SECTION I

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

APPLICATION FOR RESEARCH GRANT
CONTINUATION SUPPORT

LEAVE BLANK EXCEPT FOR GRANT NUMBER

TYPE	PROGRAM	GRANT NUMBER
5	P07	FR 00311-02

REVIEW GROUP	FORMERLY

DATE RECEIVED	INVENTION STATEMENT
	☐ YES ☐ NO

TO BE COMPLETED BY PRINCIPAL INVESTIGATOR

ABBREVIATED TITLE OF RESEARCH PROJECT *(Same as shown on last Notice of Research Grant Awarded)*

Advanced Computer for Medical Research

2. DATES OF ENTIRE APPROVED PROJECT PERIOD		3. DATES OF NEXT BUDGET PERIOD *(Usually 12 months)*		4. AMT. REQUESTED FOR NEXT BUDGET PERIOD (Direct Costs Only)—Last Item, Page 2
FROM	THROUGH	FROM	THROUGH	
9-1-66	9-30-69	8-1-67	7-31-68	$ 520,073

5A. NAME OF PRINCIPAL INVESTIGATOR (Last, First, Initial)

Lederberg, Joshua

B. DEGREE	C. SOCIAL SECURITY NO.	D. AREA CODE AND TELEPHONE NO.(S)
Ph.D.	[redacted]	415 - 321-2300 Ext. 5049

H. MAILING ADDRESS OF PRINCIPAL INVESTIGATOR *(Street, City, State, Zip Code)*

Department of Genetics
Stanford University School of Medicine
Palo Alto, California 94304

E. TITLE OF POSITION

Chairman, Computer Policy Committee

F. DEPARTMENT, SERVICE, LABORATORY OR EQUIVALENT

Stanford University School of Medicine

G. MAJOR SUBDIVISION

Stanford University School of Medicine

6. ADDRESS WHERE RESEARCH WILL BE CONDUCTED *(If same as Item 5H)* check box ☐

Stanford University School of Medicine
Palo Alto, California 94304

7. ARE FEDERAL FACILITIES TO BE USED FOR THIS RESEARCH?
☒ NO ☐ YES _____ % OF TIME
(If yes, list facilities and indicate extent of use on continuation pages.)

TO BE COMPLETED BY RESPONSIBLE ADMINISTRATIVE AUTHORITY

8. APPLICANT ORGANIZATION *(Name and Address-Street, City, State, Zip Code)*

Stanford University
Stanford, California 94305

10. NAME AND TITLE OF OFFICIAL SIGNING FOR APPLICANT ORGANIZATION

11. IDENTIFY ORGANIZATIONAL COMPONENT RESPONSIBLE FOR CONDUCT OF SCIENTIFIC ASPECTS OF PROJECT *(Must be completed. See Instructions.)*

School of Medicine

9. NAME, TITLE AND ADDRESS OF OFFICIAL TO WHOM CHECKS SHOULD BE MAILED

Mr. K. D. Creighton, Controller
Encina Hall, Stanford University
Stanford, California

12. TYPE OF ORGANIZATION *(Check applicable item)* ☐ INDIVIDUAL
PUBLIC INSTITUTION:
☐ FEDERAL ☐ STATE ☐ LOCAL ☐ OTHER
PRIVATE INSTITUTION: ☒ NONPROFIT ☐ PROFIT

13. PHS ACCOUNT NUMBER *(Enter if known)*	14. ESTABLISHED INDIRECT COST RATE *(See Instructions)*
458210	55 % S&W

15. **TERMS AND CONDITIONS.** The undersigned accept, as to any grant awarded, the obligation to comply with Public Health Service Research Project Grant Regulations in effect at the time of the award (42 CFR, Part 52) and the terms and conditions in the Grants for Research Projects Policy Statement. The undersigned further agree to comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), and the Regulation issued pursuant thereto and state that the formally filed Assurance of Compliance with such Regulation (Form HEW-441) applies to this project. The undersigned also certify that they have no commitments or obligations, including those with respect to inventions, inconsistent with compliance to the above.

16. SIGNATURES *(Signatures required on original copy only. Use ink. "Per" signatures not acceptable.)*	A. SIGNATURE OF PRINCIPAL INVESTIGATOR (SAME AS PERSON NAMED IN ITEM 5A)	DATE
	Joshua Lederberg	5/9/67
	B. SIGNATURE OF ORGANIZATION OFFICIAL (SAME AS PERSON NAMED IN ITEM 10)	DATE

SECTION II—BUDGET (USUALLY 12 MONTHS)

FROM	THROUGH	GRANT NUMBER
8-1-67	7-31-68	FR 00311-02

A. ITEMIZE DIRECT COSTS FOR NEXT BUDGET PERIOD

PERSONNEL: NAME (Last, First, Initial) (a)	TITLE OF POSITION (b)	TIME OR EFFORT %/HRS. (c)	SALARY REQUESTED (d)	FRINGE BENEFITS (See Instructions) (e)	TOTAL (f)
PRINCIPAL INVESTIGATOR					
See attached schedule					
		Subtotals →	$ 187,795	$ 19,718	
(Indicate cost of each item)			TOTAL (Columns (d) and (e)) →		$ 207,513
CONSULTANT SERVICES					$ 1,000
EQUIPMENT					
See attached schedule					$ 252,984
SUPPLIES					
Computer	$20,000				
Office	4,000				
Engineering	20,000				
			Note 1		$ 44,000
TRAVEL — DOMESTIC			Note 2		$ 4,000
TRAVEL — FOREIGN					$
HOSPITALIZATION (Study patients) — INPATIENT HOSPITALIZATION					$
HOSPITALIZATION (Study patients) — OUTPATIENT COSTS					$
ALTERATIONS AND RENOVATIONS					$
PUBLICATION COSTS			Note 3		$ 8,000
ALL OTHER EXPENSES (See Instructions) Communication (telephone, postage)					$ 2,576
			TOTAL DIRECT COSTS (Enter on Page 1, Item 4)		$ 520,073

FR 00311-02
Personnel Budget
August 1, 1967 - July 31, 1968

Name	Title of Position	Time or Effort	Salary Requested
Lederberg, Joshua	Principal Investigator		
Wiederhold, Gio	Associate Director	100%	$ 16,538
Breitbard, Gary	Systems Programmer	100	12,540
Crouse, Linda	Systems Programmer	100	9,720
Cummins, David	Systems Programmer	100	13,608
Flexer, Jules	Engineer (2 mos.)	100	2,330
Hintz, Gertrude	Systems Programmer	100	10,368
Holtz, Klaus	Engineer	100	12,960
Moore, Mabel	Statistician	100	6,930
Patel, Arunkant	Systems Programmer	100	9,396
Sanders, William	Systems Programmer	100	14,040
-------	User Education	40	3,920
-------	Statistician	100	9,600
Class, Charles	Operations Supervisor	100	9,639
-------	Computer Operators		27,240*
-------	Machinists		1,800
Osborne, DeWayne	Computer Technician	37 1/2	5,990
Weatherby, Albert	Computer Technician	37 1/2	4,992
	Part time assistants		4,800
Zilka, Teresa	Secretary	37 1/2	5,928
	Administrative Assistance by Stanford Computation Center		5,456
Total Salaries			$187,795
Fringe Benefits (10.5%)			19,718
			$207,513

*operators computed at 24 hour day x $3.38 per hour (av. operator wage) x 365 days per year x 1.15 (for holidays sick leave, and vacation) x .80 (ACME Share)

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FR 00311-02
Equipment Budget

Equipment Rental

IBM 360/50 System	$232,439		
Less 20% Stanford Campus Facility support	<46,488>		
subtotal IBM 360/50	185,951		
IBM 360/67 Utilization	20,000		
IBM 2741 Communication Terminals (20)	16,800		
		$222,751	
IBM 1360 Disk Packs (12) $12/mo.		1,728	
Data Sets (10) rental @ $30/mo.	3,600		
installation @ $60.	600	4,200	
Rented lines (10) @ $11.05/mo.	1,326		
installation @ $15.	150	1,476	
IBM 1800: additional costs			
IBM 1826 @ $599/mo.			
IBM 1442 @ 212/mo.			
IBM 029 @ 62/mo.			
IBM 7720 @ 125/mo.			
maintenance @ 171/mo.		14,028	
State sales tax on rented equipment, except data set installation, rented lines and installation, and 1800 maintenance		8,801	
subtotal, rented equipment			$252,984 Note 4

SECTION II—BUDGET (Continued)

Grant Number

FR 00311-02

B. Supplemental information regarding ITEMS in the proposed budget for the next period which require explanation. See Instructions. (Use Continuation Pages if necessary.)

(1)

Due to the higher utilization of the equipment supplies for engineering and shopwork are higher than expected in the original application ($44,000 rather than $35,000).

(2)

The amount requested fro domestic travel is less than half of the amount requested for the year 1966/1967 because of the lessened need to collect information and ideas from other centers. Due to various delays travel was actually largely paid for by the planning grant provided by the Jos. Macy, Jr. Foundation. The requested amount will support professional travel to seminars and meetings of direct professional value.

(3)

We expect during the coming year to complete the system and make it and the relevant documentation available to other installations facing similar problems.

C. If budget proposed in this submission represents a significant change (either increase or decrease) from the LEVEL originally recommended for this budget period, (1) provide an explanation for the change, and (2) indicate the effect that this change will have, if any, on the conduct of research and general level of support for the remainder of the approved project period. (Use Continuation Pages if necessary.)

NO CHANGE

D. Designate items contained in the detailed budget presented on page 2 for which indirect costs WILL NOT be claimed, or are subject to negotiation. (Use Continuation Pages if necessary.)

NONE

SECTION II - BUDGET

(4)

The delays that are being experienced with the IBM 360/67 time-sharing system lessen the benefits of equipment sharing that were hoped for in the original application.(Section 7, page 12) But since the utility of the 360/67 to the medical school is also diminished the net effect of this delay is negligible. 360/67 time is needed, however, to continue system development concurrent with regular time sharing operations.

SECTION III—FISCAL DATA FOR CURRENT BUDGET PERIOD
(USUALLY 12 MONTHS)

FROM	THROUGH	GRANT NUMBER
9/1/66	7/31/67 (11 mos.)	USPHS FR 00311-01

The following pertains to your CURRENT budget. This information in conjunction with that provided on Page 2 will be used in determining the amount of additional support for the NEXT budget period.

A. BUDGET CATEGORIES	CURRENT BUDGET (1)	ACTUAL EXPENDITURES THRU 3-31-67 (Insert Date) (2)	ESTIMATED ADDITIONAL EXPENDITURES FOR REMAINDER OF CURRENT BUDGET PERIOD 4 mos. (3)	TOTAL ESTIMATED EXPENDITURES (Col. 2 plus Col. 3) (4)	ESTIMATED UNEXPENDED BALANCE (Subtract Col. 4 from Col. 1) (5)
Personnel (Salaries)	77,675	49,612	38,140	87,752	<10,077>
Fringe Benefits	7,301	5,209	4,005	9,214	< 1,913>
Consultant Services					
Equipment	260,997	10,577	207,721	218,298	42,699
Supplies	15,250	18,716	15,000	33,716	<18,466>
TRAVEL Domestic	4,000	900	1,000	1,900	2,100
TRAVEL Foreign					
Hospitalization					
Outpatient Costs					
Alterations and Renovations	29,300	29,300	-----	29,300	-----
Publication Costs	2,750	556	1,500	2,056	694
Other Tel., Postage	2,200	4,382	2,000	6,382	< 4,182>
Other Comp. Time (Babcock)	2,340	4,652	3,000	7,652	< 5,312>
Total Direct Costs	401,813	123,904	272,366	396,270	5,543
Indirect Costs	42,721	27,287	20,977	48,264	< 5,543>
TOTALS →	$ 444,534	$ 151,191	$ 293,343	$ 444,534	$ -0-

Use below space to:
B. Explain any significant balances shown in column (5).
C. List all other research support pending or approved not previously reported. (Identify by source, project title, and amount.) NONE

B. The reduction in equipment rental resulted from delay in delivery. This was offset by an even longer delay in delivery of the software which resulted in increased project personnel to provide the basic programming system.

Supplies ran higher than estimated because it was advantageous to purchase the components and have the technical staff fabricate equipment rather than purchase certain items as: switching equipment, pulse generator and power supplies, equipment rack.

Terminal services were leased from Allen Babcock Company to serve both the development of the ACME system and to provide educational service to the medical school in the areas of terminal programming.

APPLICANT, REPEAT GRANT NUMBER SHOWN ON PAGE 1 →	GRANT NUMBER	
SECTION IV SUMMARY PROGRESS REPORT	FR 00311-02	
PROGRAM DIRECTOR (Last, First, Initial)	PERIOD COVERED BY THIS REPORT	
Lederberg, Joshua	FROM	THROUGH
NAME OF ORGANIZATION	8-1-67	7-31-68
Stanford University School of Medicine		

TITLE OF PROJECT (Repeat title shown in Item 1 on first page)

Advanced Computer for Medical Research

1. List any publications pending or published and not previously reported.
2. List and describe any foreign travel undertaken during the above period.
3. Describe accomplishments since last summary progress report. Specify and describe the significance of any changes in the direction taken by the project during the above period.

During the report period the research effort was devoted almost exclusively to the development, programming, and check-out of the ACME computer system.

The staff of the project was occupied with a number of tasks which will be reported in separate paragraphs. These will cover:

1) System design and implementation
2) Program translator
3) Data acquisition and distribution programming
4) Improvements in terminal man/machine interaction
5) Data transmission tests and design
6) Production and installation of basic transmission units
7) Design of a CRT display unit for medical data
8) Development of a basic statistical and text processing library for interactive use
9) Consultation with medical staff and faculty
10) Education for medical staff and faculty
11) Installation of the computer equipment
12) Operation of the computer facility

The progress in most areas has been extremely satisfactory. In the short time between receipt and check-out of the basic IBM equipment (December 15, 1966) and this date (April 15, 1967), we have been able to transfer our systems work from the variety of computers used for development and to begin offering a very limited but true timesharing service to the medical school. The education program has led to a great deal of enthusiasm on the part of the medical staff and faculty.

The greatest lack as of this date is the delay in file capability. We can expect to have this capability available by June 1, 1967.

During this project much assistance and exchange has been effected between ACME and the Central Campus Facility at Stanford. With the current delays in software delivery of IBM's timesharing system the ACME System will be used at the Central Facility.

Continued exchange is going on between ACME and the Stanford Linear Accelerator Center in the areas of high speed data transmission and graphic support and between ACME and the Allen-Babcock Company regarding terminal control and systems development. In addition, there has been a joint educational and informational effort in the 1800 computer area with the Syntex Laboratories of Palo Alto.

Throughout the ensuing paragraphs references are made to the working papers of the ACME Project, or ACME Notes, which are appended to this report as Appendix I.

SECTION IV - SUMMARY PROGRESS REPORT (continued)

Interest in the ACME System has been wide-spread.

Presentations have been invited and given at:

I.	UCLA	Health Sciences Computing Facility	3/18/66
II.	ONR	Workshop on Psycho-biology & Computers (Naval Post-Grad School, Monterey, California) The paper has been published in the proceedings of the conference.	7/17/66
III.	IBM	Research in Cambridge, Mass.	6/10/66
IV.	IEEE	Workshop on Progress in Time Sharing Lancaster, Pa.	10/12/66
V.		University of Toronto, Toronto, Canada	8/4/66
VI.		Argonne National Laboratories Conference on Time-Sharing Model 50's The paper is due to be published as part of the proceedings.	11/1/66
VII.		COMMON Meeting, New Orleans, La. A report has been published through COMMON prior to this meeting which is the result of a joint effort of IBM and four 1800 users, including ACME: Report of the 1800 Time Sharing Executive System Review Committee.	11/29/66
VIII.		ACM, Los Angeles Section The presentation has been reviewed in the March issue of DATAMATION.	2/1/67
IX.		CALTECH, Pasadena	3/29/67

In addition, a system description has appeared in IBM's internal documentation.

Even though our system is barely operational, IBM has made arrangements under which the University of Witwatersand, Johannesburg, South Africa and the University of Paris, France have visited us, and are currently communicating extensively on the applicability of the ACME System for their installations.

The progress experienced would not have been possible without the enthusiastic support of the staff.

NIOR ACME STAFF

NAME	HIGHEST DEGREE	YEARS OF EXPERIENCE	PREVIOUS POSITION OR EXPERIENCE
Gio Wiederhold	BS 1957	9	Visiting Prof., IIT, Kanpur, India Head of Programming, U.C. Berkeley
*Gary Y. Breitbard	MA 1963	8	Wrote Student Compiler at U.C. Berkeley
Charles Class	AA 1963	4	Operator, Stanford
Linda Crouse (part-time)	129 units	4	Desert Research Institute U.C., Davis
*David E. Cummins	BA 1963	5	Programmer, IBM
*Robert Flexer	MS 1965	1	Post-graduate work, U.C., Berkeley Electrical Engineering
*Ann Hintz	BA 1961	5	Associate Systems Engineer Associate Programmer, IBM
Klaus Holtz	BS 1964	4	Engineer at Linear Accelerator, Stanford
Zeva LaHorgue (part-time)	BA 1958	2	State Dept. of Public Health, Berkeley Bureau of Chronic Diseases
Gerald Miller (leave of absence)	BA 1964	5	Systems Programmer III, U.C., Berkeley
Mabel Moore	BS 1965	2	Genetics Dept., Stanford
*Arun Patel	MA 1965		Electrical Engineering, U.C. Berkeley
William S. Sanders	MS 1964	7	Time sharing project group General Electric, Phoenix
Voy Wiederhold (part-time)	MA 1960	7	Programmer, UCLA, Health Sciences

In addition to the secretary there are three technician/operators on the full-time staff and a number of part-time student assistants.

*Charged to funds provided by the Josiah Macy, Jr. Foundation.

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PERSONNEL DISTRIBUTION

	SENIOR STAFF													CLERICAL & JUNIOR STAFF	MONTHLY OR CONTRACT WITH S.C.C.
	GW	GYH	CC	LC	DEC	RF	AH	KH	ZL	MM	AP	WJS	VW		
Management, Adm.	.5													1	1
System Dev.					.5						1.	.2			1
Compiler Dev.	.2	1.												.8	
Data acquisition program					.4		.8					.7		2.5	
Hardware Dev.						1.		.5							
Hardware Prod.								.4						3.3	
Statistics, etc.	.1								.4	.7					
Consultation	.2			.3	.1		.2	.1	.1	.3		.1			
Education													.4		
Operations			1.												3

1. SYSTEM DESIGN AND DEVELOPMENT

Thanks to the additional funding provided by the Josiah Macy, Jr. Foundation we had been able to do design, simulate, and test hypotheses for the ACME computer system prior to the grant period.

A simulation, written in Burroughs Algol and run on the Stanford Computation Center B5500 computer (ACME Note QL-1) indicated that the proposed scheduling algorithm using "yielding" - logic rather than "time-slice-cutoff" logic was valid. For the simulation data from the MIT timesharing system (MAC) (ACME Note OP-1) and the large-computer experience from the Stanford and U.C. Berkeley 7090/7094 systems were used to insure a system responsive to qualitatively large demands. This yielding-logic is a radical departure from large timesharing systems (ACME Note AY-1) currently in existence and promises to give the facilities and computing power required by serious researchers. One system using this logic currently in a less general environment is the MEDLAB system at the LDS Hospital, Salt Lake City, Utah, set up by Dr. Homer Warner.

Another aspect of a system in a life-science area is that the data tends to be voluminous. To aid the researcher in the problem of keeping track of the amount of data that can be handled by a large computer system a formal method for handling data is being implemented. All data stored by the system can be automatically identified with the user's name, project, the date and time, file sequence numbers and the actual data name (ACME Notes FC-1, FI-3, FD-1, FF-1, FP-1, FE-1). Indexes to the data are kept separately to facilitate updating, safekeeping, and search for data previously collected (ACME Notes FA-1, FLU-1). Storage modes are limited to textual data and real type numeric data. IBM support for the mechanical storage device (the IBM 2321 pie file) did not arrive until February 15, 1967, and a considerable percentage of the ACME effort is now going into the provision of the file capability.

The remainder of the system is operational and is able to support the hardware maximum of 15 users at typewriter terminals, and to respond to real time data requests. (ACME Notes IOA-2, IO-2, MA-1)

The majority of the system is written in FORTRAN, including the scheduling and file supervisory mechanisms so that this system can be transformed to operate on other equipment with a minimumof effort. It also enables us to adjust the system easily on the basis of data gathered from experience, to accommodate equipment changes, and to introduce new ideas and procedures.

2. THE PROGRAM TRANSLATOR

The ACME/PL translator is a true incremental compiler. As far as we can determine it is the only one currently in existence, even though much discussion on the usefulness of such a tool in the timesharing environment has taken place.

It generates absolute binary machine language code from the PL/1 statements typed in by the user.

Through careful subsetting of the PL/1 language (ACME Note PL-2) we can deliver to the user a quality of computational power which is otherwise limited to batch systems. The compiler is operational, although language extensions continue to be added. This rapid development was again made possible largely due to the fact that the predecessor to this compiler, the STUDENT compiler at the Berkeley Computation Center IBM 7040-7094 system had been written in FORTRAN; that planning funds were made available by the Josiah Macy foundation; that the Stanford 7090 system and the IBM 360-50 computers at the Stanford Linear Accelerator and at the Allen-Babcock Company were made available for testing and development (ACME Notes HL-2, HDC-1 and YA-1).

Initial measurements of the performance of the generated code indicate a slightly higher execution speed than IBM's PL/1 compiler currently achieves, although that compiler runs in a batch mode only, and considerably higher speeds than interpretive systems as are generally in use now in interactive time-sharing systems (ACME Notes KO-6, MT-2, ND-1, NT-4, NS-1).

The compiler takes care also of command handling, (ACME Notes RC-1, LA-2, PC-2) and user debugging facilities (ACME Notes RU-2, LM-3) and is designed to present to the user a consistent one-level interface. The user input/output facilities are not yet completed, but available are the facilities we expect to be used generally: free format multi-value input in response to system prompts and system formatted multi-value output (ACME Notes FS-2, OF-1, OP-1, TV-2).

3. DATA ACQUISITION AND DISTRIBUTION PROGRAMMING

The programming to control real time data acquisition and distribution has not yet been integrated into the system. This work could not commence until the computer facility was operating smoothly. We initially experienced considerable difficulty in our efforts to keep information transfer compatible with IBM's Operating System Standards.

This goal required intensive and extensive study of the system (ACME Notes CP-2, OS-2, CL-1, DN-1, DG-2). We have overcome this hurdle now and we are very satisfied with IBM design in this area. A change of IBM support staff recently has helped us also in the communication required with the manufacturer. We are not able to communicate properly with non-IBM supported devices as PDP-8's, linc-computers, displays, and data transmission apparatus. The integration of these programs into the time-sharing system is scheduled to begin May 1, 1967, and limited user availability is expected in June. In the meantime, check-out of hardware and some production data acquisition is taking place on a scheduled non-time-sharing basis using the software in its current status.

4. MAN-MACHINE INTERACTION

In order to improve the man-machine interaction ACME is equipping its terminals with an indicator panel (ACME Note LI-2) so that the user is always aware of the status of the computer and his problem. In addition an ATTENTION Key has been programmed (ACME Note PA-2) to give the user ability to immediately interrupt whatever action the system or his program is carrying out. Another aspect of satisfying the responsiveness of the system is the data acquisition implementation, which assures that the user controls when his equipment is to be sampled (ACME Note HA-1).

5. DATA TRANSMISSION TESTING AND DESIGN

Considerable effort has been made in testing and developing means for economic data transmisstion throughout a modern building such as the Stanford Medical School (ACME Note HDT-1).

This has led us to connect our IBM terminals to the IBM computer directly. The use of telephone communication equipment is hereby avoided with an attendant cost reduction. The cost reduction is largely due to the fact that data transmission use of voice telephone facilities, which are engineered with another set of problems in mind, is less than ideal. An ACME built switching panel is located at the computer operator's console for connecting users into the system (ACME Notes KA-1, KB-2, HSW-1).

From remote locations we use data-phone and voice frequency FM coded data transmission.

ACME has to thank the Instrumentation Research Laboratory of the Department of Genetics who are sharing both their facilities and experience to make the current level of work possible.

6. HARDWARE PRODUCTION AND INSTALLATION

As a result of the field work detailed above, standard circuits have been designed and built. The majority of these used integrated circuit logic, and are mounted and checked out within the ACME Facility (ACME Note H7-1). These are now in stock as off-the-shelf items and can be combined with standard power supplies in a rack mounted units containing the required number and types of data input and output devices. Two labs (Respiration and Pediatric Cardiology) are currently routinely transmitting data via these links to ACME and the ACME Engineering staff is working at the installation of additional links (ACME Note HT-1). An input/output typewriter has been connected to one input line to give lower case alphabetic keypunching capability (ACME Note KP-1). A link to a small computer has recently been checked out and others are being assembled.

Much of this effort is being done on a cost sharing basis with the laboratories involved, both to conserve ACME funds, and to insure joint real interest in the projects.

LIST OF TERMINALS REQUESTED TO DATE

NAME	DEPARTMENT	DATE OF INSTALLATION
Ed Brown	Dept. of Medicine	
Dr. J. W. Bellville	Anesthesia	
Dr. K. M. Colby	Computer Science Dept.	12/20/66
Dr. K. L. Chow	Neurology	
Dr. E. Dong	Surgery	1/16/67
Dr. Djerrassi	Genetics/Chemistry	
Dr. W. Forrest	Anesthesia	12/20/66
Dr. Fred Fox	Clinical Lab.	
Dr. Allen Gates	Gynocology	1/16/67
Dr. A. Goldstein	Pharmacology	
Dr. D. Harrison	Cardiology	
Dr. L. Herzenberg	Genetics	
Dr. A. M. Iannone	Neurology	
Dr. K. Killam	Pharmacology	1/16/67
Dr. Kopell	Psychiatry, VAH	12/20/66
Dr. J. Lederberg	Genetics	
Dr. S. Liebes	Genetics	
Dr. Mesel/Conn	Pediatrics	2/6/67
Dr. Mesel/Northway	Pediatrics	
Dr. Mesel/Radiology	Pediatrics	
Dr. T. Nelson	Surgery	
W. Reynolds	Genetics	
Dr. L. Rosenberg	Med. Micro-Biology	
Dr. Stewart (3)	Fleischman Lab.	
Dr. L. Stryer (2)	Biochemistry	
Dr. Wasserman/Van Kessel &	Dept. of Medicine	1/16/67
Dr. Luetcher	Dept. of Medicine	
Dr. Bagshaw	Radiology	
Dr. T. Merigan	Infectious Diseases	
Dr. George Wertheim	Psychiatry	
Dr. S. Kountz	Surgery	1/16/67
J. Hwang	Genetics	

7. CATHODE RAY TUBE DISPLAY

In order to present data quickly in the high data rate interactive experiments, cathode ray tube displays are of great value. The data to be displayed in much life-science work has the form of time series graphs, annotated with the results of the computer analysis.

With this in mind, as a joint project of ACME and the Instrumentation Research Laboratory a CRT display has been designed with the following features:

1) Display tube is driven by digital logic to insure stability of display

2) The digital logic is controlled by an independent memory to give an economic source for the required regeneration cycles.

3) A memory organization is oriented toward vector display to allow effective use of the unit for time-series graphs.

The proto-type of this unit is currently under test, being driven by FORTRAN programs in the 360 and has demonstrated the feasibility of the approach.

The cost of the parts has been about $6,500 of which the majority is accounted for by the CRT tube itself and the core memory unit. The connection to the computer follows ACME small computer conventions and the programming logic is similar to the driving of the CALCOMP digital plotters so that the same programs may be used.

8. STATISTICAL AND TEXT PROCESSING LIBRARY

A beginning has been made with the development of a library to process data on this interactive system.

A number of statistical highly interactive routines are currently available on ACME's Babcock terminal (ACME Notes EB-1, EBA-1, EBB-1, EBD-1, EBL-1), while a survey has been made of existing statistical routines (ACME Note ES-1) which are candidates for inclusion in the system. Testing of various of these is currently in progress, whereas about a dozen are currently available to the users on the Babcock terminal. Much experience is being gathered to organize these routines so that they may be used directly by the medical researcher without having to consult professional or semi-professional programming staff. It is hoped that by the end of the summer a fairly complete statistical library will be available and that the efforts of the group can then be diverted more to the problems of analyzing continously arriving data.

As a by-product and extension of the compiler development some text processing routines have become available. These are not yet integrated into the timesharing system, but are available on a stand-alone basis. The current capabilities include text sorting (ACME Notes KC-1, KH-5) concordance preparation, word list with frequency count generation, key word in context type indexing and capability for specifying uninteresting words for deletion (stop words). In the process of check-out are options for searching-for sentences-containing-specific-words, text comparisons, and generation of data for further statistical processing. The routines are oriented toward the processing of large files and economic usage of core memory. (ACME Note WTXT-1) They have been used at Stanford for analyzing Rorschach test responses, psychiatric diagnosis and setting up clinic appointments.

9. CONSULTATION

A fair amount of staff time has been spent in discussing with staff and faculty of the medical school the feasibility and approach to a large number of projects. ACME has gathered a good impression of the range of problems that the system will have to respond to, and also found a few that cannot be solved with current technology and facilities. As a result of those discussions we are certain that the medical school will quickly saturate every resource that can be made available through the system at its present level of support.

10. EDUCATION

To educate the medical faculty and staff in a manner that is directly related to their problems is one of the tasks of a specialized medical facility. To enable an early start for this area a terminal to the Allen-Babcock time-sharing system is being rented through the Stanford Computation Center.

A monthly seminar is being conducted to inform the medical school of the progress with the Project, and to give us the opportunity to hear speakers from other institutions discuss their work in relevant areas.

During November through February a series of 15 four-and-a-half hour courses were conducted which were successfully completed by 167 members of the medical school faculty and staff. (ACME Notes ABC-1 thru 10)

The current demand for these terminals, exceeds their availability to the extent that weekly sign-up is required, despite this having only limited computing capability and no data acquisition facilities.

A user's manual (ACME Note AM-1) has just been drafted which again is oriented towards solving medical research problems. A new series of courses is due to start in May using ACME's own facilities.

11. EQUIPMENT INSTALLATION

The installation of the computer equipment in the specially built structure was finally completed on April 8, 1967.

Due to delays in approval of the various funds used to construct a special structure and adapt it to the computer's requirements, primitive and novel means were used to enclose the computer and keep it operating while the construction progressed. The dust has finally settled down and the facility is now not only functional, but also extremely attractive and much commented on by visitors to the STANFORD-PALO ALTO HOSPITAL and the Medical School.

Thanks are due here to the Stanford Business School who made a computer floor available, the medical school architect's office who believed that the impossible was possible, and IBM who were willing to risk their equipment to the elements and the construction crews.

12.. COMPUTER OPERATIONS

The operation of the computer is handled through arrangements with the Stanford Central Facility which enables us to secure reliable 24-hour-7-day staffing without having to employ redundant back-up staff. The technical aspect of operations is supervised by a member of the ACME staff. Full staffing has resulted in very reliable operations under unfavorable conditions and our machine has shown an availability during the period from 12/12/66 to 4/09/67 of 97.5 per cent after scheduled maintenance (4.0%). Much of the computer's time is being used for ACME hardware check-out. The ACME System development takes priority currently, but users problems are routinely run at least overnight.

The system has a very poor batch performance since the requirements for time-sharing have taken precedence in both hardware and software selection. (ACME Notes CN-2, CQ-1, DL-1, OD-1) It will be interesting to compare cost to productivity ratios when the time-sharing service is in full swing.

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