

J.A.

DATE: December 10, 1973

To : Clayton Rich, M.D.

FROM : Joshua Lederberg, Chairman and Grant Professor
Department of Genetics

SUBJECT: SUMEX Research Project - Request for Assistance in Equipment Financing

Introduction and Summary

The SUMEX (Stanford University Medical EXperimental Computer) proposal to establish a resource for research on advanced applications of computer science in medicine has been pending with the National Institutes of Health for some time. Early last summer, the proposal received final approval by the Advisory Council to the Biotechnical Resources Branch (BRB). In the intervening months a funding decision has waited on internal NIH deliberations relating programmatic priorities and anticipated funding levels. We received a two months interim award on October 1, 1973 to up-date previous planning and to settle a variety of policy, budgetary, and technical issues preparatory to implementing the SUMEX facility along the Council-approved guidelines. These issues have been resolved and NIH has awarded Stanford a 5-year grant for the SUMEX project effective December 1. The 5-year budget for the award totals \$2,747,882 in direct costs, not including the interim award (see Attachment A).

Because of vagaries in the fiscal 1974 NIH appropriation levels, uncertainties had persisted as to the arrangements under which purchase of the research computer for the proposed SUMEX resource could be funded. BRB had expressed a desire to fully fund the purchase in the first year, but a recent (11/7/73) examination of available funds made this impossible at present. An alternative plan has now been proposed by BRB which would entail direct NIH funding of approximately 38% of the purchase price in the first year. The remaining purchase costs to be advanced by Stanford University, would be repaid over three succeeding grant years. BRB has reaffirmed their intent, without a commitment at present, to accelerate these payments, if possible, within future funding allocations (See Attachment A - letter from Dr. Baker).

It is technically not feasible to delay purchase of any significant portion of the needed research equipment to match the above NIH funding schedule. We are therefore requesting assistance from Stanford University in financing this purchase according to the time table of the grant award. This would entail a loan for approximately \$556,000, starting in April 1974, covering the portion of the purchase price not initially funded by NIH. The principal of this loan would be refunded by NIH in three installments: \$170,000 on 8/1/74, \$170,000 on 8/1/75, and \$216,000 on 8/1/76. At the end of this term, cumulative interest charges amounting to between \$67,000 (based on 8.5% interest rate) and \$75,000 (9.5%) would remain unreimbursed to the University.

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An analysis indicates that through the term of this loan the University's investment, including cumulative interest, would be adequately secured by the expected resale value of the equipment. Title to the equipment would be vested in Stanford. This low financial risk and the potential medical research benefits arising from the SUMEX project, suggest that it is in Stanford's interest to assist the implementation of the SUMEX resource.

We may also point out that the SUMEX facility may be the nucleus of much larger investments by the NIH and other agencies in specialized national computer resources sited at Stanford. We do not know whether this will indeed be the pattern of future federal funding, or whether we will wish to participate at larger levels than at present. However, failure to accept this option at the present time may well foreclose the freedom to decide in the future owing to the competing interests of other institutions. Also at stake are other current large grants involving the Departments of Genetics, Chemistry, and Computer Science, on work interrelated with SUMEX.

A timely decision on this proposal is obligatory primarily because of a deadline of December 31 imposed by the principal equipment vendor (Digital Equipment Corporation) to take advantage of a discount agreement. In light of recent pricing policy changes within DEC, reopening these negotiations could substantially reduce the approximately \$150,000 price advantage we have achieved and which is essential to be able to purchase an adequate computer configuration for our technical objectives.

It is unfortunate that the budgetary decisions by NIH came so late, necessitating an accelerated consideration of this financing proposal. For the above reasons, however, we urge that the steps be taken to ensure a decision allowing procurement action as early as possible in December. In summary of the approach elaborated on page 7 of this memorandum, rather than attempt an emergency Board of Trustees action in December, we propose that the appropriate University officer issue firm purchase orders in December in anticipation of a Board decision on January 8, 1974. The equipment vendors would accept such a University authorization as meeting the December 31 deadline. However, if a subsequent negative Board decision requires cancellation before January 9, 1974, DEC will accept such a cancellation without penalty.

The following paragraphs describe in more detail the rationale behind the SUMEX project, the financing and risk analysis, and the importance of immediate action.

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SUMEX Rationale

The SUMEX proposal has been pending with NIH for approximately one and a half years (originally submitted on June 1, 1972). In this time the application has undergone several rounds of elaboration with the Computer and Biomathematical Sciences Study Section, including two site visits. The most recent version of the proposal was submitted on March 18, 1973. As a result of Study Section review and subsequent approval by the National Advisory Research Resources Council, portions of that proposal were selectively emphasized in formulating a funding priority and guidelines for the Biotechnology Resources Branch. The SUMEX project, as approved, would establish a powerful national resource for advanced research on applications of Artificial Intelligence techniques in Medicine (AIM). This objective comprises two main themes: 1) the exploration of advanced computer science applications in medicine and 2) the development of the relatively new concept of nationally shared resources for NIH. The portion of our research proposal which dealt with applications of analytical methodologies, such as gas chromatography/mass spectrometry, to clinical problems of biomolecular characterization was de-emphasized in this context and subsequent discussions with the BRB have suggested splitting it out as a separate project. It is in the process of being reformulated and proposed under somewhat different funding auspices.

The SUMEX resource would consist of a PDP-10 computer facility together with a local group of professionals, experienced in utilizing AI techniques in a range of problem areas. This group is interdisciplinary, representing medical science under me as Principal Investigator and computer science under Professor Feigenbaum. The core of the research effort will be our on-going Heuristic DENDRAL project which seeks to apply artificial intelligence techniques to the interpretation of mass spectra and a relatively new project, in collaboration with UC San Diego, to infer protein structure from x-ray crystallographic data. A number of additional projects have been identified as potential initial users of the resource including two at Stanford and an NIH-funded AI research effort at Rutgers University under Professor Saul Amarel. The two Stanford projects are "Computer-based Consultations in Clinical Therapeutics" under Professor Cohen of the Medical School and "Higher Mental Functions Modelling" under Dr. Colby of the Computer Science Department.

These projects could consume approximately 20-25% of the initial SUMEX facility and would act as a basis for attracting and promoting new efforts by other groups in this area of medical research. The resource would be made available to a national community of NIH-funded users and would gain access to existing AI software via the ARPANET computer network. Using a communications network which is national in scope, facilities such as SUMEX potentially offer a far more economical means of supporting advanced computer related research and encouraging regular intellectual interactions between remote groups.

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The SUMEX facility will be organized such that access is controlled under either of two auspices: 1) a National AIM Advisory Committee comprising members from NIH, the AI research community at large, and the SUMEX user community; or 2) the Principal Investigator representing the Stanford Medical School. The resource capacity will be roughly divided in half, the one-half at the disposal of the AIM Advisory Committee and the other at the Principal Investigator's disposal for Medical School projects. Of the projects mentioned above, those under Professor Amarel and Dr. Colby would fall in the former category and the others in the latter. The facility will not charge fees for service as this would impair the intended environment attracting new research efforts in AI applications in medicine. On the other hand the two control mechanisms will act to ensure that only appropriate research efforts be allowed to gain access and that priorities be set to prevent saturation of the resource or to recommend augmentation when justified.

This facility does not seek nor does it represent a competition for the funding base of other campus computing facilities. In formulating the SUMEX proposal, numerous consultations were held with Professor Franklin, the Associate Provost for Computing. Experience at Stanford (ACME and SCC) and elsewhere illustrates the difficulties encountered in accommodating AI computer research with general service computing. These problems arise principally because of the very large program sizes routinely encountered in AI research and the rather specialized software support (e.g., languages or major subprograms) required to maintain contact with on-going research. Such problems could be solved for a few local research projects within the SCIP facilities by augmenting the IBM hardware and software facilities. This would entail a cost, however, which could not be justifiably spread over the general user community for whom these augmentations would offer little benefit. On the other hand, the few local research projects involved could not command the necessary funding resources on their own. There would also be a question as to whether such a solution would be the best one in the long term considering that the bulk of the research in this area utilizes PDP-10 systems and the use of other machines creates needless barriers to program interchange.

The only discernable mechanism to obtain substantial funding for this line of research has been to create a resource which addresses both the specific research objectives of AI applications in medicine and the equitable availability of such resources to authenticated research efforts elsewhere in the nation. For these reasons we have arrived at the present formulation of the SUMEX resource, to establish at Stanford a PDP-10 computer facility configured and administered to promote national research in medical AI research.

Potential advantages for Stanford University support of this project include: 1) the availability of 50% of the resource for Medical School research in this area under local PI control, 2) the prestige arising from serving as a national center for AI research in medicine, and 3) intangible benefits for other local projects growing, for example, out of the experience which would be developed in computer networking.

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Financial Considerations

As discussed in previous memoranda (see references), two alternative methods of financing the computer system for the SUMEX resource have been considered: direct NIH purchase or Stanford purchase with reimbursement of the principal by NIH over the term of the grant. Other alternatives such as a lease-purchase plan with Digital Equipment Corporation or third party leasing are not feasible because of interest costs which cannot be allowed in the first instance and budget limitations in the second. The Council-approved budget was reduced specifically in such a way as to constrain the machine configuration to be minimal with respect to program needs. Thus any attempt to lease the equipment would entail increased costs to cover third party involvement which, because of the NIH budget ceiling, would have to be absorbed as an unacceptable reduction in the equipment configuration. The most recently designed system, consistent with current constraints, is detailed along with the configuration rationale in Attachment B.

The question of full NIH purchase or Stanford financing has remained open until recently (November 7) pending internal NIH budget decisions. Throughout these deliberations NIH has indicated a desire to purchase the facility as quickly as possible so as to take advantage of budgetary opportunities which could increase BRB's flexibility for funding new research projects in future years. Based on the NIH-approved budget in the SUMEX grant award effective December 1, an intermediate arrangement has been proposed by BRB. This would entail a payment of approximately 38% of the equipment costs at the time of acceptance late in the first grant year (~ 4/74) and payment of the remaining principal in three succeeding installments. The details of the proposed plan are contained in Attachment C including applicable assumptions as well as a tabulation and graphs of relevant budget and cost figures. The graphs show investment risk as a function of grant years and the relation of expected interest costs to various budgeted direct and indirect cost recoveries. The analysis has been based on the assumption of an outside loan to finance the purchase (see reference 4). It also includes the full benefit of a 15% discount from DEC for PDP-10 equipment which we have been able to maintain until December 31 on the basis of a recent negotiation.

The data presented represent conservative funding expectations on the part of NIH. NIH has indicated a strong interest in accelerating the equipment purchase which would reduce Stanford's costs. On the other hand, government funding cannot be legally guaranteed for the 5 year term of the grant; and a "worst case" analysis is therefore also presented. As shown in Attachment C, if funding is terminated at any point, Stanford's loan would be secured by the resale value of the equipment. Title would be vested in Stanford. A conservative estimate of resale value is shown plotted in relation to outstanding principal plus cumulative interest costs. For the overall system (PDP-10 plus ARPANET interface) we estimate approximately an exponential decline to 20% of list price in 5 years. Historically DEC equipment has done better than that although relatively few PDP-10 systems have been resold recently.

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The proposed system is the latest design marketed by DEC and hence can be expected to be in the early years of its decline to obsolescence. Some assurance as to resale market may be derived from the growing number of universities, ARPA contractors, and medium-scale business applications for PDP-10's. An incomplete list of current PDP-10 facilities includes Stanford (AI Lab and IMSSS), Caltech, UCLA, MIT, Harvard, Carnegie-Mellon, SRI, Ames Research Center, Tymshare, Copley Press, First National City Bank of New York, INTEL, Abbott Laboratories, Western Electric, and Ramada Inns. These data suggest a very adequate security for Stanford's investment.

At the end of the grant term, title to the machine would pass to the University. It could then be an important research asset or in the worst case could be sold to recover interest costs on the loan. We intend also to formulate a "gift opportunity presentation" to solicit gifts directed at assisting the University in carrying the burden of interest costs.

REASONS FOR BOARD OF TRUSTEES ACTION

The result of many months of discussion has been a grant award by NIH to proceed with the SUMEX project. Within the funding currently in sight, they have proposed an intermediate plan combining direct NIH funding and Stanford financing to purchase the required computing equipment. This plan would cost Stanford approximately \$70,000 in interest charges. These are offset by the benefits, tangible and intangible, to be derived from the existence of the SUMEX resource and the longer term prospect of full recovery through a gift or sale of the equipment. We feel it is in the University's interests to advance the necessary funds so that we may proceed with this project.

Timely approval is important for a number of reasons including internal budget limitations, a time limitation on the negotiated equipment discount with DEC, and the desirability of establishing a viable resource as soon as possible relative to the national user community. We have exhausted a significant portion of our available manpower resources during the protracted negotiations with NIH on this grant application. Further delay in being able to accept the December 1 award compounds these problems. Valuable personnel have already been forced to accept other positions in view of the uncertainties of this award.

The discount agreement we have negotiated with DEC for a 15% reduction in equipment price is one year old. We have been fortunate in retaining this agreement for the new configuration which is significantly reduced in scope in terms of DEC-supplied equipment. DEC has placed a December 31 deadline on this price agreement for receipt of a firm purchase order as well as a minimum equipment price of \$700,000. Since the original agreement one year ago, DEC pricing policy has changed in regard to software bundling and a significant increase in PDP-10 orders has occurred. The most recent quotation maintains both the 15% discount (~ \$115,000) and avoids the new pricing policy which includes software in the central processor price (\$40,000). It is problematical whether DEC would perceive it as in their interest to extend this offer beyond December 31 without significant changes to reflect their more current policies.

From the viewpoint of implementing a useable resource as soon as possible, our own computing efforts over the past year as well as those of Professor Amarel's group at Rutgers have suffered from the unavailability of the projected resource. Whereas a few weeks more delay is not critical, the possible need for renegotiation of the equipment order with DEC after December 31, entailing price changes and reconfiguration to remain within the budget ceiling, could severely impair the overall feasibility of the project or prolong the delay into months (DEC's fabrication cycle is organized around end-of-the-month shipping dates so delays result in slips by one month increments). If the \$150,000 price advantage were removed in such a renegotiation, so much DEC equipment would have to be deleted from the configuration as to raise serious question about the ability of the remaining system to adequately meet the resource objectives.

For these reasons we feel it is important to obtain approval to proceed with the procurement action in December. We considered two alternative means to this end: 1) an emergency action of the Board of Trustees (no regular December meeting is scheduled) or 2) an interim University approval to issue the purchase orders in anticipation of Board approval at their next regular meeting on January 8, but with the possibility of cancellation penalties if Board concurrence is not obtained.

The second approach has appeared the more feasible owing to the severe time constraints which would be imposed by the first approach in reaching a decision within the University and then soliciting emergency Board concurrence over the holiday season. The second alternative becomes even more attractive with the elimination of possible cancellation penalties should the purchase orders have to be rescinded after the Board meets in January. We had previously negotiated a privilege which allows cancellation up to 90 days before delivery in our existing purchase orders which are contingent on the availability of funding. We have been able to obtain a March 31 shipping date commitment from DEC, relative to which a possible cancellation on January 9 would not normally satisfy the 90 day constraint. However, the vendors (principally DEC) have indicated during negotiations involving Mr. O. R. Blanton of the Stanford Purchasing Department, that they would accept non-contingent December purchase orders authorized by the University Administration, but requiring Board of Trustees approval, as responsive to the December 31 deadline. In addition they will waive cancellation penalties up through January 9 should a negative Board decision result. This concession is based on their perception that such approval on the part of the University Administration would represent a strong interest to proceed with the SUMEX project and that the risk in anticipating Board of Trustees approval by 8 days, given Administration support, warrants extending the penalty-free cancellation privilege through January 9.

The critical schedule involved is unfortunate but has been unavoidable. The course of action proposed appears to satisfy the vendor-imposed deadlines at a minimum risk to the University and at the same time ensures a timely implementation of the SUMEX facility. We urge Administration approval to proceed as outlined above.

Note: The following memoranda are attached to document previous discussions which have taken place on this subject:

- 1) Memorandum from J. Lederberg to Clayton Rich, M.D.,
Subject: Agenda Item for the June Board of Trustees Meeting,
May 16, 1973 (attached).
- 2) Memorandum from Elliott Levinthal to Clayton Rich, M.D.,
Subject: SUMEX Grant, November 14, 1972 (attached).
- 3) Memorandum from William B. Rowland to Clayton Rich, M.D.,
Subject: Request for Advance of Capital, December 1, 1972
(attached).
- 4) Memorandum from Frank G. Riddle to Clayton Rich, M.D.,
Subject: Purchase of PDP-10 Computer for SUMEX Grant Proposal,
December 1, 1972 (attached).

