SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM

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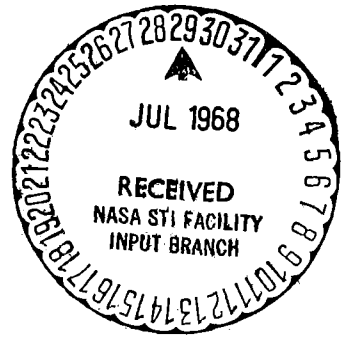

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I. INTRODUCTION

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A. General

The aeronautical and space activities conducted by the National Aeronautics and Space Administration (NASA) are creating an impressive body of knowledge of great potential scientific and technological usefulness. In carrying out its congressional mandate to disseminate this information for ultimate benefit of the general public, NASA has engaged in an extensive publications program; in particular, publications under the auspices of NASA's Technology Utilization Division (TUD) are specifically aimed at expeditiously transferring NASA developments to the scientific and industrial community.

Special difficulties are encountered when it is attempted to transfer NASA-derived technology, by means of TUD publications alone, to scientists in the biomedical fields. These scientists are particularly overburdened by the copious amounts of published biomedical material; additionally, they are by and large unfamiliar with the language and symbology of the physical and engineering sciences. As a result, technology in physical science and engineering has often not been as effectively transferred to biomedical applications as it deserves to be.

The TUD's investigations of the chain of events leading to the introduction of new products, technological inventions, and methods into medical practice have suggested that the biomedical research teams at medical schools and similar biomedical research institutions play a key role in this process. New discoveries, introduced by these groups, tend to proceed naturally through stages of professional approval, manufacturing interest and participation, on to the level of the practicing physicians, bringing direct health benefits to the public. It would seem an attractive goal to introduce NASA-derived advances at the level of the biomedical research team, and thus to utilize the existing channels to the medical practitioner and his patients for effective technological transfer.

As a result of these investigations, NASA's TUD has developed a general methodology for the solution of this important and special technological transfer problem. Prominently included in this methodology was the establishment of several strategically placed Biomedical Application Teams consisting of appropriately cross-trained and broadly experienced physical and biological scientists. It is the task of the Biomedical Application Team to facilitate and improve the productive interaction between NASA centers and biomedical research teams. Emphasis is on interpersonal contact, in which the cross-trained members of the Biomedical Applications Team form an active link between these two groups of scientists. A flexible system is

maturing in which both principal groups, NASA personnel and biomedical researchers, freely and effectively participate in mutually beneficial exchange of skills and knowledge.

B. Participating Personnel

The following scientists are participating in the program:

- Southwest Research Institute Biomedical Application Team, Southwest Research Institute Personnel:

  - Ray W. Ware, M. D., Director
  - Louis S. Berger, Assistant Director
  - Raul San Martin, M. D.
  - Charles J. Laenger, Sr.
  - Robert J. Crosby
  - Chester A. Heath
  - Felix St. Claire

  Special Consultant: Andre G. Buck (West Coast Institutions)

  Key Coordinators at User Institutions:

  - C. W. Hall, M. D., Asst. Professor, Department of Experimental Surgery, Baylor University School of Medicine, Houston, Texas
  - F. Hermann Rudenberg, Ph. D., Associate Professor, Department of Physiology, The University of Texas Medical Branch, Galveston, Texas
  - Jack B. Johnson, Asst. Chief, Biomedical Instrumentation Section, Southern Research Support Center, Veterans Administration, Little Rock, Arkansas
  - Mr. John Hall, Seattle Handicapped Center, Seattle, Washington
  - Mr. Don Baker, University of Washington, Department of Bioengineering, Seattle, Washington
  - Mr. H. A. Miller, Stanford University School of Medicine
  - N. P. Thompson, M. D., Palo Alto Medical Research Foundation
  - Joseph Canzoneri, III, (SRS), Director, Biomedical Engineering, Texas Institute for Rehabilitation and Research, Houston, Texas
  - V. Mooney, M. D., (SRS), Rancho Los Amigos Hospital, Downey, California

Other Southwest Research Institute Staff consulted:

Leon M. Adams, Ph. D., Manager, Organic and Polymer Chemistry

- Wallace L. Anderson, Ph. D., Senior Research Engineer
- Robert Bond, Ph. D., Senior Research Physicist
- J. Wray Fogwell, Manager, Electromechanical Research
- Gerald Gardner, Ph. D., Senior Research Physicist
- Stephen Juhasz, Ph. D., Editor, Applied Mechanics Review
- Richard T. Mannheimer, Senior Research Engineer
- Paul D. May, Senior Research Chemist
- Frank C. Milstead, Senior Research Engineer

II. NEW PROBLEMS

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(1) RNV-1

TITLE: Efficient Electromagnetic Power Transmission Through Living Tissue

SOURCE: Donald R. McNeal, Ph.D.
Principal Engineer
Rancho Los Amigos Hospital

DATE SUBMITTED: 22 April 1968

The problem involving stimulation of erratic peripheral motor nerves and thereby controlling neuromuscular spasticity evolved into four problems. The first, RNV-1, is occupied with the optimum frequency at which electromagnetic energy most efficiently radiates through living tissue.

INITIAL DISPOSITION:

This problem was subdivided into RNV-1 through 4. A search statement was suggested and combined with RNV-2.

COMMUNICATIONS:

28 May 1968--Search request forwarded to A. G. Buck.

9 June 1968--Problem submitted to WESRAC for computer search.

(2) RNV-2

TITLE: Design of Implanted Antennas

SOURCE: Donald R. McNeal, Ph.D.
Principal Engineer
Rancho Los Amigos Hospital

DATE SUBMITTED: 22 April 1968

In keeping with the original problem of neuromuscular disorder control, this problem seeks the optimum design parameters for an implantable antenna for use in transferring electromagnetic energy through living tissue.

INITIAL DISPOSITION:

Problem was combined in search with RNV-1.

COMMUNICATIONS:

28 May 1968--Search request forwarded to A. G. Buck.

9 June 1968--Search request sent to WESRAC for computer search.

(3) RNV-3

TITLE: Material for Nerve Stimulating Electrode Leads

SOURCE: Donald R. McNeal, Ph.D.
Principal Engineer
Rancho Los Amigos Hospital

DATE SUBMITTED: 22 April 1968

This problem involves the finding of a material which is most suitable for use as an electrode lead for chronic nerve stimulation in an implant situation.

INITIAL DISPOSITION:

After separating RNV-3 from RNV-1, a WESRAC computer search request of the NASA data bank was drafted.

COMMUNICATIONS:

28 May 1968--Search statement draft forwarded to A. G. Buck.

17 June 1968--Search request sent to WESRAC for computer search.

(4) RNV-4

TITLE: Optimum Neurological Electrodes

SOURCE: Donald R. McNeal, Ph.D.
Principal Engineer
Rancho Los Amigos Hospital

DATE SUBMITTED: 22 April 1968

As a measure for controlling neuromuscular disorders, controlled stimulation of motor nerves is planned. Best materials, placement and configuration of the stimulating electrodes are sought.

INITIAL DISPOSITION:

Although many new developments in stimulating electrodes are unlikely, a search request was submitted in the off-chance of finding some aid to the problem.

COMMUNICATIONS:

31 May 1968--Search request and cover letter was forwarded by F. L. St. Claire to A. G. Buck for editing and relay to computer.

5 June 1968--Search request was relayed to WESRAC by A. G. Buck with recommendations for personal communication with F. L. St. Claire before finalization of search strategy.

(5) RNV-5

TITLE: Pressure Measurement to Aid Prevention of New Decubitus Ulcers (Processing is coordinated with NWR-2)

SOURCE: Donald R. McNeal, Ph. D.
Principal Engineer
Rancho Los Amigos Hospital

DATE SUBMITTED: 26 April 1968

A technique is sorely needed for measuring the distribution of pressure on the surface of the skin underlying a cast, brace, or prosthetic device such as an artificial leg. This information would be an invaluable aid in the design of these devices because it is critical to distribute the load as evenly as possible to avoid high-pressure points which will damage the skin. At the present time, there is virtually no quantitative information of this sort available. The reason is that a satisfactory and economical technique for measuring pressure is not available.

INITIAL DISPOSITION:

Since it was known that this problem area was of interest to the participating member institution, a carefully screened search yield of of searches previously conducted on pressure transducer technology was sent before official problem submission to the institutional coordinator (Dr. Mooney) on 22 April 1968. In addition, the West Coast Consultant has begun an investigation of technology developed at Ames Research Center and other NASA generated technology with which the Consultant is personally familiar. He is also investigating commercial sequential pressure scanners.

COMMUNICATIONS:

20 May 1968--Mr. A. G. Buck informed the Problem Originator of proposed solution (for the static case, at least) using NASA's Multiple Pressure Sensing Techniques (as developed for aerodynamic investigation). "Scanivalve" Company in San Diego has been contacted and is preparing recommendations with cost estimate for solving the submitted problem.

24 May 1968--Mr. A. G. Buck wrote letter of report to Problem Originator describing a proposed measurement system using NASA technology and "Scanivalve" commercial equipment. Plans are being made to build up a prototype system and furnish this to the Problem Originator.

27 May 1968--Problem Originator requested that Consultant go ahead with the proposed plans for preparing a prototype for evaluation using NASA developed technology and "Scanivalve" system. The Problem Originator reported that he has available manpower for aiding in prototype construction.

7 June 1968--During a visit to NASA ERC, Cambridge, by L. Berger, tunnel diode transducers developed by Dr. W. Rindner and Dr. A. Garfein were discussed in terms of their possible usefulness to this problem. A reprint of a descriptive article, "Miniature Tunnel Diode Transducers" from Solid State Electronics, Pergamon Press, 1967, Vol 10, pp 1227-8, was obtained and forwarded to Problem Originator (26 June 1968).

24 June 1968--A. G. Buck and L. S. Berger met with Problem Originator and verified that fabrication of a system, including stitched, plastic, quilted (matrix-like) pillows is progressing. Mr. John Rogers, Engineering Research Associates, assisted Mr. A. C. Pemberton, (Scanivalve Corporation, President) and completed arrangements to borrow a prototype system. He also received advice regarding pillow design.

(6) RNV-6

TITLE: Integral Impedance Matching, Impedance Transformation, and Signal Conditioning at the Transducer

SOURCE: Worden Waring, Ph.D.
Rancho Los Amigos Hospital

DATE SUBMITTED: 7 May 1968

Efficient shielding techniques are needed for surface biopotential electrodes. These electrodes will be employed to transduce

electromyographic potentials into signals useable for activating motorized prosthetics.

INITIAL DISPOSITION:

This problem, originally RNV-6, was subdivided into RNV-6, -7, -8, and -9. A search request was drafted for RNV-6.

COMMUNICATIONS:

5 June 1968--Mr. C. J. Laenger, Sr. contacted Mr. Jack Johnson at the Southern Research Support Center to request his comments and suggestions on this problem. Mr. Johnson is a specialist in the problem area.

11 June 1968--Telephone call from Mr. Jack Johnson. He said that his recommendations would be forwarded to the Biomedical Application Team by letter as soon as possible.

24 June 1968--Letter received from Mr. Jack Johnson containing his professional advice concerning this problem.

(7) RNV-7

TITLE: Shielded Rooms for Physiological Studies

SOURCE: Worden Waring, Ph.D.
Rancho Los Amigos Hospital

DATE SUBMITTED: 7 May 1968

A shielded room is needed in which to measure biopotentials and to evaluate electronics and sensors designed as biopotential acquisition devices.

INITIAL DISPOSITION:

RNV-7 is the second part of the original RNV-6. Initial action was consultation with Mr. Jack Johnson of the Southern Research Support Center, Veterans' Administration Hospital, Little Rock, Arkansas.

COMMUNICATIONS:

13 May 1968--A letter was sent to Mr. A. G. Buck advising him of the breakdown of RNV-6 into RNV-6, -7, -8, and -9.

(8) RNV-8

TITLE: Surface Biopotential Electrodes

SOURCE: Worden Waring, Ph.D.
Rancho Los Amigos Hospital

DATE SUBMITTED: 7 May 1968

This subdivision of the original problem RNV-6 deals with the necessity for higher specificity of myographic electrodes; that is, the avoidance of other electric or bioelectrical potentials than those due to motoneuron action potentials. The use of the integrated type electrode was proposed.

INITIAL DISPOSITION:

A search request was drafted.

COMMUNICATIONS:

2 July 1968--Search request drafted.

(9) RNV-9

TITLE: Shielding Techniques for Active Surface Biopotential Electrodes

SOURCE: Worden Waring, Ph.D.
Rancho Los Amigos Hospital

DATE SUBMITTED: 7 May 1968

A special active impedance-matching circuit is desired. This circuit is to be integral and enclosed within the case or body of a surface bioelectrode. It must provide low noise amplification, filtering, and portability as well as impedance matching.

INITIAL DISPOSITION:

RNV-9 is the final segment of RNV-6 (original designation). A search request was drafted for RNV-9.

COMMUNICATIONS:

5 June 1968--Mr. C. J. Laenger, Sr. contacted Mr. Jack Johnson at the Southern Research Support Center to request his comments and suggestions on this problem.

11 June 1968--Telephone call from Mr. Jack Johnson. He said that his recommendations would be forwarded to the Biomedical Application Team by letter as soon as possible.

24 June 1968--Letter received from Mr. Jack Johnson containing his professional opinions concerning this problem.

(10) WSM-1

TITLE: Ultrasonic Energy Coupling Techniques

SOURCE: Mr. Donald W. Baker
Technical Manager
Bioengineering Program
University of Washington

DATE SUBMITTED: 17 April 1968

The problem is to find a device, material, or technique which will increase the efficiency of coupling of ultrasonic energy between piezoelectric transducers and flesh.

INITIAL DISPOSITION:

It was decided that a WESRAC computer search of the NASA data bank was in order.

COMMUNICATIONS:

3 May 1968--Search statement draft was sent to Mr. A. G. Buck.

9 June 1968--Search results returned to Problem Originator.

27 June 1968--Search results discussed with Problem Originator during a visit by L. S. Berger and A. G. Buck. Misunderstandings in the search description seemed to have developed. WESRAC will be consulted, and a rescreening of the search results will be requested.

(11) WSM-2

TITLE: Rheology of Human Arteries

SOURCE: Dr. Colin H. Daly
Assistant Professor
Mechanical Engineer
University of Washington

DATE SUBMITTED: 12 April 1968

It is desirable for diagnostic purposes to determine the stress versus strain relationship of segments of human arteries in normal and in diseased states.

INITIAL DISPOSITION:

A WESRAC computer search of the NASA data bank is in order.

COMMUNICATIONS:

23 May 1968--Mr. R. J. Crosby called Dr. Daly to clarify the problem statement.

28 May 1968--Search statement sent to A. G. Buck for relay to WESRAC.

(12) WSM-3

TITLE: Instantaneous Skin Surface Temperature Measurement

SOURCE: Dr. Kenneth K. Kraning
Senior Fellow
University of Washington

DATE SUBMITTED: 12 April 1968

A method is needed by which to apply short pulses of radiant energy to human skin, and to measure the time-course of the skin's surface temperature.

INITIAL DISPOSITION:

A computer search of the NASA data bank is in order.

COMMUNICATIONS:

22 April 1968--After consultation with a specialist in the problem area, it was decided to request additional information from the Problem Originator.

30 April 1968--Possible overlap with Research Triangle Institute problem DU-4, "Measurement of Small Temperature Changes," was revealed by a Termatrex System search. A duplicate of the search yield and the Problem Abstract responses to DU-4 was requested from Research Triangle Institute, Biomedical Applications Team.

22 May 1968--Mr. R. J. Crosby called Dr. Kraning to clarify problem statement.

28 May 1968--Search statement draft forwarded to consultant from Southwest Research Institute.

17 June 1968--Search request sent to WESRAC

27 June 1968--Search request discussed with Mr. Baker during a visit by L. S. Berger and A. G. Buck.

(13) WSM-4

TITLE: Multistress Effects on the Cardiovascular System

SOURCE: Drs. Loring Rowell and John Murray
University of Washington

DATE SUBMITTED: 1 December 1967

Singly imposed stress and the resultant effects on the heart and cardiovascular system have been studied. But what happens when two or more stress elements are simultaneously applied? And what is the separate result, as well as the combined result? The experimenters had at their disposal complete inclined-plane treadmills to provide the physical effort stress and to affect oxygen transport. It was desired to add, under controlled conditions, the stress of heat and heat transfer.

INITIAL DISPOSITION:

This problem was unofficially submitted to Mr. A. G. Buck prior to Mr. Buck's formal activities as Project Consultant. As a result of Mr. Buck's effort, NASA Manned Spacecraft Center loaned two liquid cooled garments to the Problem Originator in December 1967.. In April, a letter of acknowledgement was sent to Mr. Paul Purser, Special Assistant to the Director, Manned Spacecraft Center, which expressed appreciation for the loan, and furnished a most positive evaluation of the usefulness of the loaned technology.

(14) NWR-1

TITLE: Motion Pattern Measurement of Patients

SOURCE: A. W. Guy, Ph.D.
Assistant Professor
Department of Physical Medicine and Rehabilitation
University of Washington

DATE SUBMITTED: 17 April 1968

Neuromuscular facilitation is a relatively new means of treating the effects of central nervous system damage. It utilizes many sources of energy input to assist in the restoration of normal motion patterns. The goal of this project is to evaluate the efficacy of neuromuscular facilitation techniques in the treatment of patients with various forms of central nervous system deficiencies. The problem involved is to measure the motion pattern of the effected individual before, during, and after the treatment, and to relate these to the motions of normal individuals.

INITIAL DISPOSITION:

A computer search will be done jointly with the functionally very similar problem PLR-2, "Measurement of Surface Kinematics of the Canine Heart."

COMMUNICATIONS:

26 April 1968--Backup material on Tech Brief 67-10114, "Integrated Mobility and Notation System" was sent to communicator, informing him also that this problem was being prepared for searching.

10 May 1968--Letter received from coordinator advising that the Tech Brief material furnished 26 April appears to be of great value to research in the subject area.

23 May 1968--Search statement draft sent to consultant.

4 June 1968--Search statement submitted to WESRAC.

5 June 1968--Two research references were forwarded to Problem Originator: (1) AD 828067 "Cartographic Production Equipment Handbook" and (2) AD 828750L "Mono Versus Stereo Analytical Photogrammetry, Part 2".

26 June 1968--Search results forwarded to Problem Originator.

26 June 1968--During a visit by L. S. Berger and A. G. Buck, Problem Originator stated that TB67-10114 appears to be applicable to the problem and will be investigated in the future as staffing becomes available.

(15) NWR-2

TITLE: Pressure Measurement to Aid Prevention of New Decubitus Ulcers (Processing is coordinated with RNV-5)

SOURCE: A. W. Guy, Ph. D.
Assistant Professor
Department of Physical Medicine & Rehabilitation
University of Washington

DATE SUBMITTED: 17 April 1968

The development of decubitus ulcers in patients on rehabilitation programs is an extremely costly event in the patient's progress toward his maximum functional level. This occurs primarily in patients with sensory loss, when an area of tissue is subjected to prolonged application of pressure which exceeds the pressures within the tissue's capillary bed, and necrosis of that tissue ensues. Many means of relieving the forces involved are employed in the clinical situation with marginal and varying degrees of success. A means of measuring the pressure distributions developed between the "relieving" devices and the patient would allow evaluation of and/or a basis for further development of such apparatus.

INITIAL DISPOSITION:

A carefully screened excerpt of previously performed searches on pressure transducers was sent to Dr. Guy for review (22 April). In addition, the West Coast Consultant has begun an investigation of technology developed at Ames Research Center and of other NASA generated technology with which the Consultant is personally familiar. He is also investigating commercial sequential pressure scanners.

COMMUNICATIONS:

23 April 1968--Search results from previously performed literature screened.

24 May 1968--Mr. A. G. Buck wrote letter of report to Problem Originator describing a proposed measurement system using NASA technology and "Scanivalve" commercial equipment. Plans are being made to build up a prototype system and furnish this to the Problem Originator.

7 June 1968--During a visit to NASA ERC, Cambridge, by L. Berger, tunnel diode transducers developed by Dr. W. Rindner and Dr. A. Garfein were discussed in terms of their possible usefulness to this problem. A reprint of a descriptive article, "Miniature Tunnel Diode Transducers" from Solid State Electronics, Pergamon Press, 1967, Vol 10, pp 1227-8, was obtained and forwarded to Problem Originator.

26 June 1968--A. G. Buck and L. S. Berger visited with Problem Originator. Originator requested that technological descriptive material

("Scanivalve") be sent to him so that he can evaluate the technical stability and estimate the staffing requirements. He will review the furnished search results in detail, and, as an initial reaction, feels that the search material is quite useful, appropriate, and novel. He also intends to follow up on the tunnel diode transducers at ERC.

(16) NWR-3

TITLE: Parameters for Telemetry Systems

SOURCE: A. W. Guy, Ph. D.
Assistant Professor
Department of Physical Medicine & Rehabilitation
University of Washington

DATE SUBMITTED: 17 April 1968

There is a need for lightweight telemetry transmitter and antenna systems that can be worn by a human subject while he is engaged in normal activities. The system is required to transmit physiological information concerning the subject to a central monitoring location in a large medical center. The frequency, power, and antenna gain should be such that the system is operable, regardless of the location of the subject and monitor, within the confines of the medical center.

INITIAL DISPOSITION:

Utilization of Consultant's knowledge of relevant NASA research. Reports were furnished to Problem Originator 29 March and 17 June.

COMMUNICATIONS:

17 June 1968--Consultant reported that the information which he furnished to the Problem Originator appears to satisfactorily solve the problem. Documentation of the transfer is being prepared. This case is considered a completed transfer and closed out.

26 June 1968--Problem Originator edited and approved the transfer report during a visit to Seattle by L. S. Berger and A. G. Buck.

(17) SFM-1

TITLE: Automatic EKG Time-Interval Measurement

SOURCE: Robert E. Stenson, M. D.
Cardiology Division
Stanford University School of Medicine

DATE SUBMITTED: 16 April 1968

For detection of certain pathologic conditions, time correlations between EKG and cardiovascular pressure waves at various sites are desired. A computer program to augment the above is sought.

INITIAL DISPOSITION:

Search request was submitted to WESRAC after several available reference documents were forwarded by Mr. St. Claire to the Problem Originator. Problem was combined with SFM-2.

COMMUNICATIONS:

24 April 1968--Mr. F. L. St. Claire wrote letter to Originator in inquiry of the capability of the Stanford Medical School staff in the fields of electronics, computer programs and languages, and mathematical analysis.

13 May 1968--F. L. St. Claire received an answer from Dr. Stenson, who requested a close adherence to strictly biomedical technology.

21 May 1968--Mr. St. Claire requested from Research Triangle Institute (E. Harrison) information packet concerning their problem DU-25, as it shows promise of being helpful to Dr. Stenson.

22 May 1968--F. L. St. Claire sent applicable search results from previously performed searches to A. G. Buck for forwarding to Dr. Stenson.

4 June 1968--Mr. A. G. Buck relayed material of 22 May to Problem Originator after having added some documents of his own.

21 June 1968--F. L. St. Claire received, via E. Harrison, Research Triangle Institute, backup information on DU-25. Although after review the material appeared to be of little value to Dr. Stenson, it was nevertheless forwarded to the Problem Originator via L. Berger on his trip of 24 June 1968 to the West Coast.

28 June 1968--Problem Originator was visited by A. G. Buck and L. S. Berger. They discussed technical details of the problem. A telephone conference will be arranged with specialists at SwRI to plan the next step in attacking this problem.

(18) SFM-2

TITLE: Automatic Techniques for Smoothing Blood Pressure Waveforms

SOURCE: Robert E. Stenson, M. D.
Cardiology Division
Stanford University School of Medicine

DATE SUBMITTED: 16 April 1968

In order to use blood pressure waves for diagnostic testing through a computer, artifacts and noise which would confuse the computer logic must be eliminated. Automatic artifact rejection and waveform smoothing are therefore desired.

INITIAL DISPOSITION:

Search request was submitted to WESRAC after several available reference documents were forwarded by Mr. St. Claire to the Problem Originator. Problem was combined with SFM-1.

COMMUNICATIONS:

24 April 1968--Mr. F. L. St. Claire wrote letter to Originator in inquiry of the capability of the Stanford Medical School staff in the fields of electronics, computer programs and languages, and mathematical analysis.

13 May 1968--F. L. St. Claire received an answer from Dr. Stenson, who requested a close adherence to strictly biomedical technology.

21 May 1968--Mr. St. Claire requested from Research Triangle Institute (E. Harrison) information packet concerning their problem DU-25, as it shows promise of being helpful to Dr. Stenson.

22 May 1968--F. L. St. Claire sent applicable search results from previously performed searches to A. G. Buck for forwarding to Dr. Stenson.

4 June 1968--Mr. A. G. Buck relayed material of 22 May to Problem Originator after having added some documents of his own.

21 June 1968--F. L. St. Claire received, via E. Harrison, Research Triangle Institute, backup information on DU-25. Although the material appeared to be not directly related to Dr. Stenson's problem, it was nevertheless forwarded to the Problem Originator via L. Berger on his trip of 24 June 1968 to the West Coast.

28 June 1968--Problem Originator was visited by A. G. Buck and L. S. Berger. They discussed technical details of the problem. A telephone conference will be arranged with specialists at SwRI to plan the next step in attacking this problem.

(19) GLM-17

TITLE: Respiratory Gases Measurements

SOURCE: Quang X. Nguiem, M.D.
The University of Texas Medical School, Galveston

DATE SUBMITTED: 9 April 1968

Measurement of respiratory gases.

INITIAL DISPOSITION:

After exploring the qualities and specifications of certain commercially available gas measurement devices, it was decided that a search request was in order.

COMMUNICATIONS:

15 April 1968--R. J. Crosby and F. L. St. Claire are jointly undertaking to write a search request.

15 April 1968--Mr. R. J. Crosby called Mr. Gruben, the "Westinghouse" representative in Dallas, about their fuel-cell-type oxygen detector. He sent us descriptive literature, and it appears likely that the system would be suitable for breath-by-breath O_2 analysis in noncombustible atmospheres. Started writing search request for gas sensors.

22 April 1968--Literature on "Westinghouse Oxygen Analyzer" received.

24 April 1968--Results of investigation of NASA sponsored gas sensor technology was forwarded to Problem Originator. The status of research was established in part by conversation with Mr. John T. Wheeler, TUO, Manned Spacecraft Center, on 11 April 1968, which resulted in further discussions with staff members at Manned Spacecraft Center and engineers at Perkin-Elmer Company, and in part from knowledge of the NASA sponsored research project in the subject area which is currently being undertaken at Southwest Research Institute.

1 May 1968--Search request and cover letter sent to WESRAC.

1 May 1968--Problem Originator was interviewed by one of the preparers of the search statement (Mr. R. J. Crosby). The Problem Originator approved the search approach, and formulation and was sent a copy of the search statement for his records. A visit to Galveston was tentatively scheduled for 16 May 1968 by Mr. Crosby to continue discussion of the problem submission.

16 May 1968--Search results returned from search center; given to Mr. R. J. Crosby for screening and evaluation.

16 May 1968--Mr. C. J. Laenger, Sr. and Mr. R. J. Crosby visited Problem Originator and Consultant and discussed the different approaches which might be taken to problem solutions. As a result of the discussion, information on hot wire anemometers, EKG electrodes, and Perkin-Elmer technology was promised to the Problem Originator.

22 May 1968--Screened search results forwarded to Problem Originator.

22 May 1968--Mr. A. G. Buck met with various staff scientists and Technology Utilization Officials of Ames Research Center and with Mr. Peter Shipma of IITRI to investigate possibilities of using systems developed for smell analysis and fire protection work technology to the submitted problem. The system is physically quite bulky, taking up one average-size room and costing about $80,000. A lighter weight, less expensive system which might be adequate for the analysis of lighter molecular weight gases may be derivable from the Ames Technology.

5 June 1968--Mr. A. G. Buck furnished an evaluation report based on his interviews with NASA Ames staff members. His recommendation was to consider using commercial (Bendix MA-1 "Time of Flight Mass Spectrometer") equipment, and he forwarded descriptive literature for Problem Originator's consideration.

7 June 1968--During a visit to NASA ERC, Cambridge, Messrs. A. Lavery and L. E. Long displayed to L. Berger a thermistor breath sensor/recorder which may be of potential interest to this problem. Written documentation will be requested through Mr. Dennison's office and forwarded to the Problem Originator.

24 June 1968--Search Appraisal Forms sent to Problem Originator.

(20) PLR-1

TITLE: Measurement of Outer and Inner Diameters of Blood Vessels (Transcutaneous)

SOURCE: Alvin H. Sacks, Ph. D.
Bioengineering and Physiology Division
Palo Alto Medical Research Foundation

DATE SUBMITTED: 3 April 1968

The need exists for improved clinical assessment of sclerotic conditions in blood vessels. One possible avenue is accurate measurement of inner and outer diameters of blood vessels. A technique is sought.

INITIAL DISPOSITION:

Correspondence for classification of problem and determination of the physical and technical capabilities of the Palo Alto Medical Research Center was initiated by C. J. Laenger, Sr. Preparation of a search statement is being considered.

COMMUNICATIONS:

23 April 1968--Mr. C. J. Laenger, Sr., sent letter of inquiry to Problem Originator, requesting data about definition required, availability of equipment funds, applicability of catheter-tip scanning technology, and a request for a description of available staff and facilities that could be devoted to the fabrication of electronics circuitry.

22 May 1968--Problem Originator was sent a detailed letter of technical evaluation of the submitted problem, prepared by Mr. C. J. Laenger, Sr. Suggestions about organizing a literature search were also included.

(21) PLR-2

TITLE: Measurement of Surface Kinematics of Canine Heart

SOURCE: Neal B. Ingels, Ph. D.
Palo Alto Medical Research Foundation

DATE SUBMITTED: 8 April 1968

Techniques and concepts are sought for remote, essentially non-contacting means of measuring the kinematics of body surfaces; specifically the canine open-heart surface. Low inertia markers or similar mechanisms may be placed on the body surfaces. It is desired that the motion of the body surface be measured accurately and the data be processed automatically in order to obtain a complete space-time history of selected locations on the body surface. The proposed methods must not be destructive nor damaging to living tissues.

INITIAL DISPOSITION:

Computer search jointly with the functionally very similar problem, NWR-1, "Motion Pattern Measurement of Patients."

COMMUNICATIONS:

15 April 1968--Problem Statement presented to Dr. Gerald Gardner for consultation in search description preparation.

23 May 1968--Search statement draft sent to Consultant.

4 June 1968--Search statement submitted to WESRAC.

5 June 1968--Two research references were forwarded to Problem Originator: AD 828067, "Cartographic Production Equipment Handbook" and AD 828750L, "Mono Versus Stereo Analytical Photogrammetry, Part 2."

28 June 1968--L. S. Berger and A. G. Buck visited with the Problem Originator and transmitted the search results to him. His original estimate was that the search results appeared relevant and interesting.

III. BIOMEDICAL PROBLEMS

III. BIOMEDICAL PROBLEMS

A. Problem List and Status Summary

No.	Title	Status
Texas Institute for Rehabilitation and Research		
HUV-1	Reduced Workload Environment for Physically Handicapped Patients	Phase 1 and Phase 2, actual transfer; equipment is now sought.
HUV-2	Advanced Computer Display and Interface Technology	Inactive, no new information.
HUV-3	Computer Scheduling Techniques	Solution to staffing problem is being sought.
HUV-4	Heart Sounds, Interval Analysis	Second search results are being evaluated.
HUV-5	End Tidal Air Sampler	Inactive, no new information.
HUV-6	Ambulation Aid	Problem Abstract disseminated.
HUV-7	Scheduling for Ward Patients	Solution to staffing problem is being sought.
HUV-8	Mechanisms of Onset of Orthostatic Hypotension	Completed, now inactive.
HUV-9	Prosthetic Materials for Urinary Tract	Staff consultation planned with Biomedical Application Team specialist.

No.	Title	Status
HUV-10	Instrumented Prosthetic Leg	The original, very broad problem has been placed on the inactive list; the project has been funded. Audio-visual problem abstract produced; technology tentatively identified.
HUV-11	Improved Gas Sample Flow Control and Measurement	Inactive, no new information.
HUV-12	Special Automobile Modifications for Disabled Persons	Inactive, no new information.
HUV-13	Human Transfer Function Measurements	Solution to staffing problem is being sought.
HUV-14	Physical Space Utilization	Transfer in progress.
HUV-15	Advanced Computer Terminal and Display Technology	Closed out; inactive.
HUV-16	Novel Joint Design Applied to Assistive Devices for Human Limbs	Transfer in progress.
Rice University		
RCU-1	"Artificial Heart" Control System Technology	This problem has been combined with BLM-4.
Veterans Administration Southern Research Support Center		
SRS-1	Indirect Measurement of Blood Pressure During Rest and Exercise on Arms and Legs	Periodic literature review is requested.
SRS-2	Catheter-Tip Transducer for Blood Pressure and Flow Measurement	Periodic literature review is requested.
SRS-3	Locating Tip of Stomach Tube	Inactive; no new information.

No.	Title	Status
SRS-4	Materials Suitable for Dry Electrode Fabrication	Periodic literature review is requested.
SRS-5	Temperature Regulatory Mechanisms of the Body	Periodic literature review is requested.
SRS-6	Investigations of Cutaneous Stimuli	Closed out; actual transfer.
SRS-7	Acoustic Pest Control Technology	Inactive.
Baylor University Medical School		
BLM-1	Noiseless Gas Valves for "Artificial Heart" Use	Closed out.
BLM-2	Support Slings for Postoperative Care of Large Animals	Closed out.
BLM-3	Triggering on R Wave of ECG	Actual transfer.
BLM-4	Valve for Proportional Gas Flow Control	Technology tentatively identified.
BLM-5	Transthoracic Energy Coupling Devices	No new information.
BLM-6	Biocompatible Spray-On Plastics, Impermeable to Bacteria	Technology is being evaluated by Problem Originator.
BLM-7	Telemetry of Cardiovascular Data from Free-Ranging Animals	Contractor has been informed of search results.
BLM-8	Miniature Tape Recorder for Biological Data	Technology tentatively identified--unable to obtain prototype for evaluation.

No.	Title	Status
BLM-9	Cyclic Variation of Body Temperature in Mammals	Information has been furnished to Problem Originator. Application of this information as yet unspecified.
The University of Texas Medical Branch, Galveston		
GLM-1	Analysis of Transitional Flow-Convection/Diffusion	Transfer accomplished; problem closed out.
GLM-2	Monitoring of Blood Pressure by Extravascular Sensor, Using Wireless Telemetry of Information	Inactive; information transfer still operative.
GLM-3	Determination of Local Blood Flow, Blood Gas Concentration, and Blood pH in Small Portion of an Organ	Actual transfer.
GLM-4	Implanted Blood Pressure Transducer	Technology being evaluated by Problem Originator.
GLM-5	Chronic Intracranial Pressure Measurement in Man	Technology being evaluated by Problem Originator.
GLM-6	A Model Vascular System	Reference documents are being evaluated.
GLM-7	Viscosity Measurement of Minute Samples of Blood	Reference documents evaluated; possible Problem Abstract.
GLM-8	Computer Program for Electroencephalograph: Period Analysis	Reference documents are being evaluated.
GLM-9	Measurement of Local Tissue Oxygen Consumption, In Vivo	Actual transfer.
GLM-10	Computer Program for Flame Spectrophotometry	Technology tentatively identified; Problem Abstract drafted.

No.	Title	Status
GLM-11	Elimination of Electrostatic Charge in Experimental Animals	Closed out; actual transfer.
GLM-12	Computer Selection and Elimination of Artifacts	Reference documents are being evaluated.
GLM-13	Multiple Cospectral Density Analysis of Time-Series Data	Problem Abstract disseminated, possible transfer being evaluated.
GLM-14	Repetitive Measurement of Kidney Mass in Intact Animal	References being evaluated by Problem Originator.
GLM-15	Respiration Volume and Rate Measurements in Unencumbered (Free) Child	Problem Originator evaluating reference material.
GLM-16	In-Situ Tumor Mass Determination on Rat Leg	Meeting held for researcher and Biomedical Application Team members; search statement drafted.
GLM-17	Respiratory Gases Measurement	References being evaluated by Problem Originator.
Wilford Hall USAF Hospital		
WLH-1	Blood Recirculation Technology	References being evaluated by Problem Originator.
Palo Alto Medical Research Center		
PLR-1	Measurement of Outer and Inner Diameter of Blood Vessels	Problem under study; possible search request.

No.	Title	Status
PLR-2	Surface Movement	Search results forwarded to Problem Originator.
University of Washington Medical School		
WSM-1	Ultrasonic Coupling Techniques	Search results being evaluated by Problem Originator.
WSM-2	Atherosclerotic Lesion Detection	Search request sent to NASA data bank.
WSM-3	Infrared Irradiation of Skin Surface	Search request sent to NASA data bank.
WSM-4	Simultaneous Multistress Effects on the Cardiovascular System	Actual transfer; closed out.
Stanford University Medical School		
SFM-1	Automatic EKG-Time Interval Measurement	References being evaluated by Problem Originator.
SFM-2	Automatic Techniques for Smoothing Blood Pressure Waveforms	References being evaluated by Problem Originator.
Northwest Handicapped Center		
NWR-1	Motion Pattern Measurement of Patients	Search results submitted to Problem Originator.
NWR-2	Pressure Measurement to Aid Prevention of New Decubitus Ulcers	Transfer in progress.
NWR-3	Parameters for Telemetry Systems	Actual transfer; closed out.

No.	Title	Status
Rancho Los Amigos Hospital		
RNV-1	Efficient Electromagnetic Power Transmission Through Living Tissue	Search request drafted.
RNV-2	Design of Implanted Antennas	Search request drafted.
RNV-3	Electrode Wires for Implantation	Search request forwarded.
RNV-4	Optimum Neurologic Electrodes	Search request submitted.
RNV-5	Pressure Measurement to Aid Prevention of New Decubitus Ulcers	Combined with NWR-2; transfer in progress.
RNV-6	Integral Impedance Matching, Impedance Transformation, and Signal Conditioning at the Transducer	Search request drafted.
RNV-7	Shielded Rooms for Physiological Studies	Specialist in field under consultation; search request drafted.
RNV-8	Surface Biopotential Electrodes (EMG, EEG, ECG, ...)	Search request drafted.
RNV-9	Shielding Techniques for Active Surface Biopotential Electrodes	Search request drafted.
The University of Texas Medical School at San Antonio		
SNM-1	Enhancement of X-Ray Contrast Study Films	Enhancement procedure has not yet been successful.

B. Problem Case Histories Status

HUV-1 REDUCED WORKLOAD ENVIRONMENT FOR PHYSICALLY HANDICAPPED PATIENTS

Communications

4 April 1968--In response to an inquiry from Texas Institute for Rehabilitation and Research workers, Mr. Dave Bendersky, Midwest Research Institute, was telephoned to obtain information on helmet respiratory gases collecting scheme and triaxial accelerometer availability. The information obtained was forwarded to the requesting researchers.

22 April 1968--Search results returned from KASCenter.

23 April 1968--Information on "Westinghouse Oxygen Analyzer" received.

30 April 1968--Final arrangements for preparation of video tape version of new Problem Statement/Problem Abstract were made by telephone call to Consultant. A trip is planned for 8 May 1968, for a team member to assist in the tape preparation and editing.

8 May 1968--Screened search results were delivered to Problem Originator during Mr. R. J. Crosby's site visit.

15 May 1968--Mr. R. J. Crosby received, during a visit to Texas Institute for Rehabilitation and Research, a list of 13 references which the Problem Originator requested in connection with the search results.

21 May 1968--Mr. R. J. Crosby obtained information from the Texas State Agency for Surplus Property on procuring some reduced gravity simulator hardware, and he forwarded this information by telephone to the Problem Originator.

24 June 1968--Search Appraisal forms sent to Problem Originator.

HUV-9 PROSTHETIC MATERIALS FOR URINARY TRACT

Communications

28 February 1968--Problem Originator was contacted by telephone and advised that visit by physical chemist to Houston is being planned.

13 March 1968--Unscreened copy of search sent to Research Triangle Institute.

15 May 1968--Dr. Ware called Dr. Scott (who was not in his office) and left word that a conference concerning this problem would be sought toward the end of the week of 20 May 1968.

HUV-10 INSTRUMENTED PROSTHETIC LEG

Communications

29 April 1968--Unscreened search results from previously performed searches on pressure transducer technology, and NASA Tech Brief 67-10664 "Pneumatic Pressure Wave Generator Provides Economical Simple Testing of Pressure Transducers," was sent to Consultant.

28 May 1968--L. Berger called Dr. C. Lombard at Northrop to check on availability of a microsphere mattress sample for evaluation. Dr. Lombard stated that he is sending a sample for evaluation purposes immediately.

7 June 1968--During a visit to NASA ERC, Cambridge, by L. Berger, tunnel diode transducers developed by Dr. W. Rindner and Dr. A. Garfein were discussed in terms of their possible usefulness to this problem. A reprint of a descriptive article, "Miniature Tunnel Diode Transducers" from Solid State Electronics, Pergamon Press, 1967, Vol. 10, pp. 1227-8, was obtained and forwarded to Problem Originator.

18 June 1968--Researchers at Northrop were sent a request for prototype loan which had been scheduled for immediate delivery in past telephone conversations of 1 April and 28 May 1968.

24 June 1968--Sample cushion furnished by Dr. Lombard for evaluation.

HUV-16 NOVEL JOINT DESIGN APPLIED TO ASSISTIVE DEVICES FOR HUMAN LIMBS

Communications

23 May 1968--NASA SP 5047, Technology Survey on Teleoperators and Human Augmentation, forwarded to Problem Originator.

SRS-6 INVESTIGATIONS OF CUTANEOUS STIMULI

Communications

2 May 1968--Mr. C. J. Laenger, Sr. wrote to Problem Originator to ascertain use made of references furnished. A survey paper was in preparation by Problem Originator, utilizing references furnished by the Applications Program.

14 May 1968--Letter was received from Problem Originator. The literature survey article, giving over 80 citations, using the reference material furnished by the program, titled "Electrical Stimulation of Sensory Nerves with Skin Electrodes for Research Diagnosis Communication and Behavioral Conditioning: A Survey," has been submitted for publication to Medical and Biological Engineering.

BLM-4 VALVE FOR PROPORTIONAL GAS FLOW CONTROL

Communications

15 May 1968--Mr. Michael J. Crosby, Aerospace Engineer, Lewis Research Center, sent Problem Originator detailed fabrication drawings of the pneumatic servo-valve developed for artificial ventricles. Included in the materials furnished to the Problem Originator were photographs of the servo-valve as used in the artificial heart control system developed at Lewis for Dr. Kolff.

GLM-4 IMPLANTED BLOOD PRESSURE TRANSDUCER

Communications

7 June 1968--During a visit to NASA ERC, Cambridge, by L. Berger, tunnel diode transducers developed by Dr. W. Rindner and Dr. A. Garfein were discussed in terms of their possible usefulness to this problem. A reprint of the descriptive article, "Miniature Tunnel Diode Transducers" from Solid State Electronics, Pergamon Press, 1967, Vol. 10, pp. 1227-8, was obtained and forwarded to Problem Originator.

GLM-5 CHRONIC INTRACRANIAL PRESSURE MEASUREMENT IN MAN

Communications

7 June 1968--During a visit to NASA ERC, Cambridge, by L. Berger, tunnel diode transducers developed by Dr. W. Rindner and Dr. A. Garfein

were discussed in terms of their possible usefulness to this problem. A reprint of a descriptive article, "Miniature Tunnel Diode Transducers" from Solid State Electronics, Pergamon Press, 1967, Vol. 10, pp. 1227-8, were obtained and forwarded to Problem Originator.

GLM-7 VISCOSITY MEASUREMENT OF MINUTE SAMPLES OF BLOOD

Communications

3 May 1968--A reference from Excerpta Medica, Section 27, Vol. 2, No. 3, March 1968, p. 103: Reference 819, "A Viscometer for the Study of Blood," Evans, A.; J.P.A. Weaver; and D. N. Walter, Department of Surgery, University of Newcastle Upon Tyne, Biorheology, 1967, was forwarded to Problem Originator.

14 May 1968--Backup package on NASA Tech Brief 67-10041 (Viscosity Measurement Using Instrumented Parallel Plate System) received from Jet Propulsion Laboratory, Mr. L. S. Doubt, TU representative.

16 May 1968--Mr. C. J. Laenger, Sr., and R. J. Crosby visited Problem Originator and obtained his evaluation of literature references. These appear to have been of very limited usefulness and a Problem Abstract preparation is contemplated.

GLM-10 COMPUTER PROGRAM FOR FLAME SPECTROPHOTOMETRY

Communications

25 March 1968--Problem Abstract draft sent to NASA headquarters for approval.

15 April 1968--SwRI received abstracts of COSMIC programs MFS-12878 and COS-10017L from Robert B. Smith. The programs will require some adaptation to make them useful for analyzing flame photometer results.

16 May 1968--Mr. R. J. Crosby and C. J. Laenger, Sr. met with Problem Originator and discussed Dr. Gardner's letter. Several questions were raised by the Problem Originator for which the team members will obtain answers and then forward them to Dr. Rudenberg.

22 May 1968--Mr. R. J. Crosby sent Problem Originator the requested letter of clarification regarding mathematical notations.

GLM-12 COMPUTER SELECTION AND ELIMINATION OF ARTIFACTS

Communications

16 May 1968--Mr. C. J. Laenger, Sr. and Mr. R. J. Crosby visited Problem Originator and advised the Problem Originator of the new TIME DATA 100 Hybrid Computer which seems ideally suited for purposes of this problem. Manufacturing information will be furnished to the Problem Originator.

GLM-13 MULTIPLE COSPECTRAL DENSITY ANALYSIS TIME-SERIES DATA

Communications

25 April 1968--Response to problem abstract received from Mr. Floyd S. Shipman through Mr. John Samos' office, Langley Research Center. This suggestion was forwarded to Problem Originator.

GLM-15 RESPIRATION VOLUME AND RATE MEASUREMENTS IN UNENCUMBERED (FREE) CHILD

Communications

14 June 1968--During a visit by L. Berger to NASA ERC, two members of Dr. William Leavitt's staff (Mr. Lavery and Mr. Long) demonstrated a thermistor bridge device which appears suitable, perhaps after minor modification, to the posed problem. A letter was written to both Dr. Leavitt and Mr. Jim Dennison, TUO, at ERC, describing Problem GLM-15 and requesting material on the technology so that the Problem Originator could become acquainted with the NASA sensor development.

GLM-16 IN-SITU TUMOR MASS DETERMINATION ON RAT LEG

Communications

4 April 1968--Problem Originator was contacted by Mr. Wray Fogwell and a visit to SwRI was arranged for Problem Originator and one of his assistants for 8 April 1968. Application of aerospace sponsored technology to this problem will be discussed at that time.

RCU-1 "ARTIFICIAL HEART" CONTROL SYSTEM TECHNOLOGY

21 June 1968--Response from Lewis Research Center to Problem Abstract evaluated by Problem Originator. It is too soon for a final evaluation, but the initial estimate is that the technology may be of considerable help.

C. Transfer Summaries

Outline Used:

TRANSFER IDENTIFICATION (TITLE)

1. THE PROBLEM
   a. Statement
   b. Source: Institution/Investigator
2. TRANSFER STATUS
3. SOLUTION
   a. Synopsis
   b. Method by Which Identified
   c. NASA Source (Program/Field Center)
4. ESTIMATE OF BENEFITS AND COSTS
   a. Actual Costs
   b. Potential Benefits
   c. Cost of Solving/Saving (To Investigator)
5. PROGNOSIS/OTHER RELEVANT INFORMATION

RNV-5A

PRESSURE MEASUREMENTS TO AID PREVENTION OF DECUBITUS ULCERS (STATIC CASE)

1. a. Patients confined to a sitting position in a wheel chair develop ulcers very likely as a result of unit overpressure for long-term periods. The curing of this condition is an unpleasant and unhappy experience for the patient, and it is quite expensive. Since all patients are different, what is needed is an economical procedure with which to take a pressure profile reading of the sitting surfaces. Apparently this has not been done effectively, if at all. With such knowledge of the pressure distribution, it should be possible to economically construct a seat-pad so contoured as to provide uniform pressures throughout the sitting area and thus prevent the localized overpressure conditions.

b. Rancho Los Amigos Hospital/Dr. Shannon Stauffer.

2. The required technology, design suggestions, and loan arrangements required have been completed.

3. a. The problem of measuring, economically, many pressures (literally numbered in the hundreds) involved herein is akin to the problem of measuring local pressures about a wind-tunnel model under stress. Consequently, conferences at which a dozen potential solutions (proprietary to NASA) were discussed and considered were held with both dynamicists and instrumentation experts at the Ames Research Center. To solve the problem rapidly, the decision was to use existing techniques; to keep the solution economical, the decision was to try to use Ames's recommended commercial products. In brief, the patient will sit upon a quilted pad, each "quilt" being a miniaturized air cushion, and each connected by a miniature (0.040" dia) tube to a pressure cell. However, for economy, a commercial product ("Scanivalve") using but one (expensive) pressure cell and a pressure "commutator" for cyclically sampling the many pressures will be employed. Construction of the quilted pad will be done by Rancho Los Amigos. The instrumentation required will be loaned (without cost) from the manufacturer who has become most interested in the humanitarian aspects.

b. Utilization of the West Coast Consultant's knowledge of this problem and of similar problems experienced by NASA.

c. Ames Research Center/Messrs. George Edwards, TUO, who is also an authority on subsonic aerodynamics, and John Dimeff.

4. a. For the first time, Rancho Los Amigos Hospital will have a fully instrumented approach to a problem which has existed for a very long time.

b. Potential benefits are significant. The Medical Director states that the County of Los Angeles sees 200 such cases each year, and that the cost of ulcer correction is about $15,000 per case. This is for just one county of one state, albeit a very large county. The humanitarian and economical potential gain is impressive.

c. Estimated savings to the investigator are two man-years of time.

5. A second phase will most probably deal with a sophisticated approach to seat materials and design.

WSM-4

MULTISTRESS EFFECTS ON THE CARDIOVASCULAR SYSTEM

1. a. Singly imposed stress and its resultant effects on the heart and cardiovascular system have been studied. But what happens when two or more stress elements are simultaneously applied? And what is the separate result as well as the combined result? The experimenters had at their disposal complete inclined-plane treadmills to provide the physical-effort stress and to affect oxygen transport. It was desired to add, under controlled conditions, stress from heat and heat transfer.

b. University of Washington/Drs. Loring Rowell, John Murray.

2. a. Actual Transfer--Conferences with the experimenters indicated that the desire was one of having a lightweight, flexible, heated suit to control skin temperature and thereby control skin blood flow and skin heat transfer for the subject (so as not to interfere with physical movement); thus one could achieve the desired experimental goals. The fact that the "Space Underwear" used by NASA Astronauts in this case can be heated rather than cooled came to mind. Arrangements were made by telephone with NASA-MSFC for the loan of the actual suits. The experiments have been completed, the report is currently being written, and an abstract has been sent to MSFC for critique.

3. a. What was needed in this problem was "hardware." Since a great deal of NASA effort had been expended in the development of the astronaut's apparel, and since such actually existed, it seemed to be correct to go directly from problem to equipment without a search or a development phase.

b. Problem-solution identification was effected by knowledge of the problem from the experimenters and from knowledge of the MSFC program.

c. Manned Spacecraft Center/Mr. Paul Purser.

4. a. Actual benefits to date are that the research program has been expeditiously completed. Experimental design of step changes in skin temperature was achieved. Reports will be available during the current year.

b. Potential benefits are far reaching. Not only has a far better understanding been obtained of the mechanisms involved, but it may be possible to predict (and guard against) results on humans exposed to a hot environment. Whether it be an infantryman or an ordinary car driver is beside the point. Most satisfying is the knowledge that NASA is interested and can use the results produced. This is a good example of a two-way street, i.e., NASA technology helps the biomedical community with a dividend return to NASA.

c. Savings to experimenters:

(1) Approximately one year's time

(2) Avoidance of repeated catheterizations of normal subjects

(3) Avoidance of extensive modification of existing equipment.

NWR-3

OPERATING PARAMETERS FOR LIGHTWEIGHT, EXTENDED RANGE, BIOMEDICAL TELEMETRY SYSTEMS

1. a. The problem requires a lightweight telemeter system to be worn by human subjects to transmit biomedical information. The problem is complicated in that information transmission must be effective over rather large areas in a reinforced concrete building, room-to-room, floor-to-floor, and down corridors at distances of up to 800 feet.

b. Seattle Handicapped Center/Dr. Arthur W. Guy.

2. Actual Transfer--Tests of recommended frequencies and equipments have been made, and have proven satisfactory. The important point was to prove that effective radio transmission in subject environment could be accomplished. This has been done, and the problem is considered solved. The follow-up instrumentation may require further problem consideration.

3. a. NASA had previously made an exhaustive study of effective radio transmission in and through wind tunnel passages and walls, and in and through reinforced concrete multi-story buildings. Technology gained directly helped to answer Dr. Guy's problem.

b. The solution was identified by knowledge of NASA study on the part of the Biomedical Team's Special Consultant. This knowledge was verified by consultation with the NASA Chief Investigator. No report was prepared by NASA on this work.

c. Ames Research Center/Mr. M. S. Nourse, Chief of Research, Electrical Engineering Branch.

4. a. Benefits, to date, of the Ames technology, serve to prove the feasibility of telemeter transmission within the difficult environment with which Dr. Guy must contend. Further, it is established that commercial equipment (for economy) is available. A major road block has been removed; i.e., Dr. Guy can proceed knowing that he will not be stymied by feasibility or excessive cost.

b. It is difficult to predict the potential benefits. However, it is apparent that efficient telemetry will benefit patients recovering from shock, injury, or illness, because they can be instrumented and monitored when they become ambulatory. Their reaction can be compared with norms, and corrective measures can be evaluated.

c. The original 1965 NASA study involved approximately four man-months' time, at GS-13 level. Assuming human efficiency has increased 100% in the interim, a study without NASA assistance may have required two man-months' study.

D. Transfer Status (2 July, 1968)

Actual Transfer	Transfer in Progress	Potential Transfer
HUV-1	BLM-7	GLM-2
SRS-6	HUV-14	GLM-4
BLM-3	HUV-16	GLM-5
BLM-6		GLM-7
GLM-1		GLM-10
GLM-3		GLM-15
GLM-9		BLM-8
GLM-11		HUV-3
SNM-1		HUV-7
WSM-4		NWR-1
NWR-3		NWR-2
RNV-5A		

IV. SUMMARY OF PROJECT ACTIVITIES

IV. SUMMARY OF PROJECT ACTIVITIES

The work performed during this period in connection with previously submitted problems with the specification of newly submitted problems is documented in Sections II and III of this report. Site visits by members of the Application Team, performed in connection with submitted problems, were as follows:

9-11 April 1968: Mr. C. J. Laenger, Sr., and Mr. R. J. Crosby--Texas Institute for Rehabilitation and Research;

11 April 1968: Dr. R. W. Ware and Mr. L. S. Berger--Texas Institute for Rehabilitation and Research;

12 April 1968: Dr. R. W. Ware--Baylor University College of Medicine (Office of Dr. M. DeBakey);

14 April 1968: Dr. R. W. Ware--Medical Research and Operations, NASA Manned Spacecraft Center, Houston;

8 May 1968: Mr. R. J. Crosby--Texas Institute for Rehabilitation and Research;

13 May 1968: Dr. Hartwig and Messrs. Howick, Barnes, Wilson, and Bivins--Southwest Research Institute, Biomedical Application Team;

16 May 1968: Mr. C. J. Laenger, Sr., and Mr. R. J. Crosby--University of Texas Medical Branch at Galveston;

12-18 June 1968: Dr. R. W. Ware--Baylor University College of Medicine. Dr. Ware visited the Baylor University College of Medicine and Methodist Hospital Cardiovascular Research Institute for the purpose of interviewing key personnel of the several Research Task Forces involved in Dr. DeBakey's artificial heart research and development program. Approximately 12 persons were interviewed; interest profile information and specific problems for possible submission were solicited. As agreed during the meeting among Dr. DeBakey, Dr. Hartwig, and Dr. Ware in January 1968, two or three ad hoc Biomedical Application Team members will be called upon to further define specific problems in their areas of speciality.

14 June 1968: Mr. L. S. Berger--Electronics Research Center, NASA Cambridge;

24-28 June 1968: Mr. L. S. Berger and Mr. A. G. Buck--All West Coast institutions and Western Research Application Center (WESRAC).

In addition to conducting business directly related to submitted problems, the above trips routinely included discussion concerning improved procedures, new approaches, and the generation of new problem statement submission. In most instances, briefings of staff members at the participating institutions who had not yet been made thoroughly familiar with the program were included.

Miscellaneous Conferences Attended:

9-11 April 1968: Mr. R. J. Crosby and Mr. C. J. Laenger, Sr. --IEEE National Telemetering Conference, Shamrock Hilton Hotel, Houston;

4-6 June 1968: Dr. R. W. Ware and Mr. L. S. Berger-- TUO Conference, Langley.

With the augmentation of the services of the Biomedical Application Team in the West Coast area by the Special Consultant, Mr. A. G. Buck, a high level of activity was generated in that region. A list of Mr. Buck's site visits follows: The purposes of these trips were, like those of the other members of the team, to provide a catalyst for new approaches and procedures and to accept new problem statement submissions as well as to conduct business on previously submitted problems.

3 April 1968: Ames Research Center;

4 April 1968: Palo Alto Medical Research Foundation and Stanford University School of Medicine;

5 April 1968: Stanford University School of Medicine;

7-9 April 1968: University of Washington Medical School and Northwest Handicapped Center;

10 April 1968: Rancho Los Amigos Hospital;

11 April 1968: Ames Research Center;

24-28 June 1968: With Mr. L. S. Berger to all West Coast user institutions and Western Research Application Center (WESRAC).

V. INSIGHTS INTO THE TRANSFER PROCESS

V. INSIGHTS INTO THE TRANSFER PROCESS

Dr. Ray W. Ware has prepared a paper, "The Insights Into Applying Aerospace Technology to Medical Fields," for presentation to the Third Annual Meeting of the Association for the Advancement of Medical Instrumentation, July 15-18, 1968, Houston, Texas. A draft of this paper is included as Appendix A in this report.

VI. PROJECTIONS FOR THE NEXT QUARTER

VI. PROJECTIONS FOR THE NEXT QUARTER

Project activities for the next quarter will include:

(1) Continuation of routine activities in connection with processing of submitted problems.

(2) Documentation of newly elucidated transfers.

(3) Engineering assistance to Texas Institute for Rehabilitation and Research for the purpose of aiding them in putting into use the lunar gravity simulator technology.

(4) Special visits by ad hoc Team members to the Methodist Hospital/Baylor University College of Medicine Cardiovascular Research Institute to define problems in the following areas:

   (a) Hydrodynamics

   (b) Polymer Chemistry

   (c) Control Systems Engineering.

(5) Participation in the Third Annual Meeting of the Association for the Advancement of Medical Instrumentation, 15-18 July 1968, Houston, Texas. Insights may be taken from the paper prepared on that topic (see Appendix A).

VII. DOCUMENTS FURNISHED TO PROGRAM PARTICIPANTS

Problem No.: HUV-1

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-38794	A Study of Man's Physical Capabilities on the Moon, Vol. 1, Part 1: Lunar Gravity Simulation Facility	15 May 68	22 May 68	12 June 68	12 June 68
A65-24072	Motion Performance of Pressure-Suited Subjects Under Zero and Lunar Gravity Conditions	15 May 68	22 May 68	19 June 68	20 June 68
N66-29207	Comparative Measurements of Man's Walking and Running Gaits in Earth and Simulated Lunar Gravity	15 May 68	22 May 68	12 June 68	12 June 68
A66-11644	Results of Preliminary Physiological Testing Under Simulated Lunar and Martian Gravity Conditions	15 May 68	22 May 68	19 June 68	20 June 68
A67-26922	Metabolic Rates During Lunar Gravity Simulation	15 May 68	22 May 68	19 June 68	20 June 68
A67-16280	Effects of Subgravity Traction Simulation On The Energy Costs of Walking	15 May 68	22 May 68	19 June 68	20 June 68
A67-12393	Man's Lunar Extra Vehicular Capabilities	15 May 68	22 May 68	19 June 68	20 June 68
N65-20613	Force Analysis of Walking at Reduced Gravity	15 May 68	22 May 68	17 June 68	20 June 68
N64-13873	Walking Responses Under Lunar and Low Gravity Conditions	15 May 68	22 May 68	1 July 68	2 July 68
A65-32792	Physiological Aspects of Walking With Partial Lightening of Body Weight and Varying Friction With The Ground	15 May 68	22 May 68	19 June 68	20 June 68

Problem No.: HUV-1

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A65-80131	Human Locomotion in Subgravity	15 May 68	22 May 68	19 June 68	20 June 68
A66-80239	Mechanics of Walking	15 May 68	22 May		
	"Miniature Tunnel Diode Transducers" SOLID-STATE ELECTRONICS, Pergamon Press 1967, Vol. 10, pp 1227-1228 Printed in Great Britain - sent by Mr. Berger to Mr. Canzoneri				20 June 68

Problem No.: HUV-3

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
Two NASA Computer programs, and general instructions on dealing with the COSMIC Center at the University of Georgia:					
MFS-1135	Computer Code for Determining the Transient Behavior of Optimum Inventories (North American Aviation-Rocketdyne)				13 September 67
GSFC-493	SIFT: Semiconductor Information Filing Technique (Booz-Allen).				13 September 67
TB 67-10240	Vis-a-plan Management Technique Provides Performance - Time Scale (also refers to HUV-7).				5 January 68
TB 67-10348	Computerized Parts Lists System Coordinates Engineering Releases, Parts Control, and Manufacturing Planning. (Applies to HUV-7).				5 January 68
TB 67-10510	Probabilistic Approach to Long Range Planning of Manpower.				31 January 68
	Meddars Library Search No. 3-67, Computers in Design of Hospital or Medical Facilities				31 January 68
TB 68-10075	Maintainability Methodology and Maintenance Analyses (Hand-carried by R. J. Crosby to TIRR)				8 May 68

Problem No.: HUV-7

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
TB 68-10075	Maintainability Methodology and Maintenance Analyses (Handcarried by R. J. Crosby to TIRR)				8 May 1968

Problem No.: HUV-10

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
TB 67-10302	Improved Compression Molding Process				19 March 68

Problem No.: HUV-13

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
TB 68-10137	Computer Program Conducts Facilities Utilization and Occupancy Survey				17 June 68
TB 68-10127	Automatic Planning Concept - An Analysis of Optimum Scheduling				17 June 68

Problem No.: HUV-14

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
NPO-10326	"Jet Propulsion Laboratory Facilities Utilization and Occupancy Survey"			6 December 67	
TB 68-10137	Computer Program Conducts Facilities Utilization and Occupancy Survey				17 June 68
TB 68-10127	Automatic Planning Concept -- An Analysis of Optimum Scheduling				17 June 68

Problem No.: GLM-2

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A64-10413	A Simple FM Subcarrier Oscillator Suitable for Physiological Telemetry	Oct. 30, 67	Nov. 2, 67	Dec. 12, 67	Dec. 14, 67
A65-10740	A Miniature Self-Pulsing Oscillator for Biomedical Telemetry	Oct. 30, 67 Reordered-	Nov. 2, 67 June 19, 68	Nov. 30, 67	
A65-25369	A High-Performance Miniature Biopotential Telemetry System	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A66-22298	Microcircuit-Microwatt Design Techniques for New Internal Medical Sensors	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
N63-10152	Techniques of Physiological Monitoring Volume 1. Fundamentals	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N63-15903	A Digital Readout Technic Applicable to Laboratory and Aerospace Medical Monitoring of Physiologic Data	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N63-21498	Biological Telemetering and Space Flight	Oct. 30, 67	Nov. 2, 67	Dec. 27, 67	Jan. 19, 68
N63-21536	The Possibilities of Experimental Evaluation of the Cerebral Blood Supply Under Conditions of an Altered Gravitational Field	Oct. 30. 67	Nov. 2, 67		Jan 22, 68
N64-13722	Internal Four-Channel Physiological Telemetry System Prototype Development	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68
N64-13872	Techniques of Physiological Monitoring. Volume II: Components	Oct. 30, 67 Reordered-	Nov. 2, 67 June 19, 68	Nov. 30, 67	
N64-27314	Biological Passive Telemetry	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68

Problem No.: GLM-2

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N65-16620	A Miniature Self-Pulsing Oscillator for Biomedical Telemetry	Oct. 30, 67	Nov. 2, 67		
N65-14491	Techniques of Physiological Monitoring Volume III: Systems	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 4, 68
N65-17230	Validation of the Aerospace Medical Research Laboratories 3-Channel Personal Telemetry System	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 7, 68
N65-25270	Bibliography on Biosensors. A Sampling of the World Literature 1960-1964. Volume III	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N66-19635	External Bioelectrodes: A Battery Substitute for Biological Telemetry Systems	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 7, 68
N66-24548	State-Of-The-Art Biological Data Handbook	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N66-35021	Neurophysiological and Behavioral Studies of Chimpanzees	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N66-36280	Pacific Northwest Laboratory Annual Report for 1965 in the Physical Sciences. Volume 4: Instrumentation	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N67-19417	Research on Microminiature Passive Telemetry for Biological Measurements	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
A64-24231	Transducers for Measurement, Part 1. Introduction and Theory of Pressure Measurement	Jan. 22, 68	Jan. 24, 68	Mar. 18, 68	Mar. 19, 68

Problem No.: GLM-2

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A64-25773	Trans. for Measurement, Part II. Devices for Measuring Pressure	Jan. 22, 68	Jan. 24, 68	Mar. 18, 68	Mar. 19, 68
A63-10606	Automatic Blood Pressure Indicator	Jan. 22, 68	Jan. 24, 68	Mar. 18, 68	Mar. 19, 68
A66-38797	A Miniature Pressure Transducer	Jan. 22, 68	Jan. 24, 68	Mar. 1, 68	
A67-11102	A Precision Capacitive Pressure Transducer Suitable for Airborne Applications	Jan. 22, 68	Jan. 24, 68	Mar. 12, 68	Mar. 14, 68
N65-16623		Jan. 22, 68	Jan. 24, 68	Mar. 1, 68	

Problem No.: GLM-2

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
These references were obtained by the problem originator:					
A65-81057	A Progress Report on Radio Telemetry From Inside the Body				
A66-81864	Telemetry of Blood Pressure in Free-Ranging Animals via an Intravascular Gauge				
A65-33281	Biomedical Instrumentation in Space Medicine				
A66-39797	In Vivo Experiments with the Bioelectric Potentials				
A67-26171	Implant Biotelemetry and Microelectronics				
N63-22980	Development of Telemetry Devices for Dental Research				
A64-80537	Utilization of Bioelectricity as Power Supply for Implanted Electronic Devices				
A65-81054	The Artifact Problem in Telemetry of Physiological Variables				

Problem No.: GLM-3

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	A reference cited in Midwest Research Institute's current quarterly report in connection with their problem KU-3 seems applicable to GLM-3, and accordingly was forwarded to Problem Originator: "Blood Gases: Continuous in Vivo Recording of Partial Pressure by Mass Spectrograph," S. Woldring, G. Owens and D. C. Woolford, Science, August 1967, pp. 885-887.				5 September 67
TTF-492	Problems in Space Biology on cerebral blood volume; Vol 5 requested from SwRI 18 March 1968 - (also applies to GLM-5).				3 April 68

Problem No.: GLM-4

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	"Miniature Tunnel Diode Transducers" Solid State Electronics, Pergamon Press 1967, Vol. 10, pp. 1227-1228, (Great Britain).				20 June 68

Problem No.: GLM-5

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	A Miniature Pressure Transducer, Massey, B. S., and Kavrak, I., J. Scie. Instrum, 1966 Vol. 43, p. 569 ff. This paper was cited as a reference for problem KU-26, "Chronic Intracranial Pressure Measurement," in Midwest Research Institute's Quarterly Rept. No. 2, 1 August - 30 October 1967, p. 4 (Ref. 11).				27 November 1967
TTF-492	Problems in Space Biology - on cerebral blood volume; Vol. 5 requested from SwRI 18 March 1968 (also applies to GLM-3).				3 April 1968
	"Miniature Tunnel Diode Transducers," Solid State Electronics, Pergamon Press, 1967 Vol. 10, pp. 1227-1228, (Great Britain).				20 June 1968

Problem No.: GLM-6

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-35027	Velocity and Pressure Measurements of Pulsating Flow in a Flexible Tube	Oct., 67	Mar. 19, 68		
N67-14572	(NASA-CR-80888) Proceedings of the Fourth International Congress on Rheology Part 4. Symposium on Biorheology	Oct., 67	Mar. 19, 68	Nov. 30, 67	Mar. 19, 68
PB 175 719	Final Report on the Mock Circulatory System Life Sciences Division, Hydrospace Research Corporation, April 1967. Sent at Dr. Ware's suggestion.				Feb. 20, 68

Problem No.: GLM-7

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A64-11980	Viscosity of Liquid He II	Oct. 30, 67	Nov. 2, 67	Dec. 13, 67	Jan. 19, 68
A66-12519	The Vibration Method of Measuring The Viscosity of Liquids	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A66-21885	Cone-and-Plate Viscometry-Explicit Formulae for Shear Stress and Shear Rate and The Determination of Inelastic Thixotropic Properties	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 20, 68
N63-20408	NBS Viscometer Calibrating Liquids and Capillary Tube Viscometers	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	May 1, 1968
N64-19041	Microdetermination of The Viscosity of Polyphenyls	Oct. 30, 67	Nov. 2, 67	Feb. 2, 68	Feb. 2, 68
N66-11514	Method of Measuring the Viscosity of Fluids	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 1, 68
N66-11860	A Detailed Procedure for Determining Intrinsic Viscosities of Polymer Solutions	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 1, 68
N67-14465	Some Flow Properties of Blood	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68
N67-14493	A Shear Creep Viscometer for Rheological Studies of Polymers	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
27 July	Problem originator was given Tech Brief 66-10539, "Computer Programs Perform Spectral Analysis of up to Seven Times Series." Additional backup information requested from Marshall Space Flight Center.				20 June 1967
MFS-0723	RAVAN: Random Vibrations Analysis Program, Marshall Space Flight Center - Computation Laboratory.				13 September 1967
MFS-12870	VITRAN: Vibration Transient Analysis Program (Lockheed); descriptions of the computer center facility for these programs (COSMIC) and instructions for obtaining the tapes.				13 September 1967
Provided with 3 October returns from KAS Center:					
TND-4161	Method of Analyzing Dynamic Data Characterized by a Time-Varying Frequency Spectrum.				
CR-846	Launch Vehicle Wind and Turbulence Response by Nonstationary Statiscal Methods.				
A67-29104	Analysis of Brain Wave Records from Gemini Flight GT-7 by Computations to be used in a Thirty Day Primate Flight	Oct. 8, 67	Oct. 15, 67	Dec. 11, 67	18 December 1968
A66-37604	Comprehensive Spectral Analysis of Human EEG Generators in Posterior Cerebral Regions	Oct. 8, 67	Oct. 15, 67	Dec. 11, 67	18 December 1968
A67-21715	Electrocardiogram Preprocessing Unit	Oct. 8, 67	Oct. 15, 67	Dec. 11, 67	Dec. 14, 67
A67-25989	Stochastic Approximation-A Recursive Method for Solving Regression Problems	Oct. 8, 67	Oct. 15, 67	Nov. 24, 67	Nov. 27, 67

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-15117	Autocorrelation Techniques Applied to the Fetal Heart Signal	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 6, 68
N66-19335	Automatic Analysis of Diurnal Periodic Changes in Human Electroencephalogram	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 6, 68
A66-24231	A Hybrid Computer System for the Measurement and Interpretation of Electrocardiograms	Oct. 8, 67	Oct. 15, 67	Nov. 20, 67	Nov. 20, 67
N66-24193	Correlation Analysis of the EEG of a Man Both in the Normal Condition and with Cerebral Centers of Damage	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 19, 68
N66-24991	Analysis of Baseline and Gemini Flight GT-7 EEG Data with Specification of On-Line Computing Requirements	Oct. 8, 67 Reordered -	Oct. 15, 67 June 19, 68	Nov. 14, 67	
N66-27539	Analysis of Brain Wave Records from Gemini Flight GT-7 by Computations to be Used in a Thirty Day Primate Flight	Oct. 8, 67 Reordered -	Oct. 15, 67 June 19, 68	Nov. 14, 67	
N67-10886	Spectral Analysis Techniques and Pattern Recognition Methods for Electroencephalographic Data	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 7, 68
N66-33387	Spectral Analysis Techniques and Pattern Recognition Methods for Electroencephalographic Data	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 7, 68

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-12444	Combination of Wavemeter and Integrator for Simultaneous Evaluation of Quantitative Wave Patterns and Mean Amplitude of Brain Potentials	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 7, 68
N66-15009	Theory and Practice of Measurements of the Electroencephalographic Sign Correlation Coefficient	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 7, 68
N66-11873	Monitoring Psychomotor Response to Stress by Evoked Auditory Response	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	Reordered - June 19, 68
N67-19682	New Methods of Analysis of Electrophysiological Responses	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 6, 68
N67-25591	Signal Variance and Its Application to Continuous Measurements of EEG Activity	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	Jan. 19, 68
N67-18723	Computer Analysis of EEG Data for Normative Library	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 6, 68
N67-19092	Electroencephalographic Baselines in Astronaut Candidates Estimated by Computation and Pattern Recognition Techniques	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	Feb. 16, 68
N67-11917	Analogic Device for Statistical Measurements of Correlation in Time	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	March 6, 68
N67-12028	Analog Computer for Analyzing Electroencephalograms	Oct. 8, 67	Oct. 15, 67	Nov. 14, 67	Feb. 16, 68

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-10190	Health Physics and Medical Division Progress Report, January - December, 1964	Oct. 8, 67 Reordered -	Oct. 15, 67 June 19, 68	Nov. 14, 67	
A65-13378	Spectral, Cross-Spectral, and Bispectral Analysis of Low Frequency Electromagnetic Data	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A65-19896	Epoch Detection-A Method for Resolving Overlapping Signals	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A65-21484	Analysis of Brain-Wave Generators as Multiple Statiscal Time Series	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A65-23393	Spectrum Analysis for Telemetry and Data Acquisition	Oct. 30, 67	Nov. 2, 67	Mar. 1, 68	Mar. 4, 68
A65-24193	Compression of Bioastronautical Data	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A65-34695	Digital Spectral Analysis	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A65-34784	Preliminary Results of a Micropulsation Experiment at Conjugate Points	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 6, 68
A65-34815	A New Correlator Applying Hybrid Analog Digital Technique	Oct, 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 16, 68
A65-36166	Application of Certain Statiscal Methods to the Treatment of Information in the Space Domain	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A66-10480	Analog Versus Digital Data Analysis- an Introduction	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A66-13608	Transfer Function Determination as a Means of On-Line Checkout	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A66-15500	Spectral Density Analysis Used for Random Vibration Testing Programs	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A66-15508	Some Analog Methods for Power Spectral Density Analysis	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A66-19099	An Electronic Correlator for Separation of Signals According to Their Shape	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 20, 68
A66-21694	A Theory and Method for Correlation Analysis of Nonstationary Signals	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A66-21731	A Method of Determining Cross-Correlation Coefficients of Time-Varying Signals	Oct. 30, 67	Nov. 2, 67		Feb. 20, 68
A66-24722	A Look at Vibration Analysis	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A66-36657	Frequency Measurements with Short Measurement Times Using an Autocorrelator	Oct. 30, 67	Nov. 2, 67	Nov. 24, 67	Nov. 27, 67
A66-36888	A Computational Compensation for Measuring System Dynamics	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 16, 68
A67-10604	A User's Evaluation of Power Spectral Analysis Procedures	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A67-11090	Analog Device for Statiscal Measurements of Correlation in Time	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 7, 68
A67-10249	Optical Spectrum Analysis of Large Space Bandwidth Signals	Oct. 30, 67	Nov. 2, 67	Dec. 11, 67	Dec. 14, 67
A67-25732	Consideration in the Analysis of Arbitrary Waveforms	Oct. 30, 67	Nov. 2, 67	Dec. 27, 67	Jan. 19, 68
A67-26561	Automatic Multichannel System for Recording and Processing Experimental Information on a Digital Computer for the Study of the Inhomogeneous Structure of the Ionosphere	Oct. 30, 67	Nov. 2, 67		
N63-14241	Magnetic Tape Copies of MIT Geophysics Program Set I	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68
N65-10036	Statistical Electroencephalograph Model	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68
N65-11516	Studies in Electroencephalography	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68
N65-19365	Comparison of Power Spectral Density Techniques as Applied to Digitalized Data Records of Nonstationary Processes Part I	Oct. 30, 67	Nov. 2, 67		
N65-27204	The Analysis and Display of the Information Contained in Time-Varying Signals	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 6, 68
N65-27954	Hybrid Analog-Digital Techniques and Random Process Studies	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 19, 68

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N65-28757	Collection of Neurophysiological and Cardiovascular Data with Data Reduction Pattern and Correlation Analysis	Oct. 30, 67	Nov. 2, 67		Feb. 29, 68
N65-28764	Statiscal Limits on Computer Defined EEG Patterns Related to Behavior	Oct. 30, 67	Nov. 2, 67		Feb. 29, 68
N65-32027	Neurophysiological Correlates of Information Transaction and Storage in Brain Tissue	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N65-35076	The Spectral Characterization and Comparison of Nonstationary Processes	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 4, 68
N65-35667	Spectra of Nonstationary Random Processes	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 4, 68
N66-11989	Fourier Analysis Computer Program	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 7, 68
N66-12548	Representation and Analysis of Signals. Part XIX: Digital and Computer Programs for Signal Analysis	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 6, 68
N66-20598	An Analysis of Dynamic Power Spectra	Oct. 30, 67	Nov. 2, 67	Mar. 1, 68	Mar. 1, 68
N66-28476	Comparison of Analog and Digital Methods for Vibration Analysis	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 20, 68
N66-28847	New Methods in Functional Analysis of Biomedical Data	Oct. 30, 67	Nov. 2, 67	Dec. 19, 67	Mar. 7, 68
N66-36053	Study of Random Process Theory	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68

Problem No.: GLM-8, -12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N67-12809	Power and Cross-Power Spectrum Analysis By Hybrid Computers	Oct. 30, 67	Nov. 2, 67		
N67-16992	Bioastronautics Laboratory Research Tool	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Feb. 20, 68
N67-17076	Dual One Dimensional Analysis and Display Program	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 14, 68
N67-19908	User's Guide for the Digital Time Series Analysis Program. Phase I and II			Jan. 2, 68	Jan. 19, 68
A64-81314	Autocorrelation and Crosscorrelation Analysis of "Labeled Work Rhythms" in the Human EGG During Muscle Work	Oct. 30, 67	Nov. 2, 67		
A65-82206	Correlation Analysis of Changes in the Human Electroencephalogram During Elaboration of a Rhythmic Motor Stereotype				
TB 67-10602	New Technique for Determination of Cross-Power Spectral Density with Damped Oscillators				Mar. 22, 68

Problem No.: GLM-10

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N66-10768	Computer Program for the Analysis of Visible Spectrometric Data: Chromaticity	Oct. 30, 67	Nov. 2, 67	Nov. 30, 67	Mar. 1, 68
N67-19098	Notes on Digital Spectral Analysis	Oct. 30, 67	Nov. 2, 67	Jan. 3, 68	Jan. 19, 68
N67-26633	Principles of Optical Data Processing for Engineers	Oct. 30, 67	Nov. 2, 67	Jan. 3, 68	Jan. 19, 68
N67-10658	Processing of Data Issued from a Spectrometer	Oct. 30, 67	Nov. 2, 68	Nov. 30, 67	April 10, 68
N66-22735	An Improved Flame Spectrometer for Biologic Calcium Analysis had already been obtained, and was found to be of no value.				
	Information set on the IL Flame Photometer-143, manufactured by Instrumentation Laboratory, Inc.				Jan. 3, 68

Problem No.: GLM-12

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
TB-63-10003	"New Low-Level AC Amplifier Provides Adjustable Noise Cancellation and Automatic Temperature Compensation" was given to Problem Originator 27 July 1967. A backup package was requested from Ames Research Center. This supplementary information was forwarded to researcher 23 August.				
TB-67-10262	"Solid State Circuit Averages Multiple Signals and Rejects those Varying Significantly from the Average" was sent to Problem Originator on 6 September 1967.				
MFS-0723	RAVAN: Random Vibrations Analysis Program, Marshall Space Flight Center - Computation Laboratory, sent 13 September 1967.				
MFS-12870	VITRAN: Vibration Transient Analysis Program (Lockheed); descriptions of the computer center facility for these programs (COSMIC) and instructions for obtaining tapes, sent 3 September 1967.				
TND-4161	Method of Analyzing Dynamic Data Characterized by a Time-Varying Frequency Spectrum. Provided by KASC with search returns.				
CR-846	Launch Vehicle Wind and Turbulence Response by Nonstationary Statistical Methods. Sent to researcher 3 October 1967.				

Problem No.: GLM-14

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A66-32171	(For Dr. Rodin, GLM-16, also) Mass Measurement of Man in a Zero Gravity Environment	Jan. 22, 68	Jan. 24, 68	Mar. 1, 68	
N66-38922	(For Dr. Rodin, GLM-16, also) Development of Prototype Mass Measurement System for Spaceflight	Jan. 22, 68	Jan. 24, 68	Mar. 1, 68	

Problem No.: GLM-15

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	The following reports, furnished courtesy of Mr. J. T. Dennison, TUO, Electronics Research Center, were sent to Problem Originator December 6, 1967:				
	Honeywell, Inc., Monthly Progress Report, March 1967, Contract NAS 12-531, Oculometer Development.				
	North American Aviation, Inc., Space and Information Systems Div., Final Report, NAS 12-1, Feasibility of Techniques for monitoring physiological variables without attached sensors.				
	Philco-Ford Corp., WDL Division, Progress Report 3325, 30 May 1967, Contract NAS 12-121, Progress Report on Physiological Monitoring Technique using unattached sensors.				
	Tech. Report 3107 - Remote Measurement of Blood Flow Velocity in Space Flight.				
N66-37217	Preliminary Analysis of the Metabolic Rate Monitor System	Jan. 22, 68	Jan 24, 68	Mar. 1, 68	Apr. 3, 68

Problem No.: GLM-17

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
N68-14167	Gas Volume Meter	10 June 68	13 June 68		
N68-14505	General Description and Evaluation of an On-Line Oxygen Uptake Computer	10 June 68	13 June 68		
N67-19897	The Design, Fabrication and Feasibility Testing of a Prototype Airborne Respiration Analyzer	10 June 68	13 June 68		
N66-23822	Development and Testing of a Prototype Respiration Analyzer, Phase II	10 June 68	13 June 68		
N66-31163	Development and Testing of a Prototype Respiration Analyzer	10 June 68	13 June 68		
N66-27237	A Feasibility Study of a Thin Film Oxygen Partial Pressure Sensor	10 June 68	13 June 68		
N66-35950	Two-Gas Atmosphere Sensor System Conceptual Design Study	10 June 68	13 June 68		
N66-35951	Development of a Two-Gas Atmosphere Sensor System (Mass Spectrometer)	10 June 68	13 June 68		
A67-83037	Breath-To-Breath Variations of Pulmonary Gas Exchange in Resting Man	10 June 68	13 June 68		
	"Oxygen Consumption Computer" bulletin of Technology, Versatronics, Inc.				5 July 68

Problem No.: WLH-1

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
A67-11945	Distortion of a Free Surface During Tank Discharge	Requested by Dr. Ware	Nov. 29, 67	Jan. 24, 68	Jan. 24, 68
A67-14604	Handling Liquid Propellents (sent Dr. Breslau)	Requested by Dr. Ware	Nov. 29, 67	Dec. 13, 67	Jan. 19, 68 Mar. 1, 68
N67-14605	Fat Embolism - A Hemorheologic Disturbance	Jan. 12, 68	Jan. 12, 68		
N65-25876	The Possibility of Inhibiting and Stopping Blood Flow by a Magnetic Field	Jan. 12, 68	Jan. 12, 68		

Problem No.: RCU-1

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
References furnished by Mr. H. Allen of Lewis Research Center: sent to Dr. C. W. Hall (overlaps BLM-4)					
					Feb. 15, 68
	Mechanical Assistance to the Circulation: The Principle and the Evaluation or Results.				
	Controller for Heart Assist Units				
	Cardiac R-Wave Detector (E-4020)				
	A Physiological Approach to Assist the Circulation				
	Respect the Integrity of the Large Veins and Starling's Law				

Problem No.: RNV-2

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	"Apparatus for Efficient Power Transfer Through A Tissue Barrier," Jack W. Fuller, IEEE Transactions on Bio-Medical Engineering, Jan. 1968 - sent by C. J. Laenger, Sr.				13 June 68

Problem No.: RNV-5

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	"Miniature Tunnel Diode Transducers," Solid State Electronics, Pergamon Press, 1967, Vol. 10, pp 1227-1228 (Great Britain).				12 June 68

Problem No.: RNV-6

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
	"EEG Preamplifier", Martin Graham IEEE Trans. on Bio-Med. Engineering, July/October. Sent by C. J. Laenger, Sr.				13 June 68

Problem No.: NWR-1

Ref. No.:	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
AD 82-8067	DOD Cartographic Production Equipment Handbook.				23 May 68
AD 82-8750L	Mono Versus Stereo Analytical Photogrammetry; Part II				23 May 68

Problem No. :PLR-2

Ref. No. :	Reference Title	Chronology: Requested by Originator	Request processed at SwRI	SwRI Obtained Reference	Forwarded to Researcher
AD 82-8067	DOD Cartographic Production Equipment Handbook				23 May 68
AD82-8750L	Mono Versus Stereo Analytical Photogrammetry; Part II				23 May 68

GENERAL REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
Sent to University of Texas Medical Branch		
	Gait Patterns and the Speed of Walking, Grieve, D.W., Ph.D., sent for Dr. Peterson	19 April 1968
	A copy of SwRI 1936 report "Development of Indirect Blood Pressure Sensing Technique For Aerospace Vehicle and Simulator Use sent to Dr. F. H. Rudenberg and Simons.	6 May 1968
Sent to Texas Institute for Rehabilitation and Research		
TB 66-10534	"Miniature Piezoelectric Triaxial Accelerometer Measures Cranial Accelerations" and Appendix V, Muscle Accelerometer from Midwest Research Institute's August 5, 1966 report sent to Dr. Spencer	20 February 1968
TB 67-10598	"Cardiotachometer with Linear Beat-to-Beat Frequency Response	20 February 1968
TB 67-10302	"Improved Compression Molding Process" sent for possible interest on HUV-10 and general reference	19 March 1968
TB 67-10602	"New Technique for Determination of Cross-Power Spectral Density with Damped Oscillators"	21 March 1968
PB 174945	"Body Segment Parameters" for Mr. Engen	11 April 1968
NASA CR-805	"The Oculometer" (Attn: Joe Canzoneri)	11 April 1968
	"Gait Patterns and Speed of Walking"from March 1968 issue of Bio-Medical Engineering (Dr. Peterson)	15 April 1968
	Mr. Laenger sent copy of 14-1936 "Development of Indirect Blood Pressure Sensing Technique for Aerospace Vehicle and Simulator Use" to Joe Canzoneri	6 May 1968
	"A New Muscle Stimulator Controlled by Myoelectric Signals" from Excerpta Medica Section 27, Vol. 2, No. 3, March 1968 Abstract No. 881	8 May 1968

GENERAL REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
Sent to TIRR		
	Mr. Laenger sent the following copies:	13 June 1968
	To Engen - "Operation of Miniature Valves for Artificial Limbs" A. S. Morton, Ph.D., Bio-Medical Engineering, April 1968, p 170	
	To Canzoneri/Peterson - "Bioengineering Analysis of Force Actions Transmitted by the Knee Joint," James B. Morrison, Ph.D. Bio-Medical Engineering, April 1968, Vol. 3, No. 4, p. 164-170	
	To Canzoneri/Peterson - "The Patellar Tendon Bearing (PTB) Air-Cushion Socket," Erik Lyquist, Bio-Medical Engineering, Vol. 2, No. 10, October 1967.	
TND-4398	"Review of NASA-MSC Electroencephalogram and Electrocardiogram Electrode Systems Including Application Techniques" sent to Mr. Canzoneri	3 July 1968
Sent to Rancho Los Amigos		
NASA SP-5047	Teleoperator	
NASA SP-5083	Analytical Chemical Instrumentation	
NASA SP-5041	Cardiovascular Monitoring	
NASA SP-5023	Medical & Biological Application of Space Telemetry	
FAA 62-1	Analysis of Sitting Areas & Pressures of Man	
NASA-FRC	Volume Pneumotachometer	
NASA-FRC	High & Low Pressure Pneumotachometer	
NASA-Ames ARC-10083F	Multi-Channel Telemeter System	
	(Above information left with Dr. McNeal for Dr. Mooney and others)	April 1968
	"A New Muscle Stimulator Controlled by Myoelectric Signals from EXCERPTA MEDICA, Section 27, Vol. 2, No. 3, March 1968 Abstract No. 881 forwarded through Mr. Buck	May 3, 1968
	Dr. W. Waring was furnished a screened copy of the SRS-6 (Cutaneous Stimuli Investigations) on 2 April 1968. The search was	

GENERAL REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
Sent to Rancho Los Amigos (continued)		
	judged to be quite relevant to Dr. Waring's research area, and he requested all of the screened references plus 15 additional ones on 7 May 1968:	
A66-82018	Simple Motor Reaction to Tacticle Stimulation (Unable to obtain this through our usual sources)	
A66-82380	Intensensory Comparisons of Reaction Time Using an Electro-Pulse Tactile Stimulus	June 28, 1968
A66-81327	Muscular Effort and Electrodermal Responses	May 31, 1968
N64-15570	(Problem originator informed that this reference is NOT available through program	June 18, 1968
A66-81537	Electrocutaneous Pain Thresholds in Humans to Low Frequency Square-Wave Pulses	June 28, 1968
A66-81664	Some Factors Influencing the Threshold of the Electrocutaneous Stimulus	May 31, 1968
A64-80833	Modulated Alternating Current Energy Used to Stimulate Audition in Totally Deaf Humans	May 31, 1968
A64-80873	(Library is unable to obtain)	20 June 1968
A65-80103	Changes in the Electroencephalogram and Derma-Galvanic Reactions In The Process of Formation of Tentative Relationship Between Motorial and Visual Analyzers in Humans	28 June 1968
A65-80734	On The Relationship Between Tactile Perception Threshold and Potentials Evoked in the Somato-Sensitive Cerebral Cortex	31 May 1968
A66-82210	A Study on the Cutaneous Pricking Pain Threshold in Normal Man	21 June 1968
A66-82286	"Effect of Emotion on Flyer's Professional Activity (Sent Russian copy)	28 June 1968
A66-80999	Skin Conductance Change and Sensory Discrimination	31 May 1968
A66-81366	Mechanism and Measurment of the Galvanic Skin Response	31 May 1968
N62-10884	The Operation of the Tactile and Temperature Senses	21 June 1968
N63-11359	A Solid State Measuring Device for Galvanic Skin Response	28 June 1968
N64-10658	The Algorithmic Structures of Active Touch	21 June 1968
N65-11516	Studies in Electroencephalography	28 June 1968
N65-18684	Engineering Considerations in GSR Research	21 June 1968
N65-30015		

GENERAL REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
	C. Laenger sent Dr. Solomon - "A Simple Technique to Prevent Aortic Rupture Following Implant of Chronic Flow Probes, short communication - IEEE Transactions on Bio-Medical Engineering, January 1967	12 June 1968
Sent to the University of Washington		
A65-30828	Measurement of Internal Stresses in Encapsulated Electronic Modules	15 May 1968
A65-31922	Effect of a Stabilized Flow Profile on the Error of Ultrasonic Flowmeters	15 May 1968
A65-24469	The Effect of Steady-State Flow Profile on the Error of a Supersonic Flow Meter	15 May 1968
A65-32201	Transducers for Dynamic Fluid Pressures	21 May 1968
A66-27553	Electromagnetic and Ultrasonic Flow Measurement Future Applications of Nuclear Resonance and the Laser	15 May 1968
A66-36851	A High-Speed Ferromagnetic Microtransducer	21 May 1968
A66-38651	Miniature Transducer Assembly for Measuring the Properties of the Wall-Pressure Field in Turbulent Flows	15 May 1968
A66-38797	A Miniature Pressure Transducer	15 May 1968
N64-29644	High-Precision Pressure Sensor	31 May 1968
N64-29989	Catheter-Tip Flowmeter for the Measurement of Coronary Arterial Blood Flow in Intact Anesthetized Dogs	31 May 1968
A67-23079	Ultrasonic Flow Measurement	15 May 1968
	(The above references requested by D. W. Baker on May 7 by letter)	
Sent to Seattle Handicapped Center		
	"Miniature Tunnel Diode Transducers" SOLID-STATE ELECTRONICS, Pergamon Press 1967, Vol. 10, pp. 1227-1228. Printed in Great Britain. Forwarded to Mr. Buck.	

GENERAL REFERENCES FORWARDED

Ref. No.	Reference Title	Date Sent
	Westinghouse Oxygen Analyzer information sent to Consultants and Coordinators at all participating Institutions on 22 April 1968	
	Mr. Laenger sent draft copy of 14-1936 "Development of Indirect Blood Pressure Sensing Technique for Aerospace Vehicle and Simulator Use" to Jack Johnson and Dr. Molnar at SRS	6 May 1968
A68-14355	"A Short Range Underwater Biotelemetry System," sent to West Coast consultant for distribution to participating institutions	9 May 1968

A Team member, Mr. R J Crosby. read the biological problem abstract No. WF-30, An Improved Blood Vessel Constrictor" from the Research Triangle Institute on 22 April 1968. He sent a copy of INVIVO METRIC SYSTEMS' BULLETIN 109 which describes their blood vessel occluders Model VO3 and VO4 to Mr. Ernest Harrison, Jr. as a possible solution to Research Triangle Institute's problem abstract. On May 24, we received a letter from Mr. Ernest Harrison, Jr. in which he thanked us for the information and said that he was not aware of the piece of equipment, although the researcher had been. The researcher was not certain about the physical size of the units but has decided to order one for evaluation,and they will let us know how the evaluation turns out.

APPENDIX A

THE INSIGHTS

The main purpose of a pilot program is to gain by practical experience insight into the endeavor at issue. In this program, the endeavor is to develop methods for effectively transferring a maximum amount of applicable aerospace technology to the fields of medicine and biology, and of applying such methods to the accomplishment of as many transfers as possible. We have heard from previous speakers that the need for aerospace technology in medicine is great; we are aware that such technology exists now in large quantity.

I shall discuss insights gained and relate them to the major steps involved in operating the Biomedical Application Program.

The first step--selection of key consultants or communicators at the participating medical research institutions--is a matter of great importance. The communicator for example must supply much of the impetus toward overcoming the barriers to communication alluded to by Mr. Berger. Our experience has been that the most effective communicator is a person who is intelligent, possessing a broad fund of technical knowledge, and the spirit of an innovator. Because of his widespread interests, he may have the reputation for "spreading himself a little thin." He is probably a "man on the way up," but if he is too near the top of the administrative totem pole, he probably will not have sufficient time to devote to our effort.

The next step, that of identifying areas of need and of specific problems likely to be amenable to solution by aerospace technology, should be a joint venture between the investigator, the key communicator, and the Biomedical Application Team. The ideal participating investigator is one who spontaneously generates and submits a significant problem which is well thought out in advance. It has been our experience that if an investigator must be cajoled into submitting a problem, he is that much less likely to utilize technology offered to him.

In preparing a written statement of the problem once identified, the Biomedical Application Team should take the lead, using great care to eliminate jargon terms and to pose the problem in technical language which is universally understandable by scientists of any discipline. It is equally important to state the problem in such a way as to avoid bias in favor of specific answers or a specific class of technology, since such bias may steer us away from the unexpected (and possibly the superior) solution. It seems to make little difference whether the first draft is prepared by a person whose primary training is in physical science or

someone in biomedicine, but it is extremely important the the final product be the result of collaboration between both. The finished write-up should be reviewed by the problem originator if at all possible. (We should practice what we preach about closed loop communication.)

The identification and evaluation of applicable technology have been well covered by Dr. Brown and Mr. Bendersky. I will add that as we have developed our methods of procedure (which are essentially identical--although our styles may differ as we deal with different institutions--as we have developed these modi operandi, we have been able to improve the efficiency with which we go about unearthing technology. A complex, multipath flow chart has been distilled from this experience* to serve as a description of how we go about our task. Because the problems submitted are variegated, no one of the paths should be thought of as the royal road to success, and this portion of the over-all task continues to have the aspect of research and development.

With regard to evaluation of suggested technology, three things are clearly necessary: (1) a willing investigator, (2) appropriate institutional facilities, and (3) sufficient financial support. Deficiency in any one of these areas is enough to slow or halt the evaluation.

The next step, communication of technology or information to the investigator, can take many forms. In many cases, transmission of a written document just as it was retrieved is sufficient. When necessary, telephone calls or site visits are utilized. The latter method is by far the most informative, but obviously it is not always feasible. Our experience continues to justify Dr. Hartwig's initial thesis that direct person-to-person communication is the key to success.

In most instances, after technology is determined to be useful, the investigator needs no further help in applying it to his research. When equipment or hardware of special nature is essential to utilization of the technology, however, the transfer can often be expedited through assistance to the researcher in finding the needed items. In some instances non-availability of apparatus has prevented technology transfer. It is sometimes appropriate and useful for the Biomedical Application Team to render engineering advice as an aid to the investigator as he applies aerospace technology. In a few cases, the entire process of achieving the transfer is accomplished in a short time. In the majority of cases, however, our experience is that it takes longer than we estimate initially.

*Per NASA Memorandum (L. S. Wilson) of 3 July 1968.

An important part of the program is the documentation of all stages development of technology transfers and of arriving at methods of estimating cost and effectiveness factors. The three Biomedical Application Teams are presently collecting detailed information on costs of the several subtasks involved in achieving technology transfer. When we attempt to estimate the gain or reward from a given problem solution, however, we enter into a more nebulous realm. It will probably never be possible to calibrate the usefulness of our efforts with the same precision as the cost. Until we can find better ways to define the gains of this program, we are looking at such factors as: man-hours of time saved, magnitude of projects made possible by aerospace technology transferred, dollars mobilized thereby, publications relating to applied aerospace technology, and, in the case of clinical applications, the number of patients benefited throughout the country.

Finally, there is the need to let the scientific community in on what appears to be a good thing. This is accomplished by appropriate references to the sources of new technology by researchers who publish their results by documentary films and reports released by NASA, and, of course, by participation in meetings like this.

To summarize; The storehouse is filled with technology much needed by the biomedical community. Communication in both directions is uphill, but subject to facilitation. That we are succeeding is apparent; the degree to which we are succeeding will not be completely known to us until the future unfolds.