course, there need not be a unique system at each population level.) We feel strongly that at student population levels of 1,000, 5,000, 10,000, and 30,000, systems can be found that approach the cost of the Waterloo system.

We next looked briefly at the potential number of undergraduate students we may need to educate. First, we assumed that the present B.S.-level output per year in engineering and mathematics is roughly of the order of 40,000. We further assumed that no major change in the size of total undergraduate enrollment in engineering and science schools would occur. If we also assume the emergence of high-quality computer science undergraduate programs, how many of the approximately 40,000 mathematics and engineering students per year could be expected to prefer an education in computer science? We believe that, were high-quality undergraduate programs in computer science widely available, some 20 to 30 percent of the undergraduate enrollment in mathematics and engineering would shift to computer science.

The University of Waterloo indicates that it is producing 200 baccalaureates per year in computer science to support 1,000 computers in the province of Ontario. We estimated that there are about

67,000 computers in the United States (see Findings, page 13). Consequently, if we assume that the ratios are comparable, we would predict an annual baccalaureate production of 13,000 to man these computers. This figure compares reasonably well with the range of 5,770 to 19,080 computer specialists needed to support a projected 100,000 computers in 1975—1980 that we suggested in earlier sections (see Keynotes of Conference Discussion, pages 5-6, and Findings, pages 11-20).

Little thought has been given thus far to the provision of refresher courses for people in the employee pool who will constantly become obsolete. A refresher or updating course given once every five years would amount to about two tenths of a standard course or three weeks per year. If refresher courses were restricted to employees at large and medium-sized computer installations, the following number of courses per year would be necessary:

$$0.2 \times \binom{296}{82} \times 1{,}000 = \binom{60}{16} \times 1{,}000$$

If these courses operated at 100 students per section, from 160 to 600 such sections would be needed each year. If only ten percent of the employee pool were sent to refresher courses, the total number of course sections per year would be reduced to from 16 to 60—seemingly a tolerable load for the educational system (see Findings, pages 14 -23).

Appendix D Computer Science at the University of Waterloo

Computer science courses have been taught at the University of Waterloo (Waterloo, Ontario) since the academic year 1959—1960. Actually they were taught before the University installed its first computer. But not until 1964 did a program in computer science and a philosophy of operation of that program become evident in any formal sense.

The faculty at Waterloo, and many others in the field, believe that computer science should be taught as a specialized area in a basic discipline such as mathematics or possibly electrical engineering. If mathematics were chosen as the basic discipline a student would take a basic prescribed or recommended program and would then pursue optional courses in his area of specialization, be it algebra, geometry, statistics, or computer science.

Computer science courses were taught to undergraduate engineering and mathematics students at Waterloo for the first time in the academic year 1960—1961. These undergraduate courses were for the most part applications-oriented and consisted primarily of numerical methods and analysis and some programming. The first course at the undergraduate level that dealt primarily with programming was offered in 1961—1962 to the graduate engineering class. These courses were taught by three people in the mathematics department whose prime interest was computer science.

Computer science course development remained at this level until the introduction of the Honours Cooperative Mathematics Course in September 1964. A cooperative course is established in such a way that students spend alternating four-month terms in school and working in industry and business. In this way they are able to gain practical industrial experience as well as a sound academic background. The academic content is identical to the regular mathematics program offered at Waterloo. This comparative honours course had both actuarial science and computer science options. Therefore, development of a more comprehensive curriculum in computer science was necessary to supplement the courses already offered. These consisted of two numerical analysis and programming courses and courses in allied areas such as probability and statistics and logic. The curriculum to be developed for the cooperative program would be aplicable to the regular program and vice versa.

The honours mathematics program with computer science option has now been in operation on both a regular and cooperative program basis since 1964, although it is still under development and will continue to change in order to remain current. The program is based on a solid foundation in mathematics, with optional courses taken primarily in later years. To pursue an option in computer science, a student may enroll in the cooperative honours mathematics program or the regular or general mathematics programs. In an honours program a student attends the University for four years and completes 17 or 18 mathematics courses, including computer science, and nine elective courses. The difference in the regular and cooperative program, as mentioned previously, is that students in the latter spend alternating four-month terms in school and working in a business setting. Students in the general program attend the

University for three years and complete nine mathematics courses and seven elective courses. The electives may be chosen from the sciences, humanities, or engineering.

The following programs are available in computer science at the University of Waterloo:

Regular and Cooperative Honours Program in Mathematics for Students Specializing in Computer Science

First Year

Mathematics 130 Calculus

Mathematics 131 Algebra and Solid Geometry

Mathematics 132 Introduction to Computer Science

Three elective courses

Second Year

Mathematics 229 Linear Algebra

Mathematics 233 Probability and Statistics

Mathematics 237 Differential and Integral Calculus

Mathematics 240 Applications in Computer Science

Three elective courses, one of which may be another mathematics course such as Mathematics 234 (Mechanics) or Mathematics 235 (Actuarial Mathematics). Cooperative Program students must select 235.

Third Year

Five mathematics courses including:

Mathematics 329 Abstract Algebra

Mathematics 332 Theory of Functions

and at least one of:

Mathematics 334 Numerical Analysis

Mathematics 340 Computer Systems

(Students in the Cooperative Program must take 334 and 340; students in the Regular Program usually choose both.)

The remaining mathematics courses may be chosen from:

Mathematics 333 Differential Equations

Mathematics 338 Mathematical Statistics

Mathematics 351 Combinatorial Mathematics

Mathematics 352 Mathematical Operations Research

Two elective courses

Fourth Year

Five mathematics courses of which typical examples are:

Mathematics 471a Switching Circuits

Mathematics 471b Computer System Organization and Logic Design

Mathematics 472a Introduction to Automata Theory

Mathematics 470 Numerical Solution of Ordinary and Partial Differential Equations

Mathematics 457 Applied Combinatorial Mathematics

Mathematics 436 Mathematical Logic

Mathematics 455 Mathematical Programming

Two elective courses

General Program in Mathematics for Students Specializing in Computer Science

First Year

The first year is common to both honours and general programs.

Second Year

Mathematics 229 Linear Algebra

Mathematics 237 Differential and Integral Calculus

Mathematics 240 Applications in Computer Science

Two elective courses

Third Year

Three mathematics courses including at least one of:

Mathematics 334 Numerical Analysis

Mathematics 340 Computer Systems

Other courses may be selected from the list for the honours program.

Two elective courses

The course content just described is not considered complete and development of these programs still is under way. Courses also change continuously to keep current. The first two years of the program probably will remain essentially unchanged for the present; the third year will undergo moderate changes as ideas in curriculum crystallize; and the fourth year program requires additional courses before it can be considered completely viable. For example, one or two courses in programming and programming languages will be necessary before the final year of the program can be considered complete.

Appendix E A Professional Master's Program at Stanford University

In response to the demand for a professional degree for students interested in the design of hardware-software computer systems, a special degree program has been devised. Students may enroll in either the computer science or electrical engineering department. For computer science students the degree obtained bears the designation Master of Science in Computer Science: Computer Engineering. In electrical engineering the degree designation is Master of Science in Electrical Engineering: Computer Engineering. Students should indicate a preference for this degree when applying for admission.

A program in computer engineering should include 42 units of work, of which at least 36 must be graded. These will normally come from the following courses: CS 135 Numerical Methods (or both CS 137 and 138 Numerical Analysis); CS 109 Assembly Language Programming; CS 111 (EE 181) Introduction to Computer Organization; CS 112 (EE 182) Digital Computer Organization (or both EE 281 Theory of Switching and EE 282 Logic Design); CS 140 A and B (EE 286 A and B) Systems Programming; CS 144 A Data Structures; CS 246 (EE 386) Operating Systems; CS 206 Computing with Symbolic Expressions; CS 150 Introduction to Combinatorial Theory (or CS 155 Concrete Mathematics, or some course in discrete mathematics); OR 252 Operations Research; CS 298 Software Engineering Laboratory (or six units of CS 293 Computer Laboratory or six units of EE 390 Special Studies); and EE 380 Seminar on Digital Systems.

This program is open to students with a scientific bachelor's degree (a B.S. in mathematics, statistics, physics, or engineering), or with a degree having a mathematical background (courses in calculus, a knowledge of linear algebra, and probability). Some knowledge of programming will be required.

Students requiring remedial help for an inadequate background in programming should enroll in the basic programming course, CS 106, during the summer quarter preceding entrance into this program. Mathematics 113 Linear Algebra and Matrix Theory and Statistics 116 Probability Theory, or their equivalents, may be taken while the student is a candidate; however, credits for these courses will not count toward the units necessary for this degree.

The computer engineering program begins in the autumn quarter each year to enable a full-time student to complete the degree in one academic year. Honors Cooperative students should be able to complete the program in two normal academic years plus one summer quarter.

The degree in computer engineering is intended as a terminal degree. Students planning to obtain a Ph.D. degree are advised to apply directly for admission to the Ph.D. program in either the computer science department or the electrical engineering department.

Appendix F Computer Systems Laboratories

In laboratory courses students are expected to work in teams of about six under close supervision of a faculty member and a teaching assistant. Student teams concentrate on design, documentation, scheduling of their work, performance evaluation, efficiency, error recovery, diagnostics, maintainability, and other features of a well-engineered system. Each student is expected to take the equivalent of two of the laboratories described below during his course of study.

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

CS Lab. 1 Construction of Assemblers and Compilers

CS Lab. 2 Construction of Operating Systems

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

CS Lab. 4 Construction of Switching, Communication Systems, and Process Control

CS Lab. 5 Construction of Large Data Base Systems

Two laboratory courses that could be given in addition to or in place of the above are:

CS Lab. 6 Management of a Computer Facility

CS Lab. 7 Construction of Large Application Systems

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

The companion lecture courses associated with the previously listed laboratory courses are as follows:

CS Lab. 1 Construction of Assemblers and Compilers

Lecture course such as I5 and/or A1 from Curriculum 68...[10]. 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.

CS Lab. 2 Construction of Operating Systems

Lecture course such as I4 and/or A2 and/or A3 from Curriculum 68...[10]. Includes operating systems characteristics, structure of multiprogramming systems, adressing structures, interrupt handling, resource management, scheduling, file system design and management, input-output techniques, design of system modules, and subsystems.

CS 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-language, and systems.

CS Lab. 4 Construction of Switching, Communication Systems, and Process Control

Lecture course such as I4 and/or A2 of Curriculum 68...[10]. Includes traffic control, interprocess communication, system interfaces, realtime data acquisition, asynchronous and synchronous control, telecommunication, and analog-to-digital and digital-to-analog conversion.

CS Lab. 5 Construction of Large Data Base Systems

Lecture course such as A5 and A8 of Curriculum 68...[10]. 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, and 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. The use of the subsystem in such cases would have to be dedicated to the project for a considerable portion of time.

The preceding descriptions are presented as examples of laboratory courses that might be given. Each school will have different staff and facilities available and will present variations on this proposal. The essential element of any laboratory program is the supervised hands-on experience with the computer, with special attention to the practical aspects of the system.

Appendix G Computer Science and Related Degree Programs in U.S. Higher Education

The number of institutions reporting various degree programs, their total faculty, numbers of majors, both undergraduate and graduate, and the number of degrees awarded during 1966—1967 appear in Table 1. These numbers were obtained in an inventory conducted by the Southern Regional Education Board (SREB). Best estimates for each heading also are given. These estimates were obtained by applying the over-all extrapolation ratio of 1.25 to the reported totals. Though probably a little high for the higher degree levels, the estimates are likely to be within ten percent (in the direction of overestimates) of the true values.

In the 1964—1965 academic year the institutions of higher education that participated in the SREB survey predicted that they would have 18,807 undergraduate majors and 5,318 graduate majors during the academic year 1968—1969. The estimates shown in Table 1 indicate that by 1967—1968 the projected figure for undergraduates already had been exceeded (22,161) and the number of graduate majors (4,936) was fast approaching the 1968—1969 prediction. Table 2 summarizes these comparisons together with data gathered by the SREB on the number of students actually enrolled in 1964—1965.

Table 3 compares the population estimates of programs in operation during 1964—1965, those planned for about 1967—1968, and the 1966—1967 estimates. This Table shows that except for the associate degree programs, which in 1966—1967 already had exceeded the projected figure (188) for 1967—1968, the numbers of new degree programs were

TABLE 1 Computer-Oriented Degree Programs, 1966-1967[a]

Program	Number of Institutions[a]	Faculty	1966—1967 Majors: Undergraduate	1966—1967 Majors: Graduate	1966—1967 Graduates: Assoc.	B.S.	M.S.	Ph.D.
Data Processing	133	560	12,765	92	872	49	13	0
Computer Science	59	569	1,727	1,429	58	175	242	34
Option in Electrical Engineering	12	108	447	298	0	127	86	8
Information Science	10	122	100	627	0	0	64	3
Option in Mathematics	8	91	863	780	0	12	5	73
Computer Technology	8	36	496	0	13	20	0	0
Option in Engineering	7	53	35	268	4	0	9	3
Computer Programming	4	6	281	0	78	0	0	0
Information Systems	4	84	424	8	0	19	3	0
Management Science	3	43	0	125	0	0	91	15
Option in Industrial Engineering	3	31	115	26	0	41	13	0
Option in Business Administration	2	14	50	225	0	25	50	1
Systems Analysis	2	7	313	0	0	0	0	0
Information Processing	1	5	0	23	0	0	3	0
Quantitative Methods	1	3	0	0	0	0	0	0
Systems Engineering	1	11	113	48	0	7	15	2
Total	258	1,743	17,729	3,949	1,025	475	539	139
Estimated population total	311	2,179	22,161	4,936	1,281	594	674	174

[a] Institutions that offered a particular degree program at more than one level are counted only once.

TABLE 2 Estimated Numbers of Majors in Computer Sciences, Data Processing, Information Sciences, and the like

Source	Year	Number of Majors	
		Undergraduate	Graduate
SREB[a] Survey	1964—1965	4,338	1,314
SREB Survey	1968—1969[b]	18,807	5,318
SREB Inventory[c]	1966—1967	22,161	4,936

[a]Southern Regional Education Board

[b]Projections, not real values

[c]See Table 1.

TABLE 3 Estimates of Numbers of Degree Programs in Computer Science, Data Processing, Information Science, and the like

Source	Year	Status	Assoc.	B.S.	M.S.	Ph.D.	Total
SREB[a] Survey	1964—1965	In operation	83	44	61	38	226
SREB Survey	1964—1965	New, planned by 1967—1968	105	107	76	43	331
SREB Survey	1967—1968	To be in operation	188	151	137	81	557
SREB Inventory	1966—1967	In operation	192	83	87	52	414

[a] Southern Regional Education Board

lagging behind the numbers projected by the institutions. It follows then that the programs in existence during 1966—1967 were accommodating many more majors than was originally anticipated when the institutions made their projections for 1968—1969.

Table 4 lists the schools offering degree programs in computer science, data processing, information science, information systems, and information processing.

Figure 1 originally appeared in an article published in the Communications of the ACM, April 1964, entitled Status of Computer Sciences Curricula in Colleges and Universities[15]. It represents an attempt to show relationships among the various computer-related programs and some other better established academic areas. It is intended more as a point of departure in planning than as a goal or end product.

Table 5 is a list of schools offering associate degree programs in data processing, computer science, and related areas.

TABLE 4A Degree Programs in Computer Science Offered by Listed Universities[a]

School	Location	Degrees[b]
Auburn University	Auburn, Ala.	B
University of Arkansas	Fayetteville, Ark.	M
Stanford University	Palo Alto, Calif.	M; D
University of California	Berkeley, Calif.	B; M; D
University of California	Santa Cruz, Calif.	B
U.S. Air Force Academy	Colorado Springs, Colo.	B
Florida Institute of Technology	Melbourne, Fla.	B
Georgia State College	Atlanta, Ga.	M
Bradley University	Peoria, Ill.	M
Northwestern University	Evanston, Ill.	M; D
University of Illinois	Urbana, Ill.	B; M; D
Purdue University	Lafayette, Ind.	B; M; D
Iowa State University	Ames, Iowa	B; M; D
University of Iowa	Iowa City, Iowa	M; D
Kansas State University	Manhattan, Kan.	B; M
University of Kentucky	Lexington, Ky.	B
Louisiana Polytechnic Institute	Ruston, La.	B
University of Maryland	College Park, Md.	M
University of Massachusetts	Amherst, Mass.	M
Michigan State University	East Lansing, Mich.	B
University of Minnesota	Minneapolis-St. Paul, Minn.	M; D
University of Southern Mississippi	Hattiesburg, Miss.	B

(Table continues)

TABLE 4A (continued)

School	Location	Degrees[b]
University of Missouri at Rolla	Rolla, Mo.	B; M; D
Washington University	St. Louis, Mo.	M; D
Princeton University	Princeton, N.J.	M; D
Rutgers, The State University	New Brunswick, N.J.	M
Stevens Institute of Technology	Hoboken, N.J.	M
New Mexico Highlands University	Las Vegas, N.M.	B; M
New Mexico Institute of Mining Technology	Socorro, N.M.	B
New Mexico State University	University Park, N.M.	M
Cornell University	Ithaca, N.Y.	M; D
Rensselaer Polytechnic Institute	Troy, N.Y.	M; D
State University of New York	Albany, N.Y.	M
State University of New York	Brooklyn, N.Y.	B
State University of New York	Potsdam, N.Y.	B
Union College	Schenectady, N.Y.	B; M
North Dakota State University	Fargo, N.D.	B
University of Dayton	Dayton, Ohio	B
Youngstown State University	Youngstown, Ohio	B
Oregon State University	Corvallis, Ore.	B; M; D
Carnegie-Mellon University	Pittsburgh, Pa.	D
Pennsylvania State University	University Park, Pa.	B; M; D
University of Pittsburgh	Pittsburgh, Pa.	M
Brown University	Providence, R.I.	M; D
University of South Carolina	Columbia, S.C.	B; M

(Table continues)

TABLE 4A (continued)

School	Location	Degrees[b]
Winthrop College	Rock Hill, S.C.	B
Middle Tennessee State University	Murfreesboro, Tenn.	B
Texas A & M University	College Station, Texas	M
University of Houston	Houston, Texas	B; M
University of Texas	Austin, Texas	M; D
University of Utah	Salt Lake City, Utah	B; M; D
Utah State University	Logan, Utah	B
University of Virginia	Charlottesville, Va.	M; D
University of Washington	Seattle, Wash.	M; D
University of Wisconsin	Madison, Wis.	B; M; D

[a] Data in the Table are taken from the Southern Regional Education Board Computer Sciences Project, NSF Inventory of Computers.

[b] Symbols used are B for bachelor's degree, M for master's degree, and D for doctoral degree.

TABLE 4B Degree Programs in Data Processing Offered by Listed Universities[a]

School	Location	Degrees[b]
California State Polytechnic College	Pomona, Calif.	B
Kansas State College	Pittsburg, Kan.	B
Kansas State Teacher's College	Emporia, Kan.	B; M
Louisiana Polytechnic Institute	Ruston, La.	B; M
Ferris State College	Big Rapids, Mich.	B
Mississippi State University	State College, Miss.	B; M; D
Eastern New Mexico University	Portales, N.M.	B
Pace College	New York, N.Y.	B
Rensselaer Polytechnic Institute	E. Windsor Hill, N.Y.	M
Northern Oklahoma College	Tonkawa, Okla.	B
University of Chattanooga	Chattanooga, Tenn.	B
West Texas State University	Canyon, Texas	B

[a] Data in the Table are taken from the Southern Regional Education Board Computer Sciences Project, NSF Inventory of Computers.

[b] Symbols used are B for bachelor's degree, M for master's degree, and D for doctoral degree.

TABLE 4C Degree Programs in Information Science Offered by Listed Universities[a]

School	Location	Degrees[b]
Georgia Institute of Technology	Atlanta, Ga.	M
University of Chicago	Chicago, Ill.	M
Syracuse University	Syracuse, N.Y.	M; D
University of North Carolina	Chapel Hill, N.C.	M; D
Ohio State University	Columbus, Ohio	B; M; D
University of Dayton	Dayton, Ohio	M
Lehigh University	Bethlehem, Pa.	D
Point Park College	Pittsburgh, Pa.	B
University of Pennsylvania	Philadelphia, Pa.	M; D
Washington State University	Pullman, Wash.	M; D

[a] Data in the Table are taken from the Southern Regional Education Board Computer Sciences Project, NSF Inventory of Computers

[b] Symbols used are B for bachelor's degree, M for master's degree, and D for doctoral degree.

TABLE 4D Degree Programs in Information Systems Offered by Listed Universities[a]

School	Location	Degrees[b]
California State College	Los Angeles, Calif.	B
University of Maryland	College Park, Md.	B
Northeastern University	Boston, Mass.	B
Lehigh University	Bethlehem, Pa.	M

[a]Data in the Table are taken from the Southern Regional Education Board Computer Sciences Project, NSF Inventory of Computers

[b]Symbols used are B for bachelor's degree, M for master's degree, and D for doctoral degree.

TABLE 4E Degree Programs in Information Processing Offered by Listed Universities[a]

School	Location	Degrees[b]
Southern Illinois University	Carbondale, Ill.	M

[a]Data in the Table are taken from the Southern Regional Education Board Computer Sciences Project, NSF Inventory of Computers

[b]Symbols used are B for bachelor's degree, M for master's degree, and D for doctoral degree.

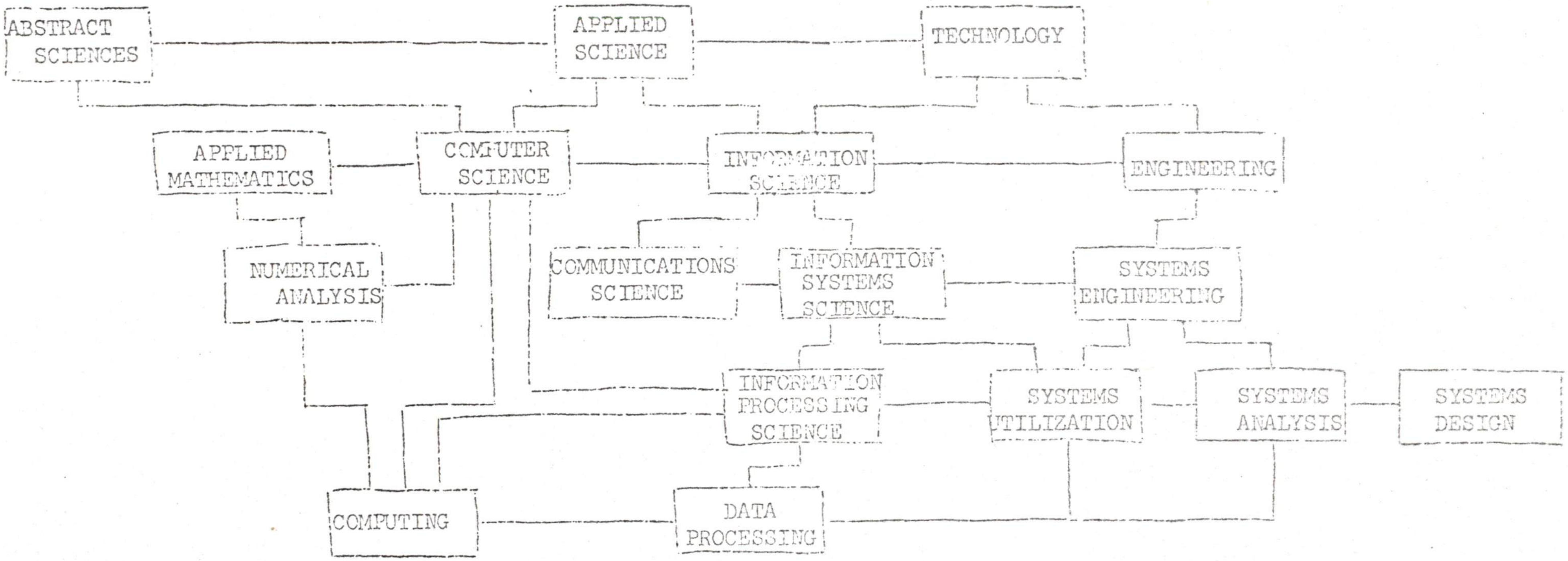

Figure 1: Hierarchy of Computer-Related Fields

TABLE 5A Colleges Offering an Associate Degree in Data Processing

School	Location
John C. Calhoun State Teacher's College	Decatur, Ala. 35699
Wm. L. Yancey State Junior College	Bay Minette, Ala. 36507
Arizona Western College	Yuma, Ariz. 85364
Phoenix College	Phoenix, Ariz. 85013
Allan Hancock College	Santa Maria, Calif. 93454
Bakersfield College	Bakersfield, Calif. 93305
Cerritos College	Norwalk, Calif. 90650
Chabot College	Hayward, Calif. 94545
Chaffey College	Altaloma, Calif 91701
San Mateo Junior College District	San Mateo, Calif. 94402
Contra Costa College	San Pablo, Calif. 94806
Diablo Valley College	Pleasant Hill, Calif. 94523
El Camino College	El Canino College, Calif. 90506
Foothill Junior College District	Los Altos Hills, Calif. 94022
Los Angeles Tr. Technical College	Los Angeles, Calif. 90015
Orange Coast College	Costa Mesa, Calif. 92699
Pasadena City College	Pasadena, Calif. 91106
San Diego Junior College	San Diego, Calif. 92101
San Jose City College	San Jose, Calif. 95114
Southwestern College	Chula Vista, Calif. 92010
Mesa College Main Campus	Grand Junction, Colo. 81501
Otero Junior College	La Junta, Colo. 81050
Southern Colorado State College	Pueblo, Colo. 81005
Trinidad State Junior College	Trinidad, Colo. 81082

(Table continues)

TABLE 5A (continued)

School	Location
Norwalk Community College	Norwalk, Conn. 06854
Norwalk State Technical Institute	S. Norwalk, Conn. 06854
Thames Valley State Teachers College	Norwich, Conn. 06360
Junior College of Broward County	Fort Lauderdale, Fla. 33314
Miami-Dade Junior College	Miami, Fla. 33156
North Florida Junior College	Madison, Fla. 32340
Pensacola Junior College	Pensacola, Fla. 32504
St. Petersburg Junior College	Clearwater, Fla. 33515
Abraham Baldwin Agricultural College	Tifton, Ga. 31794
Black Hawk College	Moline, Ill. 61265
Chicago City College	Chicago, Ill. 60601
Danville Junior College	Danville, Ill. 61832
Kaskaskia College	Centralia, Ill. 62801
Illinois Valley Community College	La Salle, Ill. 61301
Morton Junior College	Cicero, Ill. 60650
Rock Valley College	Rockford, Ill. 61111
Southern Illinois University-VTI	Carbondale, Ill. 62901
Elgin Community College	Elgin, Ill. 60120
Triton College	Northlake, Ill. 60164
Vincennes University	Vincennes, Ind. 47591
Butler County Community College	El Dorado, Kan. 67042
Eastern Kentucky University	Richmond, Ky. 40475

(Table continues)

TABLE 5A (continued)

School	Location
Anne Arundel Community College	Arnold, Md. 21012
Community College of Baltimore	Baltimore, Md. 21299
Harford Junior College	Bel Air, Md. 21014
Newton Junior College	Newtonville, Mass. 02160
Delta College	Bay City, Mich. 48710
Ferris State College	Big Rapids, Mich. 49307
Flint Community Junior College	Flint, Mich. 48503
Lansing Community College	Lansing, Mich. 49814
Macomb County Community College	Warren, Mich. 48093
Muskegon County Community College	Muskegon, Mich. 49442
Northwestern Michigan College	Traverse City, Mich. 49684
Schoolcraft College	Livonia, Mich. 48151
Washtenaw Community College	Ann Arbor, Mich. 48107
Copiah Lincoln Junior College	Wesson, Miss. 39191
Jefferson Davis Junior College	Gulfport, Miss. 39501
Central Missouri State College	Warrensburg, Mo. 64093
Florissant Valley Community College	St. Louis, Mo. 63135
Meramec Community College	St. Louis, Mo. 63122
Forest Park Community College	St. Louis, Mo. 63110
Metro Junior College of Kansas City, Missouri	Kansas City, Mo. 64111
Missouri Southern College	Joplin, Mo. 64801
New Hampshire Technical Institute	Concord, N.H. 03301
Ocean County College	Toms River, N.J. 08753

(Table continues)

TABLE 5A (continued)

School	Location
Mercer County Community College	Trenton, N.J. 08608
New Mexico Junior College	Hobbs, N.M. 88240
New Mexico State University	University Park, N.M. 88001
CUNY Manhattan Community College	New York, N.Y. 10020
CUNY Kingsboro Community College	Brooklyn, N.Y. 11235
CUNY New York City Community College	Brooklyn, N.Y. 11201
Genesee Community College	Batavia, N.Y. 14020
SUNY Agricultural & Technical, Alfred	Alfred, N.Y. 14802
SUNY Agricultural & Technical, Canton	Canton, N.Y. 13617
SUNY Agricultural & Technical, Cobleskill	Cobleskill, N.Y. 12043
SUNY Agricultural & Technical, Farmingdale	Farmingdale, N.Y. 11735
SUNY Agricultural & Technical, Morrisville	Morrisville, N.Y. 13408
Auburn Community College	Auburn, N.Y. 13021
Dutchess Community College	Poughkeepsie, N.Y. 12601
Erie County Technical Institute	Buffalo, N.Y. 14221
Hudson Valley Community College	Troy, N.Y. 12180
Monroe Community College	Rochester, N.Y. 14607
Nassau Community College	Garden City, N.Y. 11530
Orange County Community College	Middletown, N.Y. 10940
Suffolk Community College	Selden, N.Y. 11784

(Table continues)

TABLE 5A (continued)

School	Location
Rockingham Community College	Wentworth, N.C. 27375
Western Carolina University	Cullowhee, N.C. 28723
Bismarck Junior College	Bismarck, N.D. 58501
North Dakota State School of Science	Wahpeton, N.D. 58075
Cuyhog Community College, Metro Campus	Cleveland, Ohio 44115
Sinclair Community College	Dayton, Ohio 45402
Central Oregon Community College	Bend, Ore. 97701
Harrisburg Area Community College	Harrisburg, Pa. 17199
Montgomery County Community College	Conshohocken, Pa. 19248
Rhode Island Junior College	Providence, R.I. 02908
Greenville Teacher's College	Greenville, S.C. 29205
Richland Technical Education Cir.	Columbia, S.C. 29205
Chattanooga State Technical Institute	Chattanooga, Tenn. 37406
Cisco Junior College	Cisco, Texas 76437
Cooke County Junior College	Gainesville, Texas 76240
Dallas County Junior College District	Dallas, Texas 75202
Del Mar College	Corpus, Christi, Texas 78404
Grayson County Junior College	Denison, Texas 75020
Navarro Junior College	Corsicana, Texas 75110
Odessa College	Odessa, Texas 79760
San Antonia College	San Antonia, Texas 78212

(Table continues)

TABLE 5A (continued)

School	Location
Texarkana College	Texarkana, Texas 75501
Wharton County Junior College	Wharton, Texas 77488
Weber State College	Ogden, Utah 84403
Northern Virginia Community College	Bailey Cross Road, Va. 22041
Richmond Professional Institute	Richmond, Va. 23220
Everett College	Everett, Wash. 98201
Grays Harbor College	Aberdeen, Wash. 98520
Highline College	Midway, Wash. 98031
Seattle Community College	Seattle, Wash. 98122
Spokane Community College	Spokane, Wash. 99202
University of Puerto Rico, Rio Piedras	Rio Piedras, Puerto Rico 00931
University of Puerto Rico, Mayaguez	Mayaguez, Puerto Rico 00708

TABLE 5B Colleges Offering an Associate Degree in Computer Science

School	Location
Gadsden State Junior College	East Gadsden, Ala. 35903
Jefferson State Junior College	Birmingham, Ala. 35215
Cornell University	Ithaca, N.Y. 14850
Youngstown State University	Youngstown, Ohio 44503
Southwestern State College	Weatherford, Okla. 73096
Chattanooga State Technical Institute	Chattanooga, Tenn. 37406
Columbia State Community College	Columbia, Tenn. 38401

TABLE 5C Colleges Offering an Associate Degree in Computer Programming

School	Location
Brevard Junior College	Cocoa, Fla. 32922
Manatee Junior College	Bradenton, Fla. 33505
Bristol Community College	Fall River, Mass. 02720
Potomac State College of West Virginia University	Keyser, W. Va. 26726

TABLE 5D Colleges Offering an Associate Degree in Computer Technology

School	Location
Prairie State College	Chicago Heights, Ill. 60411
University of Evansville	Evansville, Ind. 47704
Montgomery Junior College, Takoma Park	Takoma Park, Md. 20012
Montgomery Junior College, Rockville	Rockville, Md. 20850
New York Institute of Technology	New York, N.Y. 10023
Voorhees Technical Institute	New York, N.Y. 10036
Ohio College of Applied Science	Cincinnati, Ohio 45210
Allegheny Community College	Pittsburgh, Pa. 15212

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NAS

7/21/70

K. H. OLSEN

TO: Tony Oettinger

Cc: W. C. House

Recently I sent you a letter containing the names of some people in small colleges who we feel are particularly knowledgeable in computers and might be of use for some of the committee's projects. Here is a more complete list that might be of use sometime.

Ken

DIGITAL EQUIPMENT CORPORATION

COLLEGE/UNIVERSITY AREA

Dr. Dan Harmer	Georgia Tech	Professor of Nuc Engr
Dr. Graham Kimble	Carleton College	Dir of Computer Cen.
Mr. Rober Strickland	Berkshire Comm. College	Prof of Math
Dr. James C. Bowers	Univ of So. Florida	Proff of E.E.

SECONDARY SCHOOL AREA

Walter Koetke	Lexington H.S.	Lexington, Mass
Miss Ann Waterhouse	So. Portland H.S.	S. Portland, Maine

PREP SCHOOL AREA

Richard Rader	St. Mark's School	Southboro, Mass.
Clifford Little	The Hill School	Pottstown, Pa.
Bill Hronka	Pomfret School	Pomfret, Conn.

NAS

digital INTEROFFICE MEMORANDUM

DATE: June 26, 1970

SUBJECT: SLAC

TO: Ted Johnson
CC: Bob Savell
Allan Titcomb
Win Hindle
Ken Olsen
Ernie Frost
John Leng

FROM: Ward MacKenzie WDM

DEPARTMENT: PDP-10 Marketing

As a result of discussions between the PDP-10 Product Line and the Palo Alto District Office, a decision was made to respond with a "no bid" to the SLAC Request for Quotation. This decision was based upon the fact that the RFQ clearly indicated the preference of the group which prepared the technical specification to purchase a Sigma 5 system from Xerox Data Systems. The group that prepared the specification are currently users of an XDS 9300 computer.

The specification contained a number of items which would immediately have made the PDP-10 non-specification compliant. For example, the specification called for floating point double precision hardware and other instructions which are part of the Sigma 5 instruction set but not available on the PDP-10. The specifications called for 16 hardware priority interrupt levels in the CPU which is available on the Sigma 5 while only 7 levels are provided with the PDP-10. The performance specifications of the required peripheral devices were exactly equivalent to XDS product line items. Finally, the specification called for a 10K word background/foreground disc oriented monitor which is available from XDS while we would have been forced to quote a larger but more flexible multiprogramming system.

Adam Boyarski, who was responsible for preparing the technical specifications, practically disappeared after the RFQ was released. Our district sales people were unable to reach him even for luncheon appointments which is an indication of how excited he was about purchasing a PDP-10. My own observation after visiting Mr. Boyarski prior to the release of the RFQ was that he was very familiar with XDS equipment and in no rush to switch to DEC.

I believe that the decision to "no bid" the SLAC system was sound. If we had bid the system initially in response to the RFQ, I believe that we would have been technically eliminated as non-specification compliant. By entering a "no bid", we have made it clear that we believe that the technical specification was improperly written if SLAC had truly desired DEC to bid. I believe that SLAC will have to weigh the merits of our proposal very carefully now that we have been asked to submit a bid after formal bid closing. Submitting a bid initially would only have supported the sole sourcing of a Sigma 5 under the cover of a competitive bid.

jam

NATIONAL ACADEMY OF SCIENCES

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

28 December 1970

MEMO TO: All CS&E Board Members

FROM: Jack F. Kettler JFK

Tony has requested me to circulate the attached letter of transmittal for the Perlis Report which incorporates the spirit and often the letter of the comments received both before and at the December Board Meeting.

Please indicate your approval or final comments and return to me by 6 January 1970.

Thank you for your attention to this request.

JFK/bla

Attachment

DRAFT LETTER - 18 December 1970

Dr. Kent Curtis, Head
Computer Science and Engineering Section
Office of Computing Activities
National Science Foundation
Washington, D. C. 20550

Dear Dr. Curtis,

I hereby transmit to you an account of the conference on Computer Science Education chaired by Dr. Alan Perlis in Annapolis, Maryland, in July 1969, with the support of the National Science Foundation and under the sponsorship of the Computer Science and Engineering Board.

The purpose of the conference was to prepare for the National Science Foundation a report on computer science education in the United States, with particular attention to graduate education in computer science and to education in software and hardware systems. Explicit relations were to be developed among the expected needs for these types of education, the resources required to meet these needs under various response alternatives, and courses and programs responsive to the needs.

The conference proceedings present data, depict an approach to educational planning and illustrate types of analyses which the Board believes can be useful adjuncts to educational planning and management in the computer field.

However, in transmitting these proceedings, the Board also wishes to stress:

1. That a majority of the conferees interpreted their charge as dealing, as they put it, "principally with the education of those who will teach computer science in bachelor's degree and graduate level programs and staff the larger, more scientifically oriented computer installations," while "a number of participants regarded this limitation on conference scope as a serious mistake."

2. That the conference was held at a time before the full effects of the current national economic situation on the demand for scientific and technical personnel of all types could be foreseen. While this may be only a temporary situation, it does change the models used for forecasting demand.

3. That difficulties in determining and projecting how many computers are installed in the U.S., and how many computer science degree holders are needed per installation also create an unknown margin of error in the demand models.

Consequently, the Board regards the "Goals and Guidelines for the Planning of Four-Year College and Graduate Programs in Computer Science" resulting from this conference as only partial ones to be interpreted in the light of the foregoing comments.

Sincerely yours,

Anthony G. Oettinger
Chairman
Computer Science and Engineering Board

AGO:ch m

file

OCT 22 1970

IBM International Business Machines Corporation

Poughkeepsie, New York 12602

Office of Vice President

October 22, 1970

Memorandum to: COSEB

Subject: Security Panel

At our last meeting in September, I outlined the general concepts in mind, highlighted a draft of the panel charter distributed to those assisting me, and reviewed their comments concerning the draft.

Attached is the latest version of the panel charter for your review and comment. I hope to present this to the assembled board at our December meeting and request your response, aye or nay, as quickly as possible.

Sincerely,

Jerry

Jerrier A. Haddad

JAH/k

Attachment

DATA SECURITY

A computer system can be defined as a collection of people, devices, processes, and procedures assembled to process information. The security of this information is then a function of the measures taken by each member of the system.

We should think of data security as: the availability of hooks and features of hardware and software which allow users to do system engineering and obtain configurations, procedures, and operations which allow the desired profile of security considering the environment, application, and set of threats extant now and in the future.

Data security must not be confused with data privacy. It is important to understand that privacy and security are not synonyms nor is one a part of the other. Privacy is the claim of individuals, groups, or institutions to determine when, how, and to what extent information about them is communicated to others.[1] Security is protecting the integrity of the data by such means as physical protection (i.e. locked rooms), environmental protection (i.e. electromagnetic shielding), encrypting data, operating system procedures, etc. Portions of this protection must be provided by both the computer industry and the users of the systems.

1. Westin, A.E., "Privacy & Freedom", Atheneum, New York 1967

Concern for the security of data, that is, its safety from unauthorized disclosure (whether accidental or intentional), from modification, and from destruction, has been limited until quite recently to a few professionals involved in the application of computers to specific objectives. There is also an awareness by the management of major enterprises of their dependence on the integrity and continued availability of data in their systems. The growth of these concerns suggests the need for an objective evaluation of the ability of the users of computer systems to determine and to achieve an adequate level of data security now or in the reasonably near future.

The efficiency and effectiveness of many federal, state, and local government functions will depend on the timely availability of information. Legislation or other controls extended in an emotional response to the privacy and/or security issue, may so limit the use of electronic data processing as to preclude its use in many of these important applications. Similarly, overly restrictive controls can adversely and seriously impact the operation of essential commercial enterprises, such as retail credit. Conversely, unless necessary legal constraints are provided, taking into account the limitations of today's and tomorrow's technologies in providing data security, it may be impossible to establish important new computer applications such as regional, state, or national banks of medical records.

The growing importance of data security in both the public and private sectors, the dangers inherent in both overly restrictive and, conversely, inadequate legislative controls all suggest the necessity of a thorough study of the following items:

1. Identification of the possible types of data security violations.
2. Assessment of the availability and adequacy of security measures in computer hardware and supporting programs.
3. Identification of those security measures best, or of necessity, provided through physical security or operational procedures.

In view of the rapidly growing importance of data security as a technological problem with far reaching social, financial, and legal implications, it is appropriate that there be established a committee of the Computer Science and Engineering Board to conduct the recommended study and to prepare recommendations for further action by that Board.

JUN 8 1971

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

3 June 1971

Digital Equipment Corporation
899 Main Street
Maynard, Mass. 01754

ATTN: Security Officer

This is to inform you that the Consultant Agreement between your Facility and Mr. Kenneth Olsen insofar as it pertains to the National Academy of Sciences, is no longer necessary and may be terminated in this connection .

Sincerely yours,

John P. Gillis
Security Officer

cc: DCASR, Boston, Mass
Mr. K. Olsen
Mr. J. F. Kettler, JH 840

NATIONAL ACADEMY OF SCIENCES

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

March 12, 1971

Mr. Kenneth Olsen
President
Digital Equipment Corporation
146 Main Street
Maynard, Massachusetts 01754

Dear Mr. Olsen:

It was with considerable pleasure that I learned of your appointment to the President's Science Advisory Committee. With equal regret, do I accept your resignation from membership with the Computer Science and Engineering Board.

Please know of our sincere appreciation for your most respected contributions to the Board and the Academy over the many months of service. I wish you well in the new position of public service you have undertaken; may your service with PSAC be equally contributive, interesting, and professionally rewarding. I look forward to our new association with distinct pleasure.

Sincerely yours,

P. Handler

Philip Handler
President

09002

FEB 10 REC'D

DIGITAL EQUIPMENT CORPORATION

MAYNARD, MASSACHUSETTS

KENNETH H. OLSEN
PRESIDENT

February 4, 1971

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

Dear Tony:

I have just been appointed to the President's Science Advisory Committee. I feel most flattered by this, but it was with considerable reluctance that I accepted this task because of the great responsibility in running a corporation in times like these.

Because of this added demand on my time, I feel I will have to resign from the Computer Science and Engineering Board. I think my term ends in three or four months anyway. I would like to be kept up-to-date on the Board's activities and would like to visit once in a while if that is possible.

Sincerely yours,

[signature]

KHO/d

Cc: Dr. Warren C. House

21671
Dear Ken,

Somewhere in the mail(mine, yours or the US's) is a note from Tony responding to your closing sentence, in the positive, of course. Meanwhile, we think it is tremendous that you have been selected for PSAC. Perhaps some of the future PSAC activities will not be so distant as they have been in the past. If I can do anything at all to help, please let me know. If I encounter information that might be of use to you in your PSAC role, I'll certainly send it along. I'm sure Tony will do the same.

Warren.....

cc: Tony, John G.

Kenneth H. Olsen, President
digital

Mr. G. D. Mead
Business Manager
National Academy of Sciences
2101 Constitution Avenue
Washington, D. C. 20418

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

PREPARE IN DUPLICATE -
Forward original to Business Manager; retain carbon for applicant's records

MEMORANDUM TO: Business Manager

FROM: Please Print or Type
Name of Traveler Kenneth H. Olsen

Academy Unit Computer Science and Engineering Board

RE: Beneficiary Designation for Travel Insurance Coverage

In respect to any insurance coverage to which I am entitled while traveling on business of the Academy, the proceeds of such coverage should be paid to the following beneficiary:

Name	Mrs. Aulikki Olsen
Relationship to the Traveler	Wife
Home Address	Weston Road
	Lincoln, Massachusetts 01773

It is understood that this beneficiary designation will remain in effect until subsequently changed by me by execution of another beneficiary designation form.

Signature of Traveler ______________________

Date December 19, 1969

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

PREPARE IN TRIPLICATE - Forward original to Business Manager; one carbon to Head of Unit responsible for the trip; retain one carbon for applicant's record.

MEMORANDUM TO: Business Manager

FROM: Please Print or Type
Name of Applicant Kenneth H. Olsen

Academy Unit Computer Science and Engineering Board

RE: Application for FOREIGN TRAVEL INSURANCE COVERAGE for time spent on personal leave and/or for accompanying dependent.

In accordance with the provisions of the Academy's Group Travel Insurance Policy, as related to international travel, I hereby apply for personal coverage during the trip described below which is primarily on Academy business, as follows:

[X] Full coverage for the estimated amount of time during the trip spent on personal leave or business not related to the Academy:

Estimated Dates ____________________

Total No. of Days ____________________

(NOTE: Beneficiary designation has been previously filed or accompanies this application, otherwise proceeds are payable to the estate of the applicant)

[ ] Coverage for the following dependents accompanying me on the international trip described herein during the period for which these dependents are not entitled to reimbursement of travel expenses for the trip by the Academy: (If more than one dependent, please provide, on reverse hereof, all information required below for each additional dependent)

Name of Dependent ____________________

Relationship to Applicant ____________________

Home Address ____________________

____

____

Beneficiary of Dependent ____________________

Relationship to Dependent ____________________

Home Address ____________________

____

____

Estimated Dates Coverage Required ____________________

Estimated No. of Days of Coverage Required ____________________

Description of Trip:

Purpose of Travel ____________________

____

Proposed Itinerary ____________________

Estimated Inclusive Dates: Departure __________ Return __________

It is understood that this coverage is available provided I reimburse the Academy for the premium costs thereof at 75¢ per day, per person. It is also understood that I will specify on the travel voucher submitted for reimbursement of expenses of this trip the actual number of days of personal leave or dependent coverage, and show as a reduction of my claim for reimbursement of travel expenses the total premium due for this personal travel insurance coverage.

Signature of Traveler ____________________

Date ____________

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

PREPARE IN TRIPLICATE - Forward original to Business Manager; one carbon to Head of Unit responsible for the trip; retain one carbon for applicant's record.

MEMORANDUM TO: Business Manager

FROM: Please Print or Type
Name of Applicant Ken

Academy Unit CSVE Bd

RE: Application for FOREIGN TRAVEL INSURANCE COVERAGE for time spent on personal leave and/or for accompanying dependent.

In accordance with the provisions of the Academy's Group Travel Insurance Policy, as related to international travel, I hereby apply for personal coverage during the trip described below which is primarily on Academy business, as follows:

[X] Full coverage for the estimated amount of time during the trip spent on personal leave or business not related to the Academy:

Estimated Dates 2 days per month

Total No. of Days Approximately 24 per year.

(NOTE: Beneficiary designation has been previously filed or accompanies this application, otherwise proceeds are payable to the estate of the applicant)

[ ] Coverage for the following dependents accompanying me on the international trip described herein during the period for which these dependents are not entitled to reimbursement of travel expenses for the trip by the Academy: (If more than one dependent, please provide, on reverse hereof, all information required below for each additional dependent)

Name of Dependent __________

Relationship to Applicant __________

Home Address __________

Beneficiary of Dependent ______________________

Relationship to Dependent ______________________

Home Address ______________________

____

____

Estimated Dates Coverage Required ______________________

Estimated No. of Days of Coverage Required ______________________

Description of Trip:

Purpose of Travel C S & E Board meetings

~~in (2)~~

Proposed Itinerary ______________________

Estimated Inclusive Dates: Departure __________ Return __________

It is understood that this coverage is available provided I reimburse the Academy for the premium costs thereof at 75¢ per day, per person. It is also understood that I will specify on the travel voucher submitted for reimbursement of expenses of this trip the actual number of days of personal leave or dependent coverage, and show as a reduction of my claim for reimbursement of travel expenses the total premium due for this personal travel insurance coverage.

Signature of Traveler ______________________

Date ______________________

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

8 December 1969

TO: Computer Science & Engineering Board Panel Members

FROM: A. R. Lytle A.R.L.

SUBJECT: Insurance

The attached information on Travel Insurance is sent for your information. Please note the special form for "Assignment" if you wish different from "Estate". The form, if signed, should be sent to Mr. G. D. Mead, Business Manager of the Academy.

ARL/laa

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

October 22, 1969

MEMORANDUM TO: Heads of Offices

FROM: Robert H. Harvey
Assistant Business Manager

RE: Travel Insurance

We are pleased to announce that the Council of the Academy authorized, effective July 1, 1969, full travel insurance coverage for all persons traveling on Academy business both within and without the United States. The cost of the coverage is borne by a general indirect cost account, except for coverage provided for the time spent on personal leave during an international trip, which is described below. Attached is an excerpt from the major provisions of the policy which set forth the terms and conditions of the coverage. The following is in explanation or amplification of the technical terms of the policy:

1. In general, the five classes of persons eligible to be insured under the policy are:

   Class I - members of the Academies

   Class II - employees of the Academies, including members of the employees' immediate family, when such family members are reimbursed for their travel expenses

   Class III - board, panel and committee members

   Class IV - consultants

   Class V - other persons officially appointed or designated by the Academies to participate in an Academy activity

2. Persons who receive travel grants from the Academies are not covered by this insurance, unless they meet one of the definitions of eligibility and provided that travel is on the business of the policyholder as defined in the policy.

3. In general, if an individual meets the eligibility requirements and is entitled to reimbursement of his travel expenses for a trip, he is deemed to be "on business of the policyholder".

Trips that are combined with a vacation, other personal business, or the business of other institutions, may create some difficulty in determining whether an accident occurred while the person was on business of the Academy. If an accident should occur and a claim arise from such a trip, we shall process the claim and seek an interpretation or ruling by the insurance carrier and assistance of the Academy legal counsel in determining whether the terms of our policy apply.

4. The definition of an international trip is intentionally broad so as to cover any trip on Academy business outside the traveler's home country. His home country is considered to be his country of residence at the time of the trip; thus, any committee member residing in a foreign country who is requested to attend a meeting in the United States would be covered under the international trip definition. Similarly, a member of the Academy staff in Japan who attends a meeting in the United States would be covered. Travel to Alaska and Hawaii would be considered a domestic trip; travel to Puerto Rico, Guam or other United States territories (except, of course, the District of Columbia) and to Canada and Mexico would be considered international trips.

5. The definition of a domestic trip is sufficiently broad to cover a trip to Bethesda, Gaithersburg, Beltsville, and other suburban areas outside the District of Columbia, provided the trip meets all the other requirements of the policy.

6. The sickness benefits apply only to international travel at which time there is a $50 deductible payable by the insured person applicable to expenses arising from sickness. There is no benefit payable because of death due to sickness; the death benefit provision is applicable only in the event of death resulting from an accident.

7. The coverage is effective for travel by any form of public or private conveyance, and includes chartered, private and military aircraft, provided: (1) the traveler is not an operator or a member of the crew; (2) the aircraft at the time of the accident was used for transporting passengers only; and (3) the aircraft was not rocket propelled.

8. In the case of international travel, the traveler may obtain coverage for the time during the trip he expects to be on personal leave, and for his family members accompanying him on the trip provided he reimburses the Academy for the premium cost of the coverage at the rate of 75¢ per person, per day. This coverage which is not automatic, must be selected prior to a trip by the traveler and his plans must be recorded on prescribed forms.

9. In the case of death of an insured person, the benefit payment will be made to the estate of the insured unless there is on file with the Office of the Business Manager, a specific beneficiary designation.

10. Medical expenses incurred as a result of an accident occurring when an individual is covered by the policy and medical expenses incurred because of sickness incurred during an international trip are reimbursable up to the limit specified in the policy. However, the medical expenses that are reimbursable under this policy are only those which are in excess of such expenses reimbursable from any other source, such as Blue Cross-Blue Shield, Medicare, employee group health insurance plans, an individual's private medical plan, a state or Federally sponsored medical program, etc.

As to the administration of the plan, we request that you observe the following:

A. Coverage is automatic, except as noted in 8 for personal travel and family members. It requires no action prior to a trip, except as follows:

(1) Each person who desires to designate a beneficiary should complete the appropriate form. This does not have to be done for each trip. A beneficiary designation once made will remain in effect until subsequently changed by the person.

(2) If an individual is to engage in international travel, and desires to obtain coverage for the time during which he expects to be on personal leave or for his family members accompanying him on the trip, he must apply for such coverage on prescribed forms. The premium for this personal coverage will be deducted from his travel expense voucher. The application form for personal coverage should be prepared in triplicate, with the original forwarded to the Office of the Business Manager prior to the trip; one copy retained in your office to attach to the travel voucher as evidence for deducting the premium cost and the third copy is for the traveler's records.

B. There are no prescribed forms for making claims. In the event of death, the Office of the Business Manager should be notified so that official notification can be given to the insurance carrier. In the event of a medical claim, the traveler should submit receipted bills indicating the amount paid from other sources, if any, and the balance claimed under this policy.

C. You should provide all persons eligible for coverage under the policy, with a copy of this memo and the attached excerpt from the policy and the beneficiary designation form. In the case of international travel, you should also provide the traveler with the application form for personal coverage.

D. Administration has been simplified so that we do not have to be notified of the actual dates of travel as previously required under the foreign travel insurance plan in effect prior to July 1, 1969. Future premiums will be based on our analysis of actual travel performed during a designated period of time.

Please let me know if you need any additional information or clarification. You should also advise me as to the number of copies of the excerpt and forms you require at this time.

RHH:rv

NATIONAL ACADEMY OF SCIENCES

GROUP TRAVEL INSURANCE

July 1, 1969

COVERAGE

Part I.	ACCIDENTAL DEATH, DISMEMBERMENT AND LOSS OF SIGHT		
	Principal Sum		$100,000
Part II.	BLANKET MEDICAL EXPENSE - ACCIDENT	Limit	5,000
Part III.	Applicable only to "International Trip Definintion" Losses		
	BLANKET MEDICAL EXPENSE - SICKNESS	Limit	5,000
		Deductible Amount	50
PART IV.	PREPARATION AND TRANSPORTATION OF REMAINS	Limit	2,000
Part V.	PERSONAL DEVIATION "INTERNATIONAL ONLY"		
	Principal Sum		100,000
	Blanket Medical Expense-Accident	Limit	5,000
	Blanket Medical Expense-Sickness	Limit	5,000
		Deductible Amount	50

BENEFICIARY DESIGNATION: As on file with the Policyholder, or; the Estate of the Insured Person

AGGREGATE LIMIT OF INDEMNITY: $1,000,000

The Home Insurance Company, New York, New York hereby agrees with the Policyholder designated in the Schedule on page 1, hereinafter called the Policyholder, to pay benefits to the extent provided as to each Insured Person (hereinafter defined) and hereinafter individually called Insured Person for certain losses specified in the Benefit Provisions, subject to all the provisions, conditions, and exclusions of this Policy.

The term "injuries" as used in this Policy mean accidental bodily injuries of an Insured Person which are the direct and independent cause of the loss and occur while this Policy is in force as to such person and while such person is on a trip "on business of the Policyholder" and under circumstances and in the manner specified in the provision captioned "Description of Hazards", hereinafter called "such injuries".

The term "sickness"as used in this Policy means sickness or disease of an Insured Person contracted while this Policy is in force as to such person and while such person is on a trip "on business of the Policyholder", hereinafter called "such sickness".

ELIGIBILITY

The class of persons eligible to be insured under this Policy includes and is limited to persons who are included in one of the following classes:

Class I - includes and is limited to persons who are individually classified as a Member who is elected by the Policyholder;

Class II - includes and is limited to persons who are directly employed by and working on a full-time basis for the Policyholder and are compensated for such services by the Policyholder on a United States currency payroll, and persons who are members of the immediate family of such full-time employee, provided such family members are entitled to reimbursement by the Policyholder of their travel expenses;

Class III - includes and is limited to persons who are individually classified as a member of a Board or Panel of the Policyholder, not included in Class I or Class II;

Class IV - includes and is limited to persons who are individually classified as a paid or non-paid consultant of the Policyholder, not included in Class I, Class II or Class III; or

Class V - includes and is limited to persons who are appointed or designated by the Policyholder to participate in a regularly scheduled activity that is sponsored by the Policyholder, and not included in Class I, Class II, Class III or Class IV.

TERMINATION OF INDIVIDUAL INSURANCE

All insurance under this Policy, including insurance with respect to every Insured Person, shall terminate when this Policy ceases to be in force; and prior thereto, insurance with respect to any Insured Person shall terminate when such person ceases to be eligible for coverage under this Policy. (See provision captioned "Eligibility"). This Policy shall cease to be in force at the expiration of the Policy Term for which the premium has been paid if the Policyholder fails to pay the required premium for the next succeeding Policy Term by or in advance of the premium due date for such term, except as provided in the provision captioned "Inadvertent Error".

Termination of insurance with respect to any Insured Person shall be without prejudice to any claim originating prior to the effective date of such termination.

DEFINITION OF "ON BUSINESS OF THE POLICYHOLDER"

The words "on business of the Policyholder" as used herein means an assignment by or with the authorization of the Policyholder for the purpose of furthering the business of the Policyholder but do not include regular travel between the residence of the Insured Person and the Policyholder's place of business where the Insured Person is employed, nor any activity of the Insured Person while on vacation or leave of absence, except that the Insured Persons traveling to and from the Policyholder's field office in Japan, including travel incident to home leave approved by the Policyholder shall be deemed to be "on business of the Policyholder" during the days of travel for which expenses for subsistence, or per diem in lieu thereof, are reimbursed to the Insured Person by the Policyholder in accordance with the Policyholder's usual travel policies and procedures.

"INTERNATIONAL TRIP" DEFINITION

A trip shall be deemed to have commenced when the Insured Person leaves his place of residence or place of business, whichever occurs last, for the purpose of going on a trip, the destination of which requires the Insured Person to travel outside the country of his residence and shall continue until such time as the Insured Person returns to his residence or place of employment, whichever occurs first.

"DOMESTIC TRIP" DEFINITION

A trip shall be deemed to have commenced when the Insured leaves his residence, or place of regular employment for the purpose of going on such trip, provided such trip requires the Insured Person to travel outside the corporate limits of the town or city in which he is regularly employed or has his residence, whichever occurs last, and shall continue until such time as he returns to his residence or place of regular employment, whichever occurs first.

DESCRIPTION OF HAZARDS

The hazards against which insurance is provided include and are limited to certain losses specified in the Benefit Provisions and resulting from "such injuries" sustained by an Insured Person provided "such injuries" (1) occur while such person is "on business of the Policyholder", and (2) are in consequence of and occur during the course of a trip, and provided further that the hazards against which insurance is provided shall not include losses resulting from injuries occurring in consequence of travel or flight in any aircraft, except losses (with respect to which coverage is otherwise afforded under this Policy) resulting from "such injuries" occurring while such person is riding as a passenger in (including boarding or alighting from), and is not an operator or member of a crew of:

(A) an aircraft operated on a regular, special, or chartered flight, by a scheduled airline licensed for the transportation of passengers for hire and maintaining regular published schedules for passenger service, provided such scheduled airline then holds a Certificate of Public Convenience and Necessity issued by the duly constituted authority of the Government of the United States, or then holds an equivalent Certificate issued by the duly constituted governmental authority having jurisdiction over scheduled airlines in the country of its registry; or

(B) any tried, tested and approved (1) civilian aircraft, other than that described in subparagraph (A) above, having a valid and current "airworthiness certificate" issued by the duly constituted governmental authority having jurisdiction over civil aviation in the country of its registry, or (2) military aircraft which is then used for transportation of passengers only and not for any purpose such as testing, experimenting, or any other purpose except the sole purpose of transportation of passengers; provided that in each instance, such aircraft (a) is being operated at that time on orders of competent authority, and (b) is piloted by a person who then holds a valid and current Certificate of Competency or its military equivalent of a rating authorizing him to pilot such aircraft and (c) is not a rocket-propelled aircraft, and (d) is not engaged in flying which requires a special permit or waiver from an authority having jurisdiction over civil aviation, even though granted, unless previously consented to in writing by the Company, and (e) is not an aircraft owned or leased by the Policyholder.

The words "airworthiness Certificate" shall mean that airworthiness certificate issued by the Civil Aeronautics Administration of the United States which permits transportation of passengers in such aircraft or the equivalent of such certificate issued by the governmental authority having jurisdiction over civil aircraft in the country of its registry.

BENEFIT PROVISIONS

Part I. DEATH, DISMEMBERMENT, AND LOSS OF SIGHT - ACCIDENT

If "such injuries" shall, within 365 days after the date of accident result in any loss enumerated in this Part, the Company will pay the sum set opposite such loss but under this Part not more than the sum specified for one such loss sustained (the largest, if more than one) shall be paid for all such losses sustained by one Insured Person and resulting from one accident.

For Loss of:

Life	The Principal Sum
Both Hands or Both Feet or Sight of Both Eyes	The Principal Sum
One Hand and One Foot	The Principal Sum
Either Hand or Foot and Sight of One Eye	The Principal Sum
Either Hand or Foot	One-half The Principal Sum
Sight of One Eye	One-half The Principal Sum

"Loss", as used in this Part, with regard to hands or feet means actual severance through or above wrist or ankle joints, and with regard to eyes means entire and irrecoverable loss of sight.

Payment under this Part shall not affect the right to any indemnity payable under Part II of this Policy.

Part II. BLANKET MEDICAL EXPENSE - ACCIDENT

If "such injuries" shall require treatment by a physician or surgeon, hospital care, or the employment of a trained nurse, or other related medical expenses, the Company will pay the actual expense of such treatment and hospital and nursing care incurred within 52 weeks from the date of the accident, which is in excess of any other benefits paid or payable under any other medical reimbursement plans, Federal, State, Private, and/or Employer sponsored, but not exceeding the Blanket Medical Expense - Accident Limit specified in the Schedule, on page 1, for all such expenses on account of injuries sustained by one Insured Person resulting from one accident.

Part III. APPLICABLE ONLY TO "INTERNATIONAL TRIP DEFINITION" LOSSES

BLANKET MEDICAL EXPENSE - SICKNESS

If "such sickness" shall require treatment by a physician or surgeon, hospital care or the employment of a trained nurse or other related medical expenses, the Company will pay the actual expense of such treatment and hospital and nursing care in excess of the deductible amount, which is in excess of any other benefits paid or payable under any other medical reimbursement plans, Federal, State, Private, and/or Employer sponsored, but not exceeding the Blanket Medical Expense - Sickness Limit specified in the Schedule, on page 1, for all such

Part III continued

expenses on account of sickness of one Insured Person, provided, however, that insurance under this Provision shall cover only the actual expenses incurred within 52 weeks from the date the first such expense was incurred.

Part IV. PREPARATION AND TRANSPORTATION OF REMAINS

In the event of the death of the Insured hereunder, which occurs within the term of the Policy as to such Insured, the Company will pay the actual charges for preparing and transporting to and from their homes "in accordance with applicable requirements" the remains of any such person who may die while away from their home but not to exceed Two Thousand Dollars ($2,000.00) per Insured Person. These benefits are in addition to any other benefits payable under the terms of this Policy.

Part V. PERSONAL DEVIATION

Notwithstanding any provision, and in consideration of the payment of the premium as determined from the Premium Rate Schedule shown below which is a part of this contract, and subject to all the conditions of the contract, the benefits payable by reason of "such injury" or "such sickness" are hereby extended to include "such injury" or "such sickness" sustained while the Insured Person is on personal leave while in foreign travel status. Family members shall be deemed eligible for the extension of coverage herein described in consideration of the premium as determined from the Premium Rate Schedule below, notwithstanding the fact that travel expenses with respect to such family members are not reimbursable by the Policyholder. Personal leave means those periods of time in which the Insured Person is neither assigned to nor authorized with the purpose of furthering the business of the Policyholder for which neither expenses for subsistence, nor per deim in lieu thereof, are reimbursed to the Insured Person by the Policyholder in accordance with the Policyholder's usual travel policies or procedures.

Foreign travel status exists when the Insured Person is on a trip as defined in the paragraph "International Trip", but only if the Insured Person is outside the country of which he is a national.

The premium rate for this part shall be seventy-five cents ($.75) per person per day or any part thereof. The Policyholder shall report all premiums on a quarterly basis.

AGGREGATE LIMIT OF INDEMNITY

In case losses for which benefits are payable under the provision captioned "Death, Dismemberment, and Loss of Sight - Accident", shall be sustained by more than one person as a result of one accident or disaster, the limit of the Company's liability for all such losses in the aggregate is the amount of the Aggregate Limit of Indemnity specified in the Schedule, on page 1.

Aggregate Limit continued

If the aggregate limit is insufficient to permit payment of the sum specified and otherwise payable with respect to every such loss resulting from such one accident or disaster, the Company will be liable only for the proportionate amount of the sum specified and otherwise payable with respect to each such loss as the Aggregate Limit of Indemnity bears to the total amount of all such sums in the aggregate otherwise payable on account of all such losses resulting from such one accident or disaster.

EXCLUSIONS

A. The Accident insurance under this Policy shall not cover suicide sane or insane or any attempt thereat, hernia of any type or the contracting of disease; nor shall it cover any loss caused by or resulting from disease or medical or surgical treatment therefor except pus forming infection which shall occur through an accidental cut or wound.

B. The Sickness coverage (Part III, page 1) shall not cover any loss resulting from:

1. Accidental bodily injuries
2. A trip other than as described in "International Trip" definition (Page 3)

C. The insurance under this Policy shall not cover any loss caused by or resulting from declared or undeclared war or any act thereof; nor shall this Policy cover any expense incurred for any of the following: (1) eye refraction, eye glasses, precription therefore or equipment for corrective treatment of sight, (2) services rendered incident to engagement or employment by a physician, nurse or other person engaged by or employed by the Policyholder, (3) dentistry, dental X-rays, or services of a dentist, except such expenses for which benefits are provided under Part II for treatment of "such injuries" to the jaw and for dentistry required on account of "such injuries" to sound natural teeth, or (4) injuries occurring while the Insured Person is in or on, or in falling or otherwise descending from or with, any aircraft, other than under circumstances fulfilling the conditions for coverage in accordance with the "Description of Hazards", (5) any medical loss which is paid or payable under any other medical reimbursment plans, Federal, State, Private, and/or Employer sponsored.

GENERAL PROVISIONS

This Policy and the application of the Policyholder shall constitute the entire contract between the parties. All statements made by the Policyholder shall be deemed representations and not warranties and no such statement shall avoid the insurance or reduce benefits hereunder unless such statement is contained in a written application signed by the Policyholder. No agent has authority to change this Policy or to waive any of its provisions. No change in this Policy shall be valid unless approved by an officer of the Company and such approval be endorsed hereon or attached hereto.

General Provisions continued

Written notice of claim must be given to the Company within twenty days after the occurrence or commencement of any loss covered by the Policy. Such notice given by or on behalf of the Insured Person or the beneficiary to the Company at New York, New York, or to any authorized agent of the Company, with information sufficient to identify the Insured Person shall be deemed notice to the Company.

Failure to give notice within the time provided in this Policy shall not invalidate any claim if it shall be shown not to have been reasonably possible to give such notice and that notice was given as soon as was reasonably possible.

The Company, upon receipt of such notice, will furnish to the claimant such forms as are usually furnished by it for filing proofs of loss. If such forms are not so furnished within fifteen days after receipt of such notice, the claimant shall be deemed to have complied with the requirements of this Policy as to proof of loss upon submitting within the time fixed in the Policy for filing proofs of loss, written proof covering the occurrence, the character and the extent of the loss for which claim is made.

Written proof of loss must be furnished to the Company within ninety days after the date of the loss for which claim is made. Failure to furnish such proof within the time required shall not invalidate nor reduce any claim if it was not reasonably possible to give proof within such time, provided such proof is furnished as soon as reasonably possible and in no event, except in the absence of legal capacity, later than one year from the time proof is otherwise required.

All indemnities payable under this Policy will be paid immediately upon receipt of due written proof of loss.

Indemnity for loss of Life of an Insured Person will be payable to the beneficiary or beneficiaries specified in the beneficiary designation referred to in the Schedule (on Page 1) of this Policy. If no such designation is then effective, such indemnity shall be payable to the estate of the Insured Person. Any other accrued indemnities unpaid at the Insured Person's death may, at the option of the Company, be paid either to such beneficiary or to such estate. All other indemnities will be payable to the Insured Person.

If any indemnity of this Policy shall be payable to the estate of the Insured Person or to an Insured Person or beneficiary who is a minor or otherwise not competent to give a valid release, the Company may pay such indemnity up to an amount not exceeding $1,000 to any relative by blood, or connection by marriage of the Insured Person or beneficiary who is deemed by the Company to be equitably entitled thereto. Any payment made by the Company in good faith pursuant to this provision shall fully discharge the Company to the extent of such payment.

The Company at its own expense shall have the right and opportunity to examine the person of the Insured Person when and as often as it may reasonably require during the pendency of a claim hereunder and to make an autopsy in case of death where it is not forbidden by law.

General Provisions continued

The right to change of beneficiary is reservedto the Insured Person and the consent of the beneficiary or beneficiaries shall not be requisite to change of beneficiary or beneficiaries.

No action at law or in equity shall be brought to recover on this Policy prior to the expiration of sixty days after written proof of loss has been furnished in accordance with the requirements of this Policy. No such action shall be brought after the expiration of three years after the time written proof of loss is required to be furnished.

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

24 November 1969

TO: Mr. Kenneth Olsen

FROM: A. G. Oettinger

Dear Ken,

It now looks fairly promising that Ron Wigington's Information Systems Proposal to the Council on Library Resources will be accepted and that Wigington's planning group can get off the ground fairly soon.

As Wigington's work progresses it is very likely to concern itself with areas that I know you are interested in, on the basis of some of my visits with you in Maynard.

I should therefore be grateful if you would assume a role similar to that which Rosser and Evans played with Carter's panel and Baer and Meyer with respect to Lew Billig's.

I am therefore taking the liberty of asking Ron to keep you informed by sending you a copy of the proposal that is going to the Council on Library Resources and of any other background material he thinks relevant and henceforth copy you on significant correspondence and other materials. I would hope that you would also sit in on some of their meetings. Presumably they will follow the practice of scheduling these to coincide with Board meetings so that you will have the option of attending both or in critical cases where your time is short, attending one or the other, depending on your interest and criticality of matters that might come before either the panel or the full Board.

If you would like further information, I'd be happy to discuss this with you further on the phone. Many thanks!!

Tony

AGO:chm

cc: W. C. House
R. Wigington

DIGITAL EQUIPMENT CORPORATION

MAYNARD, MASSACHUSETTS

KENNETH H. OLSEN
PRESIDENT

June 9, 1969

Professor Anthony G. Oettinger
Aiken Computation Laboratory
Room 200
Harvard University
Cambridge, Massachusetts 02138

Dear Tony:

It might be time that we review the goals and ambitions of the Computer Science and Engineering Board.

I suggest that you might do this by sending out a questionnaire to members because it might be most valuable to get the opinion of those who tend to be quiet in the meetings and of those who do not give these meetings high enough priority in their schedule to always attend.

I wonder how many share my opinion that we are covering too broad an area, and that we are looking for responsibilities rather than looking for those areas which have to be covered because no one else is covering them and which are vital to the nation.

If we look for a measure of success, I would like to propose that our success be in proportion to how many jobs we can get done by teasing, needling, or talking other organizations into doing them.

I'm sorry I will miss the meeting this week. I'm baby-sitting the two boys for a couple weeks, and, at the last minute, found I couldn't take them to Washington with me.

Sincerely yours,

Ken

Kenneth H. Olsen

KHO:ecc

cc: Mr. Warren C. House

digital

June 9, 1969

Professor W. F. Miller
Computer Science Department
Polya Hall
Stanford University
Stanford, California 94305

Dear Bill:

You asked for my comments on the effect of Government policy concerning computer companies' policy on contributions to universities. I feel that the Government tax rules cannot help but be a very significant influence.

The Government allows you to give 5% of your profit as contributions. If you give more than this, they are not deductible. This means that there is very strong pressure not to make contributions beyond 5% of profit, and one might be very seriously criticized by stockholders if he did.

When you are in a manufacturing business, gifts ~~of~~ equipment are often at very low cost because one can deduct the full sales price, but the cost is often lower than this.

Computer companies have been accused of using charitable gifts to, in effect, lower the price of equipment where the competition is strong with other computer companies. DEC likes to believe that we make most of our equipment gifts to schools who would not be able to afford acomputer without our help. We are quite open to admit that we give these gifts where we expect direct return in students who will know about our computers.

If IBM has stopped giving educational gifts in the form of discounts, this may have a significant effect in education because others who have been giving these gifts to meet IBM's competition may see less need to do it in the future.

I'm sorry I will miss the meeting this week.

Sincerely yours,

Kenneth H. Olsen
President

cc: Mr. Warren C. House

digital

March 18, 1969

Mr. John P. Gillis
Security Officer
National Academy of Sciences
2101 Constitution Avenue
Washington, D.C. 20418

Dear Mr. Gillis:

I am enclosing herewith an Assistant Clerk's Certificate evidencing the passage by the Board of Directors of Digital Equipment at its meeting held on March 10, 1969, of a resolution noting the execution of a Foreign Investment Certificate by Kenneth H. Olsen.

Very truly yours,

DIGITAL EQUIPMENT CORPORATION

Edward A. Schwartz

Edward A. Schwartz
General Counsel

EAS:o
Enc.

ASSISTANT CLERK'S CERTIFICATE

I, Edward A. Schwartz Assistant Clerk of Digital Equipment Corporation, hereby certify that the following is a true and exact extract from the Minutes of a Meeting of the Board of Directors of Digital Equipment Corporation, duly called and held on March 10, 1969, at which meeting a quorum was present and acted throughout:

RESOLVED: That the Board hereby takes official notice of the execution of the Representative of a Foreign Interest Certificate by the following named individual under the date indicated in which certification is made that classified information will not be disclosed to any unauthorized individual or group of individuals, foreign or domestic:

Kenneth H. Olsen

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of Digital Equipment Corporation this 11 day of March 1969.

Edward G Schwartz

STATEMENT OF FULL DISCLOSURE OF ALL FOREIGN CONNECTIONS

I, Kenneth H. Olsen, hereby submit a full disclosure of my connections with foreign interests:

Digital Equipment of Canada Limited (a Canadian corporation wholly owned by Digital Equipment Corporation (DEC))	Director, President, and a holder of a minority stock-holders interest (less than 10% held in trust for DEC)
Digital Equipment Corporation, Limited (a United Kingdom corporation)	Managing Director and share-holder (less than 10% held in trust for DEC)
Equipement Digital S.A.R.L.	Shareholder (less than 10% held in trust for DEC)
Digital Equipment Australia Pty. Ltd. (an Australian corporation)	Director
Digital Equipment N.V. (a Netherlands corporation)	Managing Director
Digital Equipment A.B. (a Swedish corporation)	Director

Kenneth H. Olsen

January 31, 1969

August 29, 1969

C O P Y

Mr. Warren C. House
Executive Secretary
Computer Science and Engineering Board
National Academy of Sciences
2101 Constitution Avenue
Washington, D. C. 20418

Dear Warren:

Here are the notes I meant to send you a few weeks ago. They are of no great significance, but might give you a few ideas.

Sincerely yours,

KHO:ecc

Enclosure

digital INTEROFFICE MEMORANDUM

DATE: August 1, 1969

SUBJECT: EASTERN EUROPEAN COUNTRIES

TO: Ken Olsen

FROM: Ted Johnson

One of our trainees prepared the attached summary of inquiries.

K. H. OLSEN

8/7/69

Ken:

These inquiries were received during the last six months of 1968 and up to the present date.

Elsa

DIGITAL EQUIPMENT CORPORATION

JUL 23 1969

digital INTEROFFICE MEMORANDUM

DATE: July 23, 1969

SUBJECT: Inquiries from Communist countries, 1968-69

TO: Pat Greene

FROM: Charles King

cc: Ted Johnson
Ron Smart

The result of my research on the inquiries from the Communist countries - Eastern Europe, is shown on the graph accompanying the memo.

By using a point system giving a point for a bingo card, three points for a personal letter, five points for a request for a Performa Invoice and by totaling the points for each item per country, I came up with the accompanying graph.

It seems as if most of the interest lies in the PDP-8 family, Small Computer Handbook, Logic Handbook, and Industrial Control Handbook. Also, we receive more inquiries from Communist countries that are known to have more freedom: Yugoslavia, Czechoslavakia, etc.

bu

	PDP-8	PDP-9	PDP-10	PDP-12	PDP-15	LINC-8	LAB-8	TS-8	TYPE-8	GLC-8	INDAC	QUICKPOINT	680/I
BULGARIA	7	5	3	1		3	1						
CZECHOSLAVAKIA	30	27	12		3	5	5	5		2		1	3
EAST GERMANY	15	6	3										
HUNGARY	55	20	19	11	3	14	13		1	9	6		
POLAND	36	17		6	3	4	6			4			3
ROMANIA	14	11	7			5				3			
USSR	6	3	4	1		2	1	1		3			
YUGOSLAVIA	41	12				4	1	3					
WEIGHTED TOTAL BY PRODUCT	204	101	48	19	9	37	27	9	1	21	6	1	6

	CRT DISPLAYS	A/D CONVERTERS	PERIPHERALS	LOGIC LAB	COMPUTER LAB	MODULES	TRADE SHOWS	SMALL COMPUTER HANDBOOK	LOGIC HANDBOOK	CONTROL HANDBOOK
BULGARIA	3	1					3	4	3	1
CZECHOSLAVAKIA	7	6	9		4	12		49	51	15
EAST GERMANY	3	3			5		3	12	3	4
HUNGARY	28	8	17	3	10	10		59	51	40
POLAND		1	4	5		1		7	24	20
ROMANIA	6	4			6			21	16	11
USSR	4	1				1		1		1
YUGOSLAVIA	7	19		20			3	27	17	17
WEIGHTED TOTAL BY PRODUCT	58	43	30	28	25	24	9	180	165	109

	INTRODUCTION TO PROGRAMMING	COMPUTER LAB HANDBOOK	WEIGHTED TOTAL BY COUNTRY
BULGARIA			35
CZECHOSLAVAKIA	1		247
EAST GERMANY	3	2	62
HUNGARY	4		381
POLAND			141
ROMANIA			104
USSR		1	30
YUGOSLAVIA	6		177
WEIGHTED TOTAL BY PRODUCT	14	3	1177

*METHOD OF CALCULATING POINTS

1 POINT BINGO CARDS

3 POINTS PERSONAL LETTER

5 POINTS PROFORMA INVOICE

BRIEF - BE FACTUAL - COMPLETE DAILY - MAIL PROMPTLY PRODUCTS MOD. 8/S 8 9 10 L-8 TEST

TO: KEN OLSEN

SALES CALL REPORT NO. 54526

[X] INITIAL CONTACT [ ] FOLLOW-UP [ ] ADD TO MAILING LIST [ ] ADD TO FORECAST

% $ ORDER MONTH

PRODUCT

FROM:

FIRM: ARMSTRONG CORK COMPANY

ADDRESS: DUESSELDORF, GERMANY

PHONE AC

SALESMAN: HAROLD LEAMAN

DATE: 20 JUNE 1969

OFFICE: MUNICH

CONTACT: [X] MV [ ] TV [ ] MT [ ] TT

PERSONS CONTACTED	(✓)	KEY(✓)	POSITION	EXT.
GEORGE AARON SMITH	✓	✓	HEADS OF MARKETING FOR EUROPE, MIDDLE EAST FOR DIFFERENT PRODUCT LINES	
GERARD SCHOUTEN	✓	✓		

Re: Eastern Europe business.

SOURCE OF FUNDS

WHEN

(✓)	EVAL.	(✓)	YEARLY POT'L.
	URGENT		>150K
	HI		> 50K
	MED.		> 20K
	LO		< 20K
	FORGET		

PRO	INFLUENCED BY	CON
	PRICE	
	DELIVERY	
	QUALITY	
	SERVICE	
	OTHER (DETAIL)	

COMPETITION: (MFR./EQUIP.)

SPECIAL COMMENTS: Contacted during INTERHOSPITAL fair in Duesseldorf.

APPLICATION: Armstrong has recently begun doing business fairly extensively in Eastern Europe. In one large recent transaction, the following Swiss firm:

KELLENBERGER & GAERTNER
180 BERNERSTRASSE
ZUERICH, SWITZERLAND

helped arrange a contract with Bulgaria which provided for 50% payment in cash and 50% in commodities, i.e. fruits, produce, etc. Armstrong makes building materials and a line of industrial products.

Smith and Schouten suggested we contact this firm if we had occasion to arrange for a similar contract in Eastern Europe calling for partial payment in commodities.

ACTION TO BE TAKEN:

FOLLOW-UP DATE BY

COPIES TO PETER SCHMIDT, MORT RUDERMAN

digital INTEROFFICE MEMORANDUM

DATE: August 6, 1969

SUBJECT:

TO: Ken Olsen

FROM: J. A. Jones

The two PDP-15 proposed installations in Russia are at the following places:

Professor A. I. Alikhanian
Director, Yerevan Institute of Physics
Yerevan, Armenia U.S.S.R.

Professor A. M. Budker
Institute of Nuclear Physics
Academy of Science of U.S.S.R.
Novosikirsk, Nouchny, Gorodok
Novosilirsk, U.S.S.R.

njb

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

14 February 1969

Mr. Kenneth Olsen
President
Digital Equipment Corporation
899 Main Street
Maynard, Massachusetts 01754

Dear Sir:

In connection with the establishment of your clearance with the National Academy of Sciences, the Department of Defense has granted you a TOP SECRET clearance effective 13 February 1969. The clearance is on file with the Security Office, National Academy of Sciences.

Sincerely yours,

John P. Gillis

John P. Gillis
Security Officer

cc: Mr. W. C. House

Forwarded to John Kulik 2/10/70

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

FEB 14 1969

Digital Equipment Corporation
899 Main Street
Maynard, Massachusetts 01754

ATTENTION: Security Officer

Mr. Kenneth Olsen, an employee of your facility has been appointed to Computer Science and Engineering Board, National Academy of Sciences. We would like to designate Mr. Olsen a class "C" consultant to the National Academy of Sciences, with a clearance level of SECRET, providing your facility would agree to such a proposal.

Agreement to this proposal would require you to furnish the National Academy of Sciences a copy of the Letter Agreement outlined on Page 183, DoD Industrial Security Manual.

Your cooperation and consideration in this matter will be appreciated.

Sincerely,

John P. Gillis
Security Officer

cc: Mr. K. Olsen ✓

Mr. W. C. House

forwarded to John Kulik 2/10/70

NATIONAL ACADEMY OF SCIENCES

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

April 11, 1968

Mr. Kenneth Olsen
Digital Equipment Corporation
899 Main Street
Cambridge, Massachusetts 02140

Dear Mr. Olsen:

In behalf of the National Academy of Sciences, I would like to invite you to serve as a member of the Computer Science and Engineering Board which is now being established by the National Academy of Sciences.

The enclosed report to me of the Planning Group for the Board describes the broad range of interests that the Board is expected to span. The Planning Group's recommendations on organization and priorities may be helpful to you as illustrations of the Board's charter.

If he has not already done so, the Chairman, Professor Anthony G. Oettinger, will telephone you shortly to invite you to the first meeting.

Sincerely yours,

F. Seitz

Frederick Seitz
President

Enclosure

Report of the Planning Group
Computer Science and Engineering Board
to the
President of the National Academy of Sciences

In view of the rapid evolution of the field of Computer Science and Engineering, the National Academy of Sciences has decided to establish a Computer Science and Engineering board comprised of a distinguished group of experts in the field of computer and information science and related areas. The Board will be available to provide advice to federal agencies and to other organizations which may have problems in which the Board can be helpful. This step is in keeping with the official role of the National Academy of Sciences to provide advisory assistance to the federal government in matters of science and engineering.

Since the field of computer science and technology is developing rapidly, the Board will have a special and continuing obligation to keep itself well informed. It should be capable of perceiving the current state and the future prospects of Computer Science and Engineering, and of its professional practices in order to advise the government concerning the intellectual capital and the manpower resources necessary to insure continuing U. S. leadership in Computer Science and Engineering. It should be able to evaluate in technical terms the true meaning of the enormous and somewhat heterogeneous growth of information processing technology as it affects the public and private sectors of our nation. It should, in general, be capable of assessing the implications of advances in this branch of science and technology for the national welfare.

The Board should therefore take a broad view of this subject and of its applications to research and education in other branches of science and engineering as well as to the workaday needs of government, commerce, industry and education. Consequently, it should interact with other boards or committees under the various subdivisions of NAS/NAE/NRC.

The Organization of the Board

This view of the Board's broad role implies a need to set priorities among areas of potential interest by weighing the importance attached to these areas.

The following recommendations on organization and priorities reflect the thought the Planning Group and its guests have given to these questions.

To function with a balanced and broadly representative group of individuals without losing the working efficiency of smaller groups, the Planning Group recommends that the Board organize itself into several committees, each subsuming panels created to meet specific needs.

Between plenary sessions of the Board, the committees would meet on schedules tailored to the work of the panels or working groups under their wing. These panels or working groups should be created as needed, often on a temporary basis. They should be chaired by a member of the parent committee and staffed for appropriate competence and breadth of representation by members of committees other than the parent committee and also by the most competent individuals in the nation representing significant points of view whether or not they belong to any committee of the Board.

Specific capabilities the Board should have at its inception were studied by panels of the Planning Group. The initial areas spelled out by these panels can be covered by starting the Board with the following three committees:

1. Education

2. Research and Development

3. National Programs

The interests and responsibilities of these three committees clearly overlap. The committees should therefore have overlapping membership. This mechanism for insuring balanced coverage of all significant points of view can be supplemented by the creation of joint panels to deal with specific subjects. The staffing and the mission of such panels would be determined by recommendations of the affected committees to the chairman of the Board, who would be responsible for assuring broad and balanced representation. Since competence and partiality often go hand in hand, broad and balanced representation should be interpreted as assurance of full and free expression of contending professional points of view.

Committees of the Board

The Committee on Education should be prepared to advise on educational questions, for example how to overcome the prevalent shortage of personnel in Computer Science and Engineering. This committee very likely will need a panel on data-gathering to make recommendations about adequate statistics for describing manpower needs.

This committee should perform for education in computer science and engineering in a continuing, comprehensive and nationally representative fashion the role that the earlier committees chaired by Rosser (in NAS) and Pierce (in OST) could perform only for a limited time under restrictive charters.

The Research and Development Committee should be concerned with assessing the current state of the art and perceiving future directions for research and development. Three principal panels recommended for initial creation under the Research and Development committee would study (a) the application of computers (b) the science of machines and programs (c) systems directions.

The first panel may advise on research policy leading to better applications methodology for extending current computer applications and for developing new application areas.

The second panel may advise on the development of a formal theoretical foundation for the developing science of machines and programs.

The panel on systems directions may foster the development of new systems concepts and organizations. The systems problems continue to be of the most difficult type, heightening the importance to be attached to great improvements in the depth of understanding and of skills for tackling the wide variety of such problems which confront all levels of organization, both government and private. Panels concerned with specific functional areas, e.g. data retrieval, can be formed in cooperation with the Committee on National Programs.

Under the Committee on National Programs, panels dealing with specific requests by governmental organizations would be formed as needed.

The Committee on National Programs should perceive and assess developments in Computer Science and Engineering that affect national programs providing direct support to policy formulation and policy execution. It should advise on how human, equipment, and methodological resources may be combined to maximize the effectiveness and efficiency of federal, state and local governmental organizations.

The implications of the current state and future prospects of Computer Science and Engineering on the Formulation of Government policy affecting Computer Science and Engineering and related fields should also be a prime concern of this Committee.

Staffing of Committees

The initial organization of the Board into three major committees leads to natural emphases on staffing in the three corresponding areas. For example, the Education Committee should include people representing the universities, the schools, the professional societies, and such industrial organizations or government agencies as are concerned with education and training. Lay members should be included to assure satisfactory representation of other significant points of view.

The Research and Development committee should include the individuals most knowledgeable of affected substantive areas without regard for the institutional character of their primary affiliation.

The National Programs Committee should include among its members people chosen primarily for their familiarity with relevant aspects of national civilian or military programs as well as experts in Computer Science and Engineering.

Liaison groups should be established to inform other organizations within NAS/NAE/NRC of the discussions and plans of the Computer Science and Engineering Board and to keep the Board informed of the needs of computer users in various areas of science and technology. As the need arises, more formal joint panels can be created in conjunction with other NAS/NAE/NRC boards or committees.

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

April 10, 1968

Mr. Kenneth Olsen
Digital Equipment Corporation
899 Main Street
Cambridge, Massachusetts 02140

Dear Mr. Olsen:

The Chairman of the Computer Science and Engineering Board of the National Academy of Sciences, Professor Anthony G. Oettinger, of Harvard University, has set April 17 and 18 for the initial organizing meeting. The meeting will begin with refreshments and dinner at the Academy at 7:30 p.m., with opening remarks and discussions to follow. The business meeting will begin the following day, April 18, at 9:00 a.m. and continue through the day until 4:30 p.m. Lunch will be at a time and place to be announced at the meeting. Please indicate as soon as possible whether or not you can attend this meeting, including both the evening session on the 17th and the all-day session on the 18th, so that we can make appropriate plans for meals and facilities.

Would you please reserve the evening of May 15 and all day of May 16 for the second meeting of the CS&E Board. The times for subsequent meetings will be discussed at the first meeting.

Please wire or mail your replies to:

Warren C. House
Executive Secretary
Computer Science and Engineering Board
Room 273
National Academy of Sciences
2101 Constitution Avenue
Washington, D. C. 20418

If you have any questions, please call Area Code 202 - 961-1386 or 961-1323. Thank you.

Sincerely yours,

Warren C. House
Warren C. House
Executive Secretary
Computer Science and Engineering Board