information problems of the U. S. biomedical researchers. One member of the SRI staff has been an active member of this study group. This project has been concerned primarily with determining the nature of the information problems of biomedical researchers; determining what sources and channels of information are available, and what their limitations are; and what improvements might be considered on a local and national scale to improve the information services and scientist-to-scientist communication.

2. A Preliminary Study of the Requirements, Criteria, and Measures of Performance of Information Storage and Retrieval Systems

A preliminary study was made for the National Science Foundation of the requirements, criteria, and measures of performance of information storage and retrieval systems. Specifically, the objectives were: (1) to develop a methodology for determining user's information requirements; (2) to obtain specific data about the information requirements of a particular community of users; (3) to develop a preliminary set of criteria and a procedure that could be applied to existing information retrieval systems in order to reach tentative conclusions about the desirability of such systems; (4) to develop measures of system performances; and (5) to develop plans for a research program for the longer-range development of more basic and exhaustive criteria and methods for the assessment of alternative systems and procedures.

3. Technical Assistance in Implementation of the STEP Program

As a systematic means of reviewing a selected portion of this literature--and of separating important material from unimportant material--the Scientific Technical Exploitation Program (STEP) was established. SRI contracted with the Air Technical Intelligence Center (ATIC) to provide specific guidance on the immediate implementation of STEP and to give technical assistance to ATIC in the preparation of descriptive specifications of a semi-automated system for the entire STEP program.

The general objective was to develop a system by which a continuous scrutiny of Soviet Technical and scientific literature would provide timely and improved technical information about the Soviet technical potential, as well as providing valuable information to the R&D community, and aid in the proper guidance of Air Force research and development programs.

4. MIRF 1959

Under Air Force sponsorship, the Institute is currently studying a special approach to the problem of implementing and using very large files of information. Progress is being made on the hardware and organization design of a Multiple Instantaneous Response File (MIRF) for information retrieval. This particular file device differs from other types of memories in these respects: in response to a question, all the contents of the entire file are searched simultaneously, rather than in sequential fashion, to select those file items that satisfy the search request; all of the answers are provided in a fraction of a second; and provision is made for handling multiple simultaneous answers to the same question. This type of device would ultimately permit a user to pose a question to a file of a million or more items and obtain the answer essentially instantaneously. The logical and

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

DIVISION OF ENGINEERING RESEARCH

11 September 1959

Proposal for Research

SRI No. EU 59-115

INVESTIGATION OF TECHNIQUES FOR THE REALIZATION OF AN INSTANTANEOUS INQUIRY, MULTIPLE RESPONSE FILE

Prepared for:

Rome Air Development Center
Griffiss Air Force Base
Rome, New York

Prepared by:

Jack Goldberg
Senior Research Engineer
Computer Techniques Laboratory

Approved:

J. R. Anderson, Manager
Computer Techniques Laboratory

T. H. Morrin
Director of Engineering Research

Copy No. 27

X QUALIFICATIONS OF PERSONNEL

Personnel for this study will be chosen from those listed below and others as the work demands.

Charles P. Bourne, Research Engineer (Information Specialist) Special Projects Group, Computer Techniques Laboratory (Full Time, 1-1/4 years)

Mr. Bourne received a B.S. degree in Electrical Engineering from the University of California in 1957. He is working on an M.S. degree at Stanford University, specializing on data-processing and operations research.

He served in the U.S. Navy and the U.S. Marine Corps during 1950-51. In 1952-53 he was an Instructor in Guided Missile Instrumentation, Maintenance, Operation and Telemetry at Convair Missile Division. While he was a student he did summer work as an Engineering Aide at Stanford Research Institute on system cooling and component temperature studies for the ERMA computer system.

In June 1957 Mr. Bourne became a Research Engineer on the staff of the Institute. He has participated in a government project to investigate storage, retrieval, and reproduction techniques for a file of several million engineering drawings; an engineering and operational evaluation of a new general-purpose digital computer system for a computer manufacturer; the technical planning for the installation of a digital computer system at the Institute; and a government project to design a comprehensive mechanized system for accumulating, reviewing, disseminating, storing, and retrieving abstracts of European technical literature. He also supervised the operation and programming effort and conducted the systems studies that determined programming requirements, choice of computer, and expansion capabilities for a large digital computer system currently used as part of a military reconnaissance system.

Mr. Bourne has written several articles for technical journals, dealing with information retrieval and technical information problems, and with studies in non-linear mechanisms. He is a member of the Institute of Radio Engineers and the Association for Computing Machinery, and was Chairman of the sessions on Information Retrieval and Machine Translation at the 1959 Western Joint Computer Conference.

Bonnar Cox, Senior Research Engineer (Information Specialist) General Systems Department (Three-quarter's time, 1-1/2 years)

Mr. Cox received the B.S. degree in Electrical Engineering from Stanford University in 1948.

In 1951 Mr. Cox joined the staff of Stanford Research Institute, where he worked for several months on a radar project for the Office of Naval Research. He spent five and one-half years working on the ERMA

RADC

STANFORD RESEARCH INSTITUTE
Contact Report

SRI Confidential

20 June 1961

Company Name and Address:	Rome Air Development Center Information Processing Lab Rome, N Y. Phone: FF 6-3200, Ext. 71251 or 71170 for RAWID, Moore and Iuorno
Date and Place of Visit:	16 June 1961 RADC, Rome, N.Y.
Company Representatives:	Ernie Iuorno, Bill Moore, Sal Liotta, Ron Ferris. Fred Dion, Lt. John Choisser, Lt. Del Snyder, Capt. Kortz
Institute Representative:	M.B. Adams
Purpose of Visit:	To discuss MIRF extension and possible new work.
Subjects Discussed:	Ernie Iuorno informed me that there has been another reorganization at RADC and Howard Davis, who was Lab Chief, Information Processing Lab, is now Technical Director of the Intelligence and Electronic Warfare Directorate. Capt. B. J. Long, who was assistant to Al Barnum in the Data Processing Branch, is now Assistant Laboratory Chief. Frank Tomaini is the new Information Processing Lab Chief.

Ron Ferris is awaiting the return of Al de Luccia on Monday so that they can evaluate the feasibility of going ahead with a MIRF model development program. They will do this next week and Jack Goldberg will hear from them in the next week or two. Ferris does not want a proposal from us yet. He said they must decide whether the machines we priced for them will be competitive with such things as the AVCO approach and the NCR magnetic card using a form of Zatocoding He also mentioned the NBS "Microsite" system as a possible competitor. None of these schemes in their present form allow the type of retrieval possible with a MIRF but he must speculate on the relative saleability of these schemes.

A new man, Sal Liotta, is now in charge of hybrid computers. He is just getting educated on the subject and has visited MIT and a number of other places (Beckman) doing hybrid computer work. They will be soliciting proposals for a study of this area and we will receive a PR. We can also look for a PR in the large scale memory system area.

Another new man Fred Dion, is in charge of self organizing machines, adaptive machines and pattern recognition. He seemed quite interested in hearing of Doug's work and requested copies of the original and renewal proposals to AFOSR and any other background material so that he can decide whether he wants to sponsor the other half. He inquired, while I was there, and found out that it could be handled contractually, if they want to do it. He is also interested in hearing more about the work in Charlie Rosen's lab for the Signal Corps on pattern recognition.

Ernie Iuorno has received letters from Lockheed and Remington-Rand Univac asking for copies of the final report on 3184. He answered by referring them to ASTIA or to SRI The Lockheed man's name is Frank F Stucki, Bldg 204, 3251 Hanover St., Palo Alto. The Rem-Rand man's name is R. M Salman, R-R-U, Blue Bell, Pa.

Ernie Iuorno would also like to receive more dope on Charlie Rosen's new ONR contract on high density storage. The contract number and title would help him get reports on the project. He still wants the figure from 3184 report (in slide form) comparing all kinds of storage systems. If possible, he would also like

to borrow the cards containing the bibliography on memory and access compiled on 3184. If they are IBM cards, perhaps we can duplicate them, if not, he will have his secretary copy them and return the originals to us.

Ernie gave me a new organization chart of the Air Force Systems Command complete with verbal descriptions of all major blocks and pictures of the men in charge. Ernie tells me that a Major W. Harris, ESD, ESRRI, Hanscom Field, Bedford Mass. controls all work done under ARPD 730-J, the data processing planning document. RAWID has just received their latest copy of the BRL Survey of Domestic Electronic Digital Computer Systems, ASTIA AD-253212, Report No. 1115, and Ernie suggests we send to ASTIA for one right away if we want one as the number of copies is limited.

A number of the RAWID projects now going on may be of interest to CTL members. AF 30(602)-2514, Techniques for Hypothesis Generation and Testing, Dikewood Corporation; AF 30(602)-2543, Theory of Adaptive Mechanisms, University of Syracuse; AF 30(602)-2518, Logic of Controlled Threshold Devices, Case Institute; AF 30(602)-2474, Electronic Readout of Wideband Electron Beam Recording, Ampex Corporation.

Sal Liotta gave me a list of reports by MIT, Electronic Systems Laboratory dealing with hybrid computers in one way of another.

I left copies of the Linear Input Logic program description with Lt. Choisser. He did not have time to read it before I left but asked how many people we would feel it took to do this. I told him about 26 man-months for the first year, minimum, per Bob Minnick's suggestion. Bill Moore asked me the same question and suggested 3 or 4 men as his feeling for the first year's effort. Bill Moore is to be away from RADC for the next month.

Ernie did not give me any real encouragement on more work on access switches. He said they were still considering how best to budget their money and had not decided yet He is still very much interested in very large scale memories and said we would receive their PR on this.

I called Gableman and talked for a few minutes. He said to tell Minnick that he had succeeded in generating a counter example for 9 variables of what Winter calls complete monotonicity. He thought Bob might be interested. I sent him a copy of the LIL program description by inter office mail.

I did not get to talk to Al Barnum or Capt. Long about systems work as they were tied up all day. We should get SRI on the need-to-know list for ARPD 760-D and then they will feel free to talk about classified areas under this document. There was nothing new learned under 730-J with clearance this time, so the implication that they were holding back last time seems to have been false

Lt. Del Snyder is now in RAWIF, the new computation facility branch. They are getting a CDC-160 and, perhaps, the R-W 400 polymorphic computer. They still hope they may inherit the 220 from the ULD-1 program. The room is ready for installation of machines now.

Bill Moore mentioned that they had approved the $1,500 overhead rate increase money for 3184 but was a little unhappy that we had not notified them by the 60 percent expenditure point. He said there was no problem of availability of money but the approval had to be obtained from the Secretary of Air Force, no matter how much money was involved.

Latest list of projects in RAWID of interest to CTL:

Technical Monitor	
Fred Dion (RAWID)	Techniques for Hypothesis Generation and Testing, Dikewood Corporation - AF 30(602)-2514. Runs to next May (1962).
Pat Langendorf (RAWID) (Capt. Horner)	Theory of Adaptive Mechanisms, University of Syracuse - AF 30(602)-2543. Ends June 1962.
Jerry Klion (RAGSR)	Logic of Controlled Threshold Devices, Case Institute - AF 30(602)-2518. Ends July 1962.
Milt Bramer (RAWID)	Electronic Readout of Wideband Electron Beam Recording, Ampex - Reg Lamb, project engineer at Ampex, AF 30(602)-2474. (Just started, March 1961.)

Names of Publications Related to Hybrid Computers Obtained from Sal Liotta:

ESL - TM - 106	"Real Time Analog-Digital Computation," M.E. Connelly, April 1961, AF 19(604)-6654, Sci. Report No. 3, MIT, Electronic Systems Laboratory.
AFCRL - TN -60 - 963	"The Pulsed Analog System for Evaluating Correlation Functions for Radar," C Gordon Bell AF 19(604) 6654, AF 33(616)-6046, Electronic Systems Lab. MIT
Electronic Systems Lab, MIT, MS Thesis, Aug. 1960	"A Transistorized Operational Amplifier for Time Shared Analog Computation," Allan Richard Gunion.
AFCRL - TN - 60 - 1111	"A Pulsed Analog and Digital Computer for Function Generation," Sci. Report No. 2 (8494-R-2), AF 19(604)-6654, Electronic Systems Laboratory, MIT.
Electronic Systems Lab MIT, MS Thesis, May 1960	"A Time Shared Analog Trigonometric Resolver," James Lee Massey.

Action: Send to Fred Dion Engelbart s proposal and renewal proposal to AFOSR and background material

Name of Reporter: M. B. Adams

Distribution: Hamman, Hutchison, Hoskens, Jeffry, Noe/Wing, McGuigan, O'D nnell, Prentice, Royce, Anderson, Zeidler, Goldberg, Miller, Minnick, Engelbart.

M. B A MBA

MBA/dg

May June 21, '61

Milt Adam's report on Fred Dion, in a branch (Data Processing??) of the old Intelligence Lab (now called Information Processing Lab)...where there is interest in pattern recognition, automatic programming, and the like. Milt mentioned something about their having a mandate to worry about Air Force command and control problems, etc., but that this is probably a recent assignment.

STANFORD RESEARCH INSTITUTE
Contact Report

SRI Confidential

20 June 1961

Company Name and Address: Rome Air Development Center
Information Processing Lab
Rome, N Y. Phone: FF 6-3200, Ext. 71251 or 71170 for RAWID, Moore and Iuorno

Date and Place of Visit: 16 June 1961
RADC, Rome, N.Y.

Company Representatives: Ernie Iuorno, Bill Moore, Sal Liotta, Ron Ferris. Fred Dion, Lt. John Choisser, Lt. Del Snyder, Capt. Kortz

Institute Representative: M.B. Adams

Purpose of Visit: To discuss MIRF extension and possible new work.

Subjects Discussed: Ernie Iuorno informed me that there has been another reorganization at RADC and Howard Davis, who was Lab Chief, Information Processing Lab, is now Technical Director of the Intelligence and Electronic Warfare Directorate. Capt. B. J. Long, who was assistant to Al Barnum in the Data Processing Branch, is now Assistant Laboratory Chief. Frank Tomaini is the new Information Processing Lab Chief.

Ron Ferris is awaiting the return of Al de Luccia on Monday so that they can evaluate the feasibility of going ahead with a MIRF model development program. They will do this next week and Jack Goldberg will hear from them in the next week or two. Ferris does not want a proposal from us yet. He said they must decide whether the machines we priced for them will be competitive with such things as the AVCO approach and the NCR magnetic card using a form of Zatocoding He also mentioned the NBS "Microsite" system as a possible competitor. None of these schemes in their present form allow the type of retrieval possible with a MIRF but he must speculate on the relative saleability of these schemes.

A new man, Sal Liotta, is now in charge of hybrid computers. He is just getting educated on the subject and has visited MIT and a number of other places (Beckman) doing hybrid computer work. They will be soliciting proposals for a study of this area and we will receive a PR. We can also look for a PR in the large scale memory system area.

Another new man Fred Dion, is in charge of self organizing machines, adaptive machines and pattern recognition. He seemed quite interested in hearing of Doug's work and requested copies of the original and renewal proposals to AFOSR and any other background material so that he can decide whether he wants to sponsor the other half. He inquired, while I was there, and found out that it could be handled contractually, if they want to do it. He is also interested in hearing more about the work in Charlie Rosen's lab for the Signal Corps on pattern recognition.

Ernie Iuorno has received letters from Lockheed and Remington-Rand Univac asking for copies of the final report on 3184. He answered by referring them to ASTIA or to SRI The Lockheed man's name is Frank F Stucki, Bldg 204, 3251 Hanover St., Palo Alto. The Rem-Rand man's name is R. M Salman, R-R-U, Blue Bell, Pa.

Ernie Iuorno would also like to receive more dope on Charlie Rosen's new ONR contract on high density storage. The contract number and title would help him get reports on the project. He still wants the figure from 3184 report (in slide form) comparing all kinds of storage systems. If possible, he would also like

to borrow the cards containing the bibliography on memory and access compiled on 3184. If they are IBM cards, perhaps we can duplicate them, if not, he will have his secretary copy them and return the originals to us.

Ernie gave me a new organization chart of the Air Force Systems Command complete with verbal descriptions of all major blocks and pictures of the men in charge. Ernie tells me that a Major W. Harris, ESD, ESRRI, Hanscom Field, Bedford Mass. controls all work done under ARPD 730-J, the data processing planning document. RAWID has just received their latest copy of the BRL Survey of Domestic Electronic Digital Computer Systems, ASTIA AD-253212, Report No. 1115, and Ernie suggests we send to ASTIA for one right away if we want one as the number of copies is limited.

A number of the RAWID projects now going on may be of interest to CTL members. AF 30(602)-2514, Techniques for Hypothesis Generation and Testing, Dikewood Corporation; AF 30(602)-2543, Theory of Adaptive Mechanisms, University of Syracuse; AF 30(602)-2518, Logic of Controlled Threshold Devices, Case Institute; AF 30(602)-2474, Electronic Readout of Wideband Electron Beam Recording, Ampex Corporation.

Sal Liotta gave me a list of reports by MIT, Electronic Systems Laboratory dealing with hybrid computers in one way of another.

I left copies of the Linear Input Logic program description with Lt. Choisser. He did not have time to read it before I left but asked how many people we would feel it took to do this. I told him about 26 man-months for the first year, minimum, per Bob Minnick's suggestion. Bill Moore asked me the same question and suggested 3 or 4 men as his feeling for the first year s effort. Bill Moore is to be away from RADC for the next month.

Ernie did not give me any real encouragement on more work on access switches. He said they were still considering how best to budget their money and had not decided yet He is still very much interested in very large scale memories and said we would receive their PR on this.

I called Gableman and talked for a few minutes. He said to tell Minnick that he had succeeded in generating a counter example for 9 variables of what Winter calls complete monotonicity. He thought Bob might be interested. I sent him a copy of the LIL program description by inter office mail.

I did not get to talk to Al Barnum or Capt. Long about systems work as they were tied up all day. We should get SRI on the need-to-know list for ARPD 760-D and then they will feel free to talk about classified areas under this document. There was nothing new learned under 730-J with clearance this time, so the implication that they were holding back last time seems to have been false

Lt. Del Snyder is now in RAWIF, the new computation facility branch. They are getting a CDC-160 and, perhaps, the R-W 400 polymorphic computer. They still hope they may inherit the 220 from the ULD-1 program. The room is ready for installation of machines now.

Bill Moore mentioned that they had approved the $1,500 overhead rate increase money for 3184 but was a little unhappy that we had not notified them by the 60 percent expenditure point. He said there was no problem of availability of money but the approval had to be obtained from the Secretary of Air Force, no matter how much money was involved.

Latest list of projects in RAWID of interest to CTL:

Technical Monitor	
Fred Dion (RAWID)	Techniques for Hypothesis Generation and Testing, Dikewood Corporation - AF 30(602)-2514. Runs to next May (1962).
Pat Langendorf (RAWID) (Capt. Horner)	Theory of Adaptive Mechanisms, University of Syracuse - AF 30(602)-2543. Ends June 1962.
Jerry Klion (RAGSR)	Logic of Controlled Threshold Devices, Case Institute - AF 30(602)-2518. Ends July 1962.
Milt Bramer (RAWID)	Electronic Readout of Wideband Electron Beam Recording, Ampex - Reg Lamb, project engineer at Ampex, AF 30(602)-2474. (Just started, March 1961)

Names of Publications Related to Hybrid Computers Obtained from Sal Liotta:

ESL - TM - 106	"Real Time Analog-Digital Computation," M.E. Connelly, April 1961, AF 19(604)-6654, Sci. Report No. 3, MIT, Electronic Systems Laboratory.
AFCRL - TN -60 - 963	"The Pulsed Analog System for Evaluating Correlation Functions for Radar," C Gordon Bell AF 19(604) 6654 AF 33(616)-6046, Electronic Systems Lab. MIT
Electronic Systems Lab, MIT, MS Thesis, Aug. 1960	"A Transistorized Operational Amplifier for Time Shared Analog Computation," Allan Richard Gunion.
AFCRL - TN - 60 - 1111	"A Pulsed Analog and Digital Computer for Function Generation," Sci. Report No. 2 (8494-R-2), AF 19(604)-6654, Electronic Systems Laboratory, MIT.
Electronic Systems Lab MIT, MS Thesis, May 1960	"A Time Shared Analog Trigonometric Resolver," James Lee Massey.

Action: Send to Fred Dion Engelbart s proposal and renewal proposal to AFOSR and background material

Name of Reporter: M. B. Adams

Distribution: Hamman, Hutchison, Hoskens, Jeffry, Noe/Wing, McGuigan, O'D nnell, Prentice, Royce, Anderson, Zeidler, Goldberg, Miller, Minnick, Engelbart.

M. B A MBA

~~May~~ June 21, '61

Milt Adam's report on Fred Dion, in a branch (Data Processing??) of the old Intelligence Lab (now called Information Processing Lab)...where there is interest in pattern recognition, automatic programming, and the like. Milt mentioned something about their having a mandate to worry about Air Force command and control problems, etc., but that this is probably a recent assignment.

SUBJECT: Real-Time Computer Aid for Human Information Manipulation

MIRF copy to RADC CB project files (4)

REFERENCE: RAW-64-579 -- From PSA 16 September 1963

TO: Directorate of Procurement
Rome Air Development Center
Attn: RAKS
Griffiss Air Force Base, New York 13442

1.0 Stanford Research Institute

Stanford Research Institute is a not-for-profit corporation chartered by the State of California. The Institute was founded in November, 1946 by action of the Trustees of Stanford University, and many members of the Board of Directors of the Institute are also on the Board of Trustees of the University, although there is no operational connection between the two organizations. Headquarters and principal laboratories of the Institute are at Menlo Park, California. Regional Office locations include New York City, Detroit, Wash. D.C., Pasadena, Calif., Tokyo, Japan, and Zurich, Switzerland.

SRI is one of the largest research institutes, with excellent facilities, and a highly competent research staff with broad interests, training, and experience in the physical sciences, life sciences, engineering, and economics. The Institute has a total staff of 2300 persons, of whom over 1,200 are in technical and professional categories. Advance degrees are held by 600 staff members; of these 275 hold Ph.D. or equivalent degrees. The Institute has Top Secret clearance under Western Contract Management Region (RWIP), United States Air Force, Mira Loma Air Force Station, Mira Loma, Calif.

2.0 Qualifications and Facilities

2.1 Personnel: Eight professionals are engaged full time in original and coordinated research that is directly relevant to the subject research. Nine other professionals are providing part-time backup service in engineering, psychology, content analysis, and systems analysis.

2.2 Special Facilities: (A) Experimental laboratory equipped with a character generator and cathode-ray-tube display incorporated into a flexible console arrangement to provide real-time man-computer interaction. A CDC 160A computer to provide instantaneous real-time service for the smaller service processes (B) a telephone tie-line connecting this computer as a satellite to the Q32 computer in the Command Laboratory (an ARPA-supported activity)at Systems Development Corp., in Santa Monica. The Q32 is a fast computer of the SAGE class, with 48-bit word length, 65-thousand-word core memory, 500,000 words of high-speed drum storage, 18 tape transports, that is to be operated in a time-sharing mode to give service to a number of satellite computers, display consoles, and teletypewrite stations. (It's storage is to be increased next year with the addition of a high-transfer-rate disk file and words of core.)

2.3 Objectivity, since Stanford Research Institute is a not-for profit organization, does not hold patents, and it is not in manufacturing nor sales.

SRI has been active in the area encompassing the subject described above for a number of years. Descriptions of representative completed and current projects are listed below. A printed brochure outlining interests and capabilities in this area, and biographies of pertinent staff personnel are attached.

3.0 Representative Prior and Present Projects

3.1 These current projects form the nucleus of a coordinated research program which was conceived and developed at SRI, and which is planned as a continuing and growing activity.

3.11 Augmented Human Intellect Study

Contract AF 49(638)-1024
Air Force Office of Scientific Research, Washington, D.C.

This project has been active since March of 1961, and represents mainly a one-man effort to set the stage for present and future research aimed at improving the effectiveness of human intellectual activity through the use of real-time computer aids. The first year and a half was mainly a conceptual study, leading to the Summary Report, "Augmenting Human Intellect: A Conceptual Framework".[1] This work set the stage for the proposals and subsequent projects with ARPA and ESD described below. Recently this AFOSR work has been concerned with basic problems in computer-aided data transcription and with detailed aspects of computer-aided "micro-documentation",[2] as well as general continued development of a research foundation for a coordinated research program in the "augmented human intellect" area.

3.12 Research on the Computer Facilitation of Computer Programming

Contract ARPA - SD-163
Advanced Research Projects Agency

A direct outgrowth of the long-term research strategy developed in the above project. The objective of this project (started March 1963, five to six man level) is to establish a computer-based experimental laboratory (equipped with real-time computer service, a computer-driven cathode-ray-tube display at a console, light pen, keyboards, etc.) and to pursue a coordinated system of computer aids, system language and data structuring, and human procedures and methods. The goal is to improve human effectiveness at the whole gamut of tasks involved in designing, writing, debugging and documenting computer programs. Enclosed proposal copy[3] outlines method of approach.

3.13 Research on Computer-Augmented Information Management

Contract AF 19(628)2914
Air Force Systems Command, Electronic Systems Division
Bedford, Massachusetts.

---

[1] Copies of references 1 thru 4 are enclosed.

The objectives and method of approach for this project also are a direct outgrowth of the AFOSR-sponsored study. The project began in July, 1963, and proceeds at a $2\frac{1}{2}$ to 3-man level. Dealing only with software and system development (using hardware and basic software of the ARPA project), this project concentrates on improving the management of information involved in minute-by-minute, day-by-day and month-by-month problem-solving activity of a computer programmer and of a research group. The developments of this project will be used and evaluated not only by programmers within the ARPA-project programmer-aid system (and hence by our own researchers in their programming activity), but by the growing list of researchers (of section 2.1) in our coordinated augmented-human-intellect program for managing their individual, group, and external-source working information. Again, improved management is pursued by integrating real-time computer aids with new language and data structures, and new methods and procedures, within a coordinated working system.

3.2 Large Information Processing Systems

3.21 The Institute designed for the Air Force (Air Technical Intelligence Center), a comprehensive system for the systematic acquisition, abstracting, translating, dissemination, review, storage, and retrieval of a significant segment of the open-source foreign scientific literature. During the course of this project a comprehensive review was made of the operation and techniques of several of the largest technical information files maintained by the Air Force and other government agencies.

3.22 Another project which was completed after a two-year effort was the design and implementation of a complete data-handling system for an aerial reconnaissance project (ULD-1 Electronic Recon System - Contract AF 33(604)17231. This effort included system studies, computer selection, installation planning, program writing, and assistance with the final system test. For this project, a large data processing system was installed at the Institute for the programing and testing effort, and subsequently delivered to the client as a complete, operating system. Some special-purpose equipment such as magnetic tape converters, and special man-machine operator consoles were also developed as part of this program.

3.3 Miscellaneous Projects Related to Large Information Processing Systems.

Several related projects have been conducted by the Institute in various phases of the technical information problems, both in gross and specialized aspects of data handling, storage, and retrieval.

The following is a partial listing of these:

"Technical assistance in implementing STEP (Scientific Technical Exploitation Program) as a systematic means of reviewing technical literature and identifying important material.

A graphical data processing study, which considered the handling of raw data, identification, programing, selection, indexing, storage, access to storage, and presentation.

Investigation of the feasibility of constructing a special file for the retrieval of information--a file to contain descriptions of up to two million documents with the capability of indicating simultaneously all documents related to an inquiry.

Development of an information system to aid in controlling the leadtime of a variety of significant military research and development projects.

Development of a technique for high-speed automatic reading of printed alphanumerical material.

Development of the Videograph printer for the transfer of video images to paper.

Development of high-speed document handling techniques.

Research to develop a system of materials suitable for draftsmen to use in making original drawings which would be reproducible by transmission photocopying.

Mobilization planning studies for various agencies with the DOD, which considered detailed manufacturing problems and the transition from drawings to hardware.

Procurement planning and control studies, including major activity on the "Missile Manufacturer's Planning Report."

Studies of storage means for graphical data, including microfilming.

Studies on the encoding of data in operational situations.

Another project on which the Institute provided assistance was the design of the data processing and file portions of a bomb-damage assessment system for the joint military services. This very large information handling system will maintain a current status record of all items of military potential (weapons, ships, bridges, etc.) on a global basis. The system has necessarily been designed with methods of rapid file maintenance and the incorporation of special communication and display equipment. For this project the Institute also assisted in the selection of the data processing and auxiliary equipment.

3.4 Multiple Instantaneous Response File --MIRF
RADC Contract AF 39(602)-2772

The basic MIRF unit has been developed as a complete system for retrieval of document index information, and need not be connected to a computer. It includes an operator console with electric typewriter, paper-tape punch and other display facilities. The unit also includes two separate associative memories, one a dictionary and the other the file of indexing information for ASTIA documents. The indexing information for each item in the file includes the explicit serial numbers for eight descriptors, the explicit accession number of the document (file item) and an 80-bit single-field superimposed search code of the relevant descriptors. In use, the operator types in the descriptors in English for his inquiry. The dictionary permits a unique match and generates the coded serial number of the descriptor or informs the operator that it is a non-allowed indexing term. A search question, for the File, is derived by superimposing the codes of the desired group of descriptors. Generally, the number of descriptors used in a search question will be less than the number in a document. When this search question is complete, the File is quizzed in parallel and an immediate indication is given if any file items logically include the quizz. The unit permits and can handle multiple responses. Thus, following a "yes" response the number of documents is displayed to the operator. If the quantity is satisfactory to the operator, the indexing information on each responding item is then typed out.

3.5 Graphical Data Processing Research Study and Experimental Investigation
Contract DA 36-039-SC-78343
U. S. Army Signal Supply Agency, Fort Monmouth, New Jersey

This program has as its goal the design and construction of prototype equipment with a capability to learn to recognize certain features in maps, photographs, or other visual data. It is envisioned that the machinery will consist basically of two parts. The first part will be a fixed logic machine designed to filter the optical information and produce an output which is invariant under certain known transformations of the input (e.g., rotation, translation, size, noise, etc.). The output of the fixed part of the machine will preserve information relating only to the essential features of the input pattern. Various methods of optical sampling have been devised which together with implementations of certain theorems from Integral Geometry will prove useful in this first part of the machine.

The second part of the machine is the part which actually learns. It will be a network of interconnected elements called threshold logic elements whose thresholds and interconnecting weights can be modified. The machine training is then identified with the judicious changing of these weights and thresholds to produce useful outputs. The machine's memory of the essential features of the distinction between various patterns resides distributed among all of these weights and thresholds. Since the memory is distributed and not totally dependent on any one component, such machinery promises

STANFORD RESEARCH INSTITUTE
Contact Report

SRI Confidential

20 June 1961

Company Name and Address:	Rome Air Development Center Information Processing Lab Rome, N Y. Phone: FF 6-3200, Ext. 71251 or 71170 for RAWID, Moore and Iuorno
Date and Place of Visit:	16 June 1961 RADC, Rome, N.Y.
Company Representatives:	Ernie Iuorno, Bill Moore, Sal Liotta, Ron Ferris. Fred Dion, Lt. John Choisser, Lt. Del Snyder, Capt. Kortz
Institute Representative:	M.B. Adams
Purpose of Visit:	To discuss MIRF extension and possible new work.
Subjects Discussed:	Ernie Iuorno informed me that there has been another reorganization at RADC and Howard Davis, who was Lab Chief, Information Processing Lab, is now Technical Director of the Intelligence and Electronic Warfare Directorate.

Capt. B. J. Long, who was assistant to Al Barnum in the Data Processing Branch, is now Assistant Laboratory Chief. Frank Tomaini is the new Information Processing Lab Chief.

Ron Ferris is awaiting the return of Al de Luccia on Monday so that they can evaluate the feasibility of going ahead with a MIRF model development program. They will do this next week and Jack Goldberg will hear from them in the next week or two. Ferris does not want a proposal from us yet. He said they must decide whether the machines we priced for them will be competitive with such things as the AVCO approach and the NCR magnetic card using a form of Zatocoding He also mentioned the NBS "Microsite" system as a possible competitor. None of these schemes in their present form allow the type of retrieval possible with a MIRF but he must speculate on the relative saleability of these schemes.

A new man, Sal Liotta, is now in charge of hybrid computers. He is just getting educated on the subject and has visited MIT and a number of other places (Beckman) doing hybrid computer work. They will be soliciting proposals for a study of this area and we will receive a PR. We can also look for a PR in the large scale memory system area.

Another new man Fred Dion, is in charge of self organizing machines, adaptive machines and pattern recognition. He seemed quite interested in hearing of Doug's work and requested copies of the original and renewal proposals to AFOSR and any other background material so that he can decide whether he wants to sponsor the other half He inquired, while I was there, and found out that it could be handled contractually, if they want to do it. He is also interested in hearing more about the work in Charlie Rosen's lab for the Signal Corps on pattern recognition.

Ernie Iuorno has received letters from Lockheed and Remington-Rand Univac asking for copies of the final report on 3184. He answered by referring them to ASTIA or to SRI The Lockheed man s name is Frank F Stucki, Bldg 204, 3251 Hanover St., Palo Alto. The Rem-Rand man's name is R. M Salman, R-R-U, Blue Bell, Pa.

Ernie Iuorno would also like to receive more dope on Charlie Rosen's new ONR contract on high density storage. The contract number and title would help him get reports on the project. He still wants the figure from 3184 report (in slide form) comparing all kinds of storage systems. If possible, he would also like

to borrow the cards containing the bibliography on memory and access compiled on 3184. If they are IBM cards, perhaps we can duplicate them, if not, he will have his secretary copy them and return the originals to us.

Ernie gave me a new organization chart of the Air Force Systems Command complete with verbal descriptions of all major blocks and pictures of the men in charge. Ernie tells me that a Major W. Harris, ESD, ESRRI, Hanscom Field, Bedford Mass. controls all work done under ARPD 730-J, the data processing planning document. RAWID has just received their latest copy of the BRL Survey of Domestic Electronic Digital Computer Systems, ASTIA AD-253212, Report No. 1115, and Ernie suggests we send to ASTIA for one right away if we want one as the number of copies is limited.

A number of the RAWID projects now going on may be of interest to CTL members. AF 30(602)-2514, Techniques for Hypothesis Generation and Testing, Dikewood Corporation; AF 30(602)-2543, Theory of Adaptive Mechanisms, University of Syracuse; AF 30(602)-2518, Logic of Controlled Threshold Devices, Case Institute; AF 30(602)-2474, Electronic Readout of Wideband Electron Beam Recording, Ampex Corporation.

Sal Liotta gave me a list of reports by MIT, Electronic Systems Laboratory, dealing with hybrid computers in one way of another.

I left copies of the Linear Input Logic program description with Lt. Choisser. He did not have time to read it before I left but asked how many people we would feel it took to do this. I told him about 26 man-months for the first year, minimum, per Bob Minnick's suggestion. Bill Moore asked me the same question and suggested 3 or 4 men as his feeling for the first year's effort. Bill Moore is to be away from RADC for the next month.

Ernie did not give me any real encouragement on more work on access switches. He said they were still considering how best to budget their money and had not decided yet He is still very much interested in very large scale memories and said we would receive their PR on this.

I called Gableman and talked for a few minutes. He said to tell Minnick that he had succeeded in generating a counter example for 9 variables of what Winter calls complete monotonicity. He thought Bob might be interested. I sent him a copy of the LIL program description by inter office mail.

I did not get to talk to Al Barnum or Capt. Long about systems work as they were tied up all day. We should get SRI on the need-to-know list for ARPD 760-D and then they will feel free to talk about classified areas under this document. There was nothing new learned under 730-J with clearance this time, so the implication that they were holding back last time seems to have been false

Lt. Del Snyder is now in RAWIF, the new computation facility branch. They are getting a CDC-160 and, perhaps, the R-W 400 polymorphic computer. They still hope they may inherit the 220 from the ULD-1 program. The room is ready for installation of machines now.

Bill Moore mentioned that they had approved the $1,500 overhead rate increase money for 3184 but was a little unhappy that we had not notified them by the 60 percent expenditure point. He said there was no problem of availability of money but the approval had to be obtained from the Secretary of Air Force, no matter how much money was involved.

Latest list of projects in RAWID of interest to CTL:

Technical Monitor	
Fred Dion (RAWID)	Techniques for Hypothesis Generation and Testing, Dikewood Corporation - AF 30(602)-2514. Runs to next May (1962).
Pat Langendorf (RAWID) (Capt. Horner)	Theory of Adaptive Mechanisms, University of Syracuse - AF 30(602)-2543. Ends June 1962.
Jerry Klion (RAGSR)	Logic of Controlled Threshold Devices, Case Institute - AF 30(602)-2518. Ends July 1962.
Milt Bramer (RAWID)	Electronic Readout of Wideband Electron Beam Recording, Ampex - Reg Lamb, project engineer at Ampex, AF 30(602)-2474. (Just started, March 1961)

Names of Publications Related to Hybrid Computers Obtained from Sal Liotta:

ESL - TM - 106	"Real Time Analog-Digital Computation," M.E. Connelly, April 1961, AF 19(604)-6654, Sci. Report No. 3, MIT, Electronic Systems Laboratory.
AFCRL - TN -60 - 963	"The Pulsed Analog System for Evaluating Correlation Functions for Radar," C Gordon Bell AF 19(604) 6654 AF 33(616)-6046, Electronic Systems Lab. MIT
Electronic Systems Lab, MIT, MS Thesis, Aug. 1960	"A Transistorized Operational Amplifier for Time Shared Analog Computation," Allan Richard Gunion.
AFCRL - TN - 60 - 1111	"A Pulsed Analog and Digital Computer for Function Generation," Sci. Report No. 2 (8494-R-2), AF 19(604)-6654, Electronic Systems Laboratory, MIT.
Electronic Systems Lab MIT, MS Thesis, May 1960	"A Time Shared Analog Trigonometric Resolver," James Lee Massey.

Action: Send to Fred Dion Engelbart s proposal and renewal proposal to AFOSR and background material

Name of Reporter: M. B. Adams

Distribution: Hamman, Hutchison, Hoskens, Jeffry, Noe/Wing, McGuigan, O'D nnell, Prentice, Royce, Anderson, Zeidler, Goldberg, Miller, Minnick, Engelbart.

M. B A MBA

May June 21, '61

Milt Adam's report on Fred Dion, in a branch (Data Processing??) of the old Intelligence Lab (now called Information Processing Lab)...where there is interest in pattern recognition, automatic programming, and the like. Milt mentioned something about their having a mandate to worry about Air Force command and control problems, etc., but that this is probably a recent assignment.

copy A ICAVC CAS project files (6) MIRF

SUBJECT: Engineering Services for the Design of a System for Searching and Extracting Information

REFERENCE: E-4-109, from PSA 3470, 17 January 1964

TO: Procurement Division
Rome Air Development Center
Attn: EMKS
Griffis AFB, N.Y. 13442

Stanford Research Institute

Stanford Research Institute is a not-for-profit corporation chartered by the State of California. The Institute was founded in November, 1946 by action of the Trustees of Stanford University, and many members of the Board of Directors of the Institute are also on the Board of Trustees of the University, although there is no operational connection between the two organizations. Headquarters and principal laboratories of the Institute are at Menlo Park, California. Regional Office locations include New York City, Detroit, Washington, D.C., Pasadena, California, Tokyo, Japan, and Zurich, Switzerland.

SRI is one of the largest research institutes, with excellent facilities, and a highly competent research staff with broad interests, training, and experience in the physical sciences, life sciences, engineering, and economics. The Institute has a total staff of 2368 persons, of whom over 1300 are in technical and professional categories. Advance degrees are held by 600 staff members; of these 323 hold Ph.D. or equivalent degrees. The Institute has Top Secret clearance under Western Contract Management Region (RWIP), United States Air Force, Mira Loma Air Force Station, Mira Loma, California.

I QUALIFICATIONS AND FACILITIES

SRI has considerable experience in the design and evaluation of large information systems. The Institute maintains an up-to-date awareness of problems in the distribution and use of scientific and technical information, as well as the research being done on these problems. SRI itself has performed some studies of information resources and the problems of scientific and technical information. SRI currently operates one of the AEC Depositories and maintains its own technical report collection.

We believe that the independent nature of the Institute lends further strength to our capability in system design and evaluation; we do not produce commercial equipment, nor are we in any way allied with a particular manufacturer of data-handling equipment. At the same time, our direct contact with many manufacturers and other research organizations ensures our awareness of their progress in information-handling and related fields. Rapport with manufacturers and possession of in-house systems engineering talent have allowed us to carry out more efficiently all the phases of information-handling system implementation, from initial problem definition through design and analysis, equipment selection, detailed programming and installation, to final user acceptance-testing.

The Systems Engineerin g Laboratory of the Engineering Sciences Division is engaged in the analysis, design, and evaluation of large-scale information systems. Its programs have both an applied and a basic research component. The applied activities result in the generation of system designs in response to the specific needs of a client. The basic research activities are directly concerned with the development of improved analysis and design techniques. The work maintains a strong multi-disciplinary character. On the one hand, detailed engineering knowledge is required of the current and projected state-of-the-art for computer, communications, and control equipment. At the same time, considerable skill is required in the application of those tools that provide insight into the properties of large-scale systems--queuing theory, linear programming, information theory, modeling, graph theory, simulation, and optimization methods.

Members of this Laboratory have participated in the design of a number of large-scale systems, including a nationwide airline space-reservation system interconnecting automatic data processors and agents set in a complex communication pattern; a nationwide system for processing and disbursing commercial bank checks; a comprehensive facility for the reduction and analysis of electronic reconnaissance data; an electronically instrumented system for automatically evaluating the combat effectiveness of mobile military units; a very large memory for information retrieval problems; and a system for processing graphic information (pattern recognition) with digital computer techniques. Most recently, the members of the Laboratory have led the design effort on the Nimbus weather satellite data-handling system.

General Facilities

Extensive facilities and equipment are available to support the diversified requirements of multi-disciplinary research and development projects.

Special Facilities

Experimental laboratory equipped with a character generator and cathode-ray-tube display incorporated into a flexible console arrangement to provide real-time man-computer interaction, a CDC 160A computer to provide instantaneous real-time service for the smaller service processes, and a telephone tie-line connecting this computer as a satellite to the Q32 computer in the Command Laboratory (an ARPA-supported activity) at Systems Development Corp., in Santa Monica. The Q32 is a fast computer of the SAGE class, with 48-bit word length, 65-thousand-word core memory, 500,000 words of high-speed drum storage, 18 tape transports, that is to be operated in a time-sharing mode to give service to a number of satellite computers, display consoles, and teletypewrite stations.

II RELEVANT PROJECT EXPERIENCE

The following briefs are illustrative of projects carried out at Stanford Research Institute that are relevant to the study described in this proposed area.

1. Study of the Scientist-to-Scientist Communication Patterns of the U. S. Biomedical Research Community

The National Academy of Sciences/National Research Council, with NIH support, has formed a Task Force study group that is currently studying the

information problems of the U. S. biomedical researchers. One member of the SRI staff has been an active member of this study group. This project has been concerned primarily with determining the nature of the information problems of biomedical researchers; determining what sources and channels of information are available, and what their limitations are; and what improvements might be considered on a local and national scale to improve the information services and scientist-to-scientist communication.

2. A Preliminary Study of the Requirements, Criteria, and Measures of Performance of Information Storage and Retrieval Systems

A preliminary study was made for the National Science Foundation of the requirements, criteria, and measures of performance of information storage and retrieval systems. Specifically, the objectives were: (1) to develop a methodology for determining user's information requirements; (2) to obtain specific data about the information requirements of a particular community of users; (3) to develop a preliminary set of criteria and a procedure that could be applied to existing information retrieval systems in order to reach tentative conclusions about the desirability of such systems; (4) to develop measures of system performances; and (5) to develop plans for a research program for the longer-range development of more basic and exhaustive criteria and methods for the assessment of alternative systems and procedures.

3. Technical Assistance in Implementation of the STEP Program

As a systematic means of reviewing a selected portion of this literature--and of separating important material from unimportant material--the Scientific Technical Exploitation Program (STEP) was established. SRI contracted with the Air Technical Intelligence Center (ATIC) to provide specific guidance on the immediate implementation of STEP and to give technical assistance to ATIC in the preparation of descriptive specifications of a semi-automated system for the entire STEP program.

The general objective was to develop a system by which a continuous scrutiny of Soviet Technical and scientific literature would provide timely and improved technical information about the Soviet technical potential, as well as providing valuable information to the R&D community, and aid in the proper guidance of Air Force research and development programs.

4. MIRF

Under Air Force sponsorship, the Institute is currently studying a special approach to the problem of implementing and using very large files of information. Progress is being made on the hardware and organization design of a Multiple Instantaneous Response File (MIRF) for information retrieval. This particular file device differs from other types of memories in these respects: in response to a question, all the contents of the entire file are searched simultaneously, rather than in sequential fashion, to select those file items that satisfy the search request; all of the answers are provided in a fraction of a second; and provision is made for handling multiple simultaneous answers to the same question. This type of device would ultimately permit a user to pose a question to a file of a million or more items and obtain the answer essentially instantaneously. The logical and

and hardware design, the development of coding systems, and the implementation of a working model have already been completed.

5. Information Needs of Physicians

Under commercial sponsorship, a basic research study was conducted to explore the total information needs of physicians, and the extent to which journal publications--and one journal in particular--can meet these needs. Interviews were held with a number of practicing physicians as part of the effort to determine their information needs.

6. Availability of Japanese Technical Literature for U. S. Scientists

Under National Science Foundation sponsorship, the Institute recently conducted a study of the availability of the Japanese technical literature for U. S. scientists. This included the identification of major sources and depositories of this information in the U. S., and the extent to which translations are available.

7. Establishment of the Air Pollution Information Center

With support by the San Francisco Bay Region Air Pollution Control District, a comprehensive information center was developed by the Institute to serve as a single and comprehensive collection of information on air pollution and related topics. This file now serves as the core of the District's present technical information center.

8. Development of an Information Management System for Cooperative Man-Computer Relationships

With support from the Air Force Electronic Systems Division and the Advanced Research Projects Agency, the Institute is currently working on a comprehensive study to investigate, design, and construct information management systems that will operate in the environment of a cooperative man-computer system. Experimental facilities are being developed and used for the real-time search, display, and processing of information, using large digital computers, data communication facilities, and display consoles or work stations with cathode-ray-tube displays and various other input-output devices. This experimental facility will be used for the computer interrogation and processing of large files of data from remote user stations, with provisions for relatively easy communication between the user and the machine system.

9. Aerial Reconnaissance Data Processing

Another project which was completed after a two-year effort was the design and implementation of a complete data-handling system for an aerial reconnaissance project (ULD-1 Electronic Recon System - Contract AF 33(604)17231. This effort included system studies, computer selection, installation planning, program writing, and assistance with the final system test. For this project, a large data processing system was installed at the Institute for the programming and testing effort, and subsequently delivered to the client as a complete, operating system. Some special-purpose equipment such as magnetic tape converters, and special man-machine operator consoles were also developed as part of this program.

The following is a partial listing of other related research projects:

A graphical data processing study, which considered the handling of raw data, identification, programming, selection, indexing, storage, access to storage, and presentation.

Development of an information system to aid in controlling the leadtime of a variety of significant military research and development projects.

Development of a technique for high-speed automatic reading of printed alphanumerical material.

Development of the Videograph printer for the transfer of video images to paper.

Development of high-speed document handling techniques.

Research to develop a system of materials suitable for draftsmen to use in making original drawings which would be reproducible by transmission photocopying.

Mobilization planning studies for various agencies with the DOD, which considered detailed manufacturing problems and the transition from drawings to hardware.

Procurement planning and control studies, including major activity on the "Missile Manufacturer's Planning Report."

Studies of storage means for graphical data, including microfilming.

Studies on the encoding of data in operational situations.

III RELEVANT STAFF PUBLICATIONS

The following publications by SRI personnel are a further illustration of the background and interests of the Institute staff as relevant to the study described in this proposed area.

Bourne, C. P., Methods of Information Handling (John Wiley and Sons, Inc., New York, New York, 1963.

Bourne, C. P., "The World's Technical Journal Literature: An Estimate of Volume, Origin, Language, Field, Indexing, and Abstracting," American Documentation 13, 2, pp. 159-168 (April 1962).

Bourne, C. P., "Problems Posed by an Expanding Technical Literature," IRE Trans.PGEWS-5, 1, pp. 2-8 (August 1962).

Bourne, C. P., "A Review of the Methodology of Information System Design," in Information Systems Workshop: The Designer's Responsibility and his Methodology, pp. 11-36 (Spartan Books, Washington D. C., 1962)

Bourne, C. P., "The Historical Development and Present State of the Art of Mechanized Information Retrieval Systems," American Documentation 12, 2, pp. 108-110 (April 1961).

Bourne, C. P., "The Beginnings of Automation of Technical Drafting, Writing, and Editing Functions," Proc. of the Eighth Annual Convention of the Society of Technical Writers and Publishers, pp. 57-65 (STWP, Inc., Columbus, Ohio, 1961).

Bourne, C. P., "A Bibliography on the Mechanization of Information Retrieval," Stanford Research Institute, Menlo Park, California (February 1958). Annual supplements 1, 2, 3, 4, issued in February of 1959, 1960, 1961, 1962 repectively.

Bourne, C. P., "The Organization of a Memory System for Information Retrieval Applications" Supplement B to Quarterly Report 2, SRI Project 3101, Contract AF 30(602)-2142, Rome Air Development Center, Griffiss Air Force Base, Rome, New York (June 1960).

Bourne, C. P. and D. C. Engelbart, "Facets of the Technical Information Problem," SRI Journal, 2, No. 1, pp. 2-8 (1958). Also reprinted in Datamation (September 1958).

Bourne, C. P., G. D. Peterson, B. Lefkowitz, and D. Ford, "Requirements, Criteria, and Measures of Performance of Information Storage and Retrieval Systems," Stanford Research Institute Report to the National Science Foundation (December 1961), ASTIA No. AD-270 942, OTS price $10.50.

Engelbart, D. C., "Special Considerations of the Individual as a User, Generator, and Retriever of Information," American Documentation, 12, 2, pp. 121-125 (April 1961).

Goldberg, J. and M. W. Green, "Large Files for Information Retrieval Based on Simultaneous Interrogation of All Items," Large-Capacity Memory Techniques for Computing Systems, pp. 63-77 (The Macmillan Company, New York, New York 1962).

Goldberg, J., M. W. Green, C. H. Heckler, Jr., E. K. Van De Riet, R. C. Singleton, and E. H. Frei, "Multiple Instantaneous Response File," Final Report, SRI Project 3101, Contract AF 30(620)-2142, Stanford Research Institute, Menlo Park, California (August 1961), AD 266 169.

IV BIOGRAPHIES OF PERTINENT STAFF PERSONNEL

Tomlin, Frederick K. - Mathematician, Mathematical Sciences Department

Mr. Tomlin received a B.A. degree in 1954 and an M.S. degree in 1958, both in Mathematics from San Jose State College. During 1954-1956 he served in the U.S. Army.

Mr. Tomlin joined the staff of Stanford Research Institute in June 1958. He has since engaged in mathematical research and analysis for an Air Force sponsor. At this time he was also occupied with the development of programs for a Burroughs 220 Data Processor to evaluate the results of his previous research and analysis, and development and integration of subroutines and machine language programs to be used as a basis for a large data-handling system.

He has done extensive programming of scientific and data-handling problems using machine, assembler, and compiler (Burroughs ALGOL) language and in the process has obtained considerable experience using magnetic tapes, Programs

include radio signal strength predictions, atomic casualty study, and circuit simulation. He developed the computer operating system that controls the operation of all programs run at the SRI computer facility.

Presently he is working on a project to develop COBOL for the Burroughs 220 Data Processor. Specifically, he is developing generators and subroutines for the input-output verbs (OPEN, CLOSE, READ, WRITE, POSITION), the arithmetic verbs (ADD, SUBTRACT, MULTIPLY, DIVIDE), and others (including MOVE and EXAMINE).

His programming experience includes the use of the CDC 160A, Burroughs 220, and the IBM Q32.

Mr. Tomlin is a member of the Association for Computing Machinery.

Humphrey, Thomas L. - Research Engineer, Systems Engineering Laboratory

In October 1962 Mr. Humphrey joined the staff of Stanford Research Institute, where he has been engaged in research in man-machine interactions and mechanization of man-machine systems. His interests in this area include programming techniques and systems and logical organization processes.

In 1960 he joined A. C. Spark Plug Division of General Motors, where he worked on design and analysis of ground-support equipment for the MACE inertial guidance system. In 1961 he moved to the Advanced Research and Development Section, where he was concerned with computer system performance and reliability models and with logical design and organization techniques for reliability improvement of space-borne digital computers.

His special skills include control systems, logical design and organization, systems analysis and modeling, computer programming (using computer, assembly, and list processing languages), and circuits.

Mr. Humphrey received a B.S. degree in Applied Physics from the University of California at Los Angeles in 1960 and an M.S. degree in Electrical Engineering from Stanford University in 1961. He is currently a candidate for the degree of Ph.D. at Stanford University, being concerned with the area of man-machine systems.

Mr. Humphrey is a member of Sigma Pi Sigma, Pi Mu Epsilon, Phi Beta Kappa, the Institute of Electrical and Electronics Engineers, and the IEEE Professional Technical Groups on Electronic Computers, on Control Systems, and on Space Electronics and Telemetry.

+ Charter
Wallace
Bourne
Wensley
Engelbart
Sys Brochure