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

FINAL REPORT

1 February 1969 - 28 February 1970

Contract No. NASW-1867
SwRI Project No. 13-2538

Prepared for

Chief, Dissemination Branch, Code (UT)
Technology Utilization Division
Office of Technology Utilization
NASA
Washington, D. C. 20546

31 March 1970

CASE FILE COPY

SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

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Prepared by: David F. Culclasure
Betty J. Wall

Approved:

W. Lyle Donaldson

W. Lyle Donaldson, Director
Department of Bioengineering

TABLE OF CONTENTS

			Page
A.	INTRODUCTION		1
B.	SUMMARY OF PROJECT ACTIVITY		
	1.	Transfers Accomplished	4
	2.	Potential Transfers Identified	4
	3.	"Impacts" Made	5
	4.	Visits to User Institutions	6
	5.	Contacts with NASA Field Centers	6
	6.	Computer Searches Initiated	6
	7.	Manual Searches Completed	6
	8.	Problems Rejected	7
	9.	Problems Closed or Inactivated	7
	10.	Problems Tabled	8
	11.	Number of New Problems During Reporting Period	8
	12.	Number of Active Problems	8
	13.	Problem Statements Disseminated to NASA Centers	8
	14.	Problems Submitted as Candidates for Applications Engineering	8
C.	TRANSFER REPORTS		
	1.	Transfer Reports on Actual Transfers	11
	2.	Report on Progress of Potential Transfers	29
	3.	Reports on "Impacts"	35
D.	TEAM CONTACTS		
	1.	Visits to User Institutions	41
	2.	Responses on Problem Statements from Centers	43
E.	LITERATURE SEARCH EVALUATION REPORTS		
	1.	Computer Search Evaluation Reports	45
	2.	Manual Search Reports	63
F.	PROBLEM STATUS SUMMARY		
	1.	Problems Rejected	74
	2.	Problems Closed or Inactivated	77
	3.	Active Problem Status Summary	86
	4.	Problem Statements Disseminated to Centers	193

		Page
G.	PARTICIPATION IN SYMPOSIUMS AND MEETINGS	217
H.	COMMERCIAL PRODUCT AND/OR APPLICATION ENGINEERING ACTIVITY RESULTING FROM TEAM OPERATIONS	229
I.	INSIGHTS	240

A. INTRODUCTION

INTRODUCTION

During the report period 1 February 1969 to 28 February 1970, the Southwest Research Institute Biomedical Applications Team made a total of 146 visits to user institutions, resulting in identification of 109 new problems.

New user institutions brought into the program during the reporting period included:

CAP	Claremont Graduate School, Claremont California
DLM	University of Texas Southwestern Medical School, Dallas, Texas
DVM	University of California at Davis, California
OVA	Oklahoma Veterans Administration Hospital, Oklahoma City, Oklahoma
SWC	Scott White Clinic and Hospital, Temple, Texas
TCM	University of Arizona College of Medicine, Tucson, Arizona
UTM	University of Utah School of Medicine, Salt Lake City, Utah

Team composition during the reporting period consisted of the following individuals:

Ray W. Ware, M. D.
Louis S. Berger
W. R. Brian Caruth, Ph. D.
Robert J. Crosby
David F. Culclasure, Ph. D.
Edward E. Dean, D. V. M.
Rufus A. Holloway
Chester A. Heath
Charles J. Laenger, Sr.
Raul San Martin, M. D.
Samuel G. Schiflett
Robert E. Schuhmann
Betty J. Wall
Robert L. Wilbur
Andre G. Buck

In addition to these regularly assigned Biomedical Application Team members, the following individuals functioned as consultant communicators at the institutions specified:

F. Hermann Rudenberg	The University of Texas Medical School - Galveston, Texas
Richard G. Domey	The University of Texas Medical School - San Antonio, Texas
Harry S. Lipscomb	Baylor University College of Medicine - Houston, Texas

Generally, the approach used during the reporting period for identification of biomedical problems suitable for acceptance under the technology transfer program centered upon personal interaction between Team members and individual biomedical researchers. In consonance with the experimental nature of the project, two techniques were employed for evaluation. In one, the investigator himself was encouraged to write up the problem dimensions, to include necessary background data. In the other, the Team member interacting with the investigator assumed complete responsibility for developing the problem, to include the responsibility for conducting research needed to prepare a complete and comprehensive statement of the problem. The former approach was abandoned when it became obvious that many investigators, if constrained to prepare a written statement of a problem, elected not to participate in the program.

Section I. Insights contains observations regarding potential means by which Team function might be enhanced and the transfer process aided.

Page

B. SUMMARY OF PROJECT ACTIVITY

1. Transfers Accomplished - 7

BLM-12	"Flexible Electrode for Stimulating the Carotid Sinus Nerve"	12
CAP-2	"Galvanic Skin Response Electrodes for Long-Term Application to Human Subjects"	17
HUV-18	"Microanalysis of Mucous-Secreting Cells"	19
NWR-6	"The Effects of Electromagnetic and Acoustic Fields on Living Organisms"	21
SFM-3	"Improved Monitoring of Heart Cell Parameters"	23
UTM-19	"Spray-on Electrodes for Measurement of Heart Rate"	25
WSM-6	"High Power Infrasonic Wave Generator"	27

2. Potential Transfers Identified - 22

BLM-11	"On-Line Analysis of Biochemical Samples Collected Automatically from Patients"	30
BLM-11a	"On-Line Analysis of Biochemical Samples Collected Automatically from Patients"	30
BLM-13	"Nonthrombogenic Material for Use As A Blood Interface"	30
CAP-1	"Apparatus for Telemetering GSR in Natural Social Settings"	30
DLM-2	"Temperature Measurement of Brain Core in the Laboratory Rat"	31
DLM-6	"Measurement of Respiration Parameters of Cardiovascular Patients"	31
DVM-4	"Automatic Atraumatic Blood Pressure Measurement"	31

		Page
GLM-14	"Repetitive Measurement of Kidney Mass in Intact Animal"	31
GLM-15	"Respiration Volume and Rate Measurement in Unencumbered (Free) Child"	31
GLM-16	"In-Situ Tumor Mass Determination on Rat Leg"	32
NWR-1	"Motion Pattern Measurement of Patients"	32
NWR-5	"Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section"	32
RNV-10	"Sensors for Measuring Foot-Floor Impact Forces"	32
RNV-13	"Improved Laryngoscope for Use in Disabled Children"	32
RNV-14	"Materials for Prevention of New Decubitus Ulcers"	33
RNV-28	"Accelerometer for Human Motion Studies"	33
SNM-4	"Improved Technique for Measurement of Skin Thickness"	33
SNM-5	"Implantable Telemetry System for EKG"	33
SWC-1	"Improved Techniques for Taking EEG in Infants and Small Children"	34
UTM-7	"Chronic Electrode Implantation Technique for Artificial Eye Research"	34
UTM-9	"Tidal Volume Measurements in Respiration Studies"	34
WSM-7	"Sensitive Detection for Human Electric Field Application"	34

3. "Impacts" Made - 3

CAP-3	"Non-Computerized Reduction of Data Recorded via Conventional Polygraph Techniques"	36

Page

DVM-4 "Automatic Atraumatic Blood Pressure Measurement" 38

UTM-10 "Compensatory Tracking Techniques" 39

4. Visits to User Institutions - 146 41

5. Contacts with NASA Field Centers - 149

6. Computer Searches Initiated - 17 45

BLM-10	GLM-20
BLM-11	RNV-21
BLM-12	SFM-6
BLM-13	SNM-2
BLM-14	SNM-3
BLM-15	SNM-4
BLM-16	SRS-53
DVM-1	TCM-1
	WSM-7

7. Manual Searches Completed - 47 63

BLM-17	GLM-22
BLM-21	GLM-23
BLM-22	GLM-24
BLM-23	GLM-29
BLM-24	GLM-30
DLM-1	RNV-24
DLM-2	RNV-29
DLM-3	RNV-30
DLM-4	RNV-31
DLM-5	SNM-6
DLM-6	SNM-7
DLM-7	SNM-8
DLM-8	SNM-9
DLM-9	UTM-2
DLM-10	UTM-3
DLM-11	UTM-5
DLM-12	UTM-6
DVM-1	UTM-8
DVM-5	UTM-10
DVM-7	UTM-11

Page

UTM-12
UTM-13
UTM-14
UTM-15
UTM-16
UTM-17
UTM-18

8. Problems Rejected - 10

DLM-13 "Advanced Critical Components for IBM Computer" 75

PLR-5 "Automatic Techniques for Identifying Arterial Branches in X-Ray Films" 75

RNV-18 "Measurement of Respiratory Volume 75

RNV-20 "Systems Development of Patient Transportation Devices" 75

SFM-7 "Automatic Servo-Controlled Systems and Hardware for Anesthesia Administration" 75

SFM-8 "Study of Anomalous Reaction of Administration of Nitrous Oxide During Anesthesia" 75

SFM-9 "Small, Portable, Low Frequency Tape Recorder for Recording Static Balance in Children" 76

SNM- Pre-Problem "Use of Electrical Energy to Induce Certain Behavioral Phenomena" 76

SNM-Pre-Problem "Development of Means to Identify Virus-Containing, Inoculated Eggs" 76

SNM-Pre-Problem "Use of Fluid Amplifier Controls in Operating Rooms (Anesthesia)" 76

9. Problems Closed or Inactivated - 44 77

BLM-11
CAP-3
*DLM-3
*GLM-3
GLM-4
GLM-5
*GLM-6
*GLM-7
*GLM-8
*GLM-9

*Problems Closed

Page

*GLM-10	RNV-5
*GLM-12	RNV-10
*GLM-13	*RNV-11
*GLM-14	*RNV-12
*GLM-16	RNV-13
GLM-17	RNV-15
GLM-18	*RNV-16
GLM-25	*RNV-17
HUV-1	*SFM-1
*HUV-10	*SFM-2
HUV-16	*SFM-3
*HUV-18	SFM-3A
NWR-1	*SFM-4
NWR-6	SNM-1
*PLR-1	*WSM-1
*PLR-3	*WSM-4
*PLR-4	*WSM-7

10. Problems Tabled - 3

BLM-18P
BLM-19P
BLM-20P

These problems were all dependent upon BLM-17 and are tabled until information on BLM-17 can be obtained.

11. Number of New Problems Accepted During the Reporting Period - 109

12. Number of Active Problems - 105 86

13. Problem Statements Disseminated to the NASA Centers - 14 193

BLM-10	GLM-20
BLM-14	HUV-17
GLM-3	NWR-5
GLM-9	RNV-14
GLM-14	SNM-3
GLM-15	SRS-8B
GLM-19	WSM-1

*Ibid.

Page

14. Problems Submitted as Candidates for Applications Engineering - 2 229

CAP-1 "Apparatus for Telemetering GSR in Natural Social Settings" 231

SWC-1 "Improved Techniques for Taking EEG in Infants and Small Children" 235

C. TRANSFER REPORTS

1. Transfer Reports on Actual Transfers

TRANSFER REPORT
BLM-12

"Flexible Electrode For Stimulating the Carotid Sinus Nerve"

Dr. Gerald Glick
Baylor University College of Medicine
Houston, Texas

Problem Acquired - September 11, 1969
Transfer Made - January 28, 1970
Elapsed Time - 4 1/2 months

Description of Problem

The investigator required a biologically inert, soft, flexible conducting electrode for use in establishing an electrical connection between the surgically exposed carotid sinus nerve and a lead from an implanted cardiac pacemaker. The purpose of the connection is to permit electrical stimulation of the carotid nerve to relieve pain associated with angina pectoris. Previously, a pair of rigid platinum electrodes in silicone rubber foam was used to establish the connection. This had several disadvantages: the rigid electrodes contact and stimulate only one side of the nerve and, being rigid tends to damage the delicate nerve tissue. A soft flexible wraparound electrode was desired with a consistency much like that of Silastic rubber. The investigator had tried adding various conductive particles such as platinum and carbon to Silastic rubber, but results had been variable and unsatisfactory. Major constraints surrounding the problem were that the electrode material must be a good conductor, biologically inert, and suitable for long term implantation (at least 5 years duration).

Description of Solution

Upon receipt of the problem, the team initiated a computer search to determine if published material concerning NASA technology in flexible electrode fabrication was available. Since the search failed to reveal material directly leading to a solution to the problem, the team then began to seek a specific NASA research center where the required technology might be found. A team member, Mr. A. G. Buck was successful in locating a researcher, Mr. S. A. Rositano who was working with flexible, conductive compounds at NASA Ames Research Center. Through the cooperation of Mr. George G. Edwards, Technology Utilization Officer, NASA Ames, arrangements were made to have Mr. Rositano fabricate flexible electrodes to specifications supplied by Dr. Glick, the problem originator. Utilizing technology developed at NASA Ames, Mr. Rositano fabricated and forwarded several pairs of flexible, silver elastomer electrodes to Dr. Glick for use in his research program. Additionally, NASA Ames has undertaken development of an even more effective type of flexible electrode for stimulating the carotid sinus nerve. The attached photograph and drawing shows the NASA Ames developed flexible electrodes and their intended application. The improved version will be fabricated from platinum elastomer rather than silver, to extend the electrode's useful life.

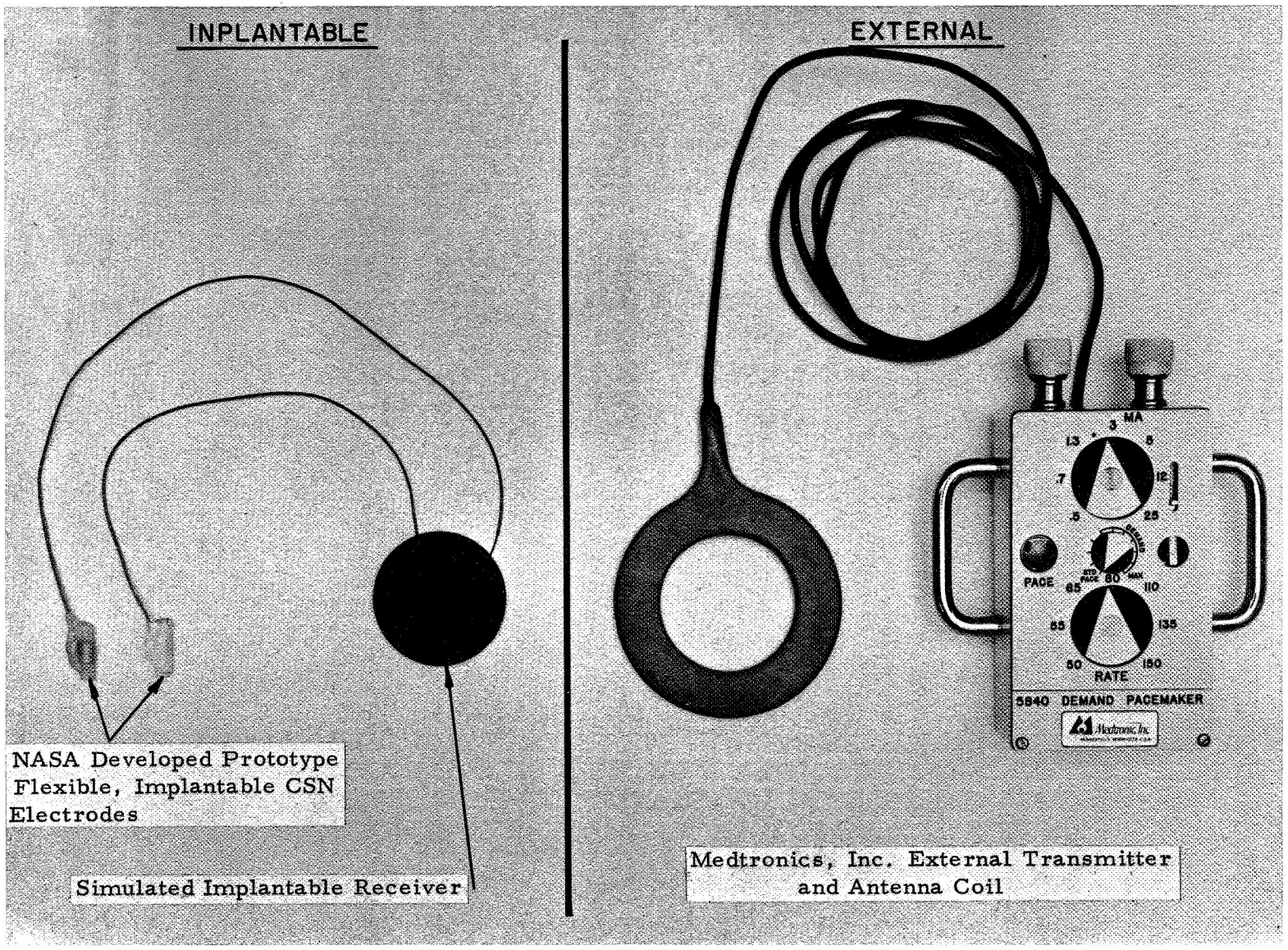
Successful Search Method

Awareness of specialized area of technology being conducted at NASA Ames Research Center by BA Team member (Mr. A. G. Buck).

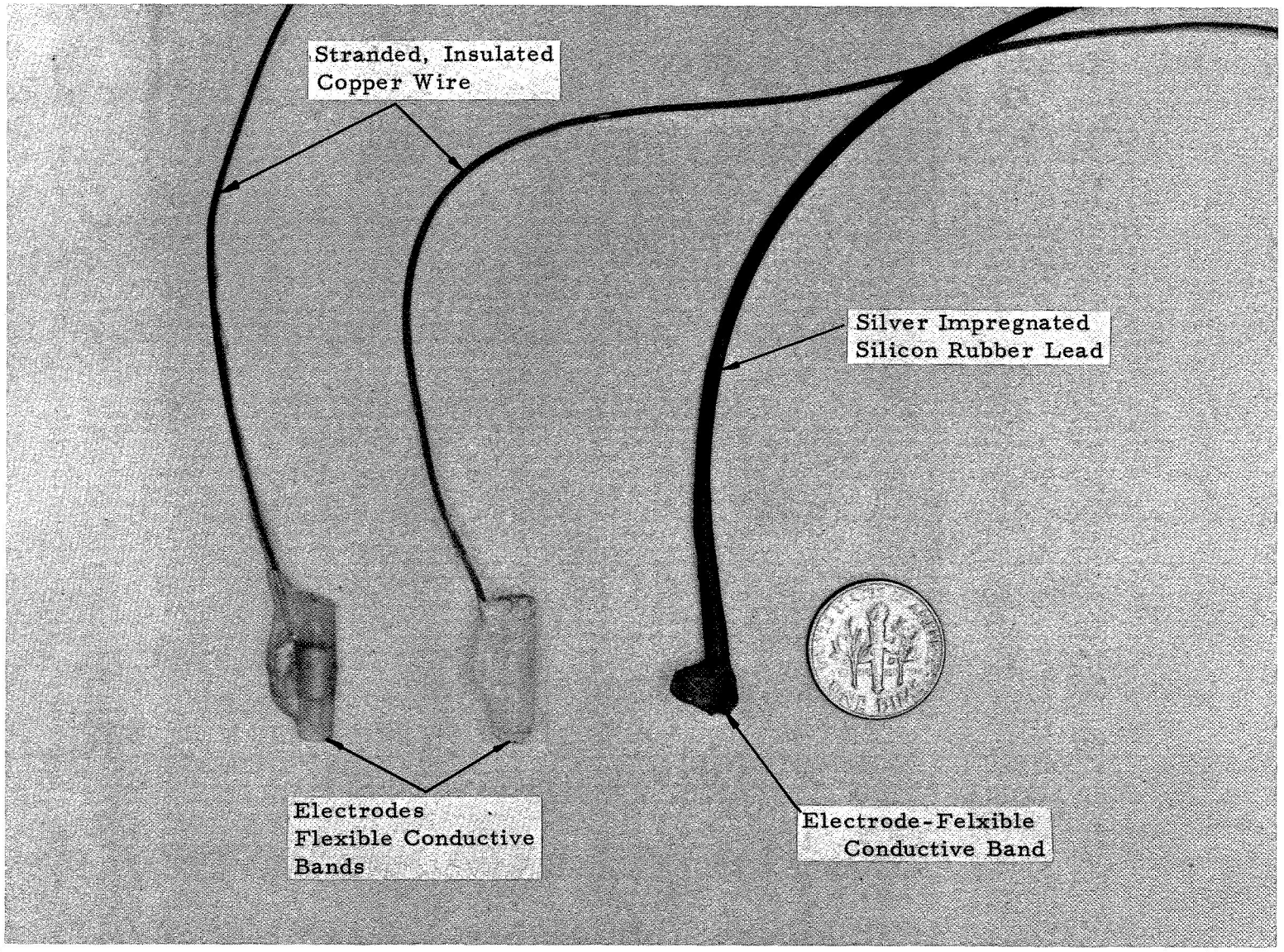
Benefits to be Derived From Transfer

Specialized technology available at NASA Ames Research Center permitted fabrication of a biologically inert, flexible electrode which could be surgically implanted in a manner to totally embrace the carotid sinus nerve, thus providing an effective electrical connection between the nerve and a lead from an implanted cardiac pacemaker. Heretofore, rigid electrodes were implanted, a procedure which involved the risk of (1) injury to the delicate carotid sinus nerve and (2) poor performance due to contact by rigid electrodes with only one side of the nerve.

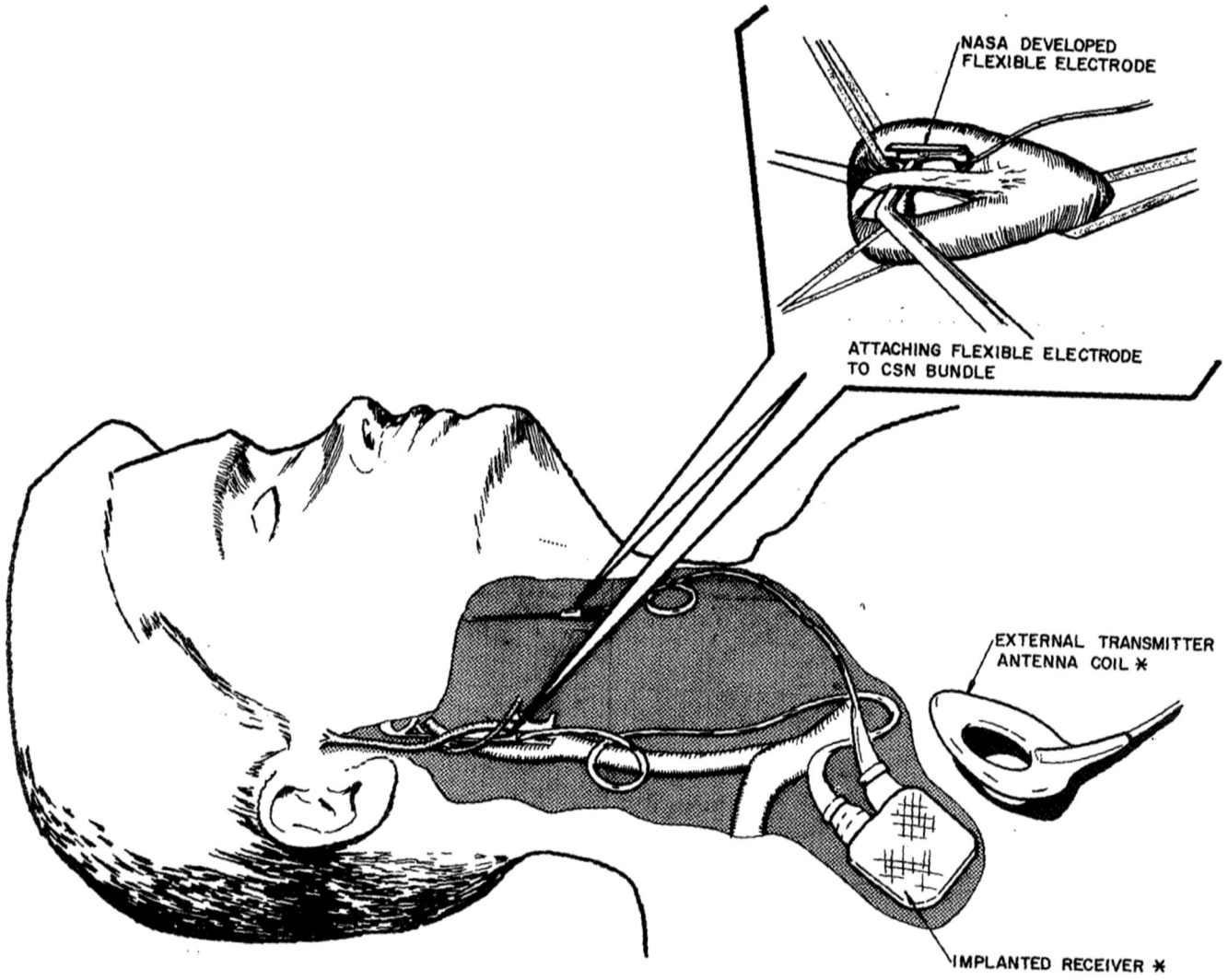
The initial assistance provided to the researcher, plus NASA Ames willingness to continue development work to improve the flexible electrode by using platimun elastomer, is expected to significantly advance ongoing research designed to perfect the use of carotid sinus nerve electrical stimulation to relieve the crippling pain of angina pectoris.



CAROTID SINUS BUNDLE STIMULATOR SYSTEM



NASA DEVELOPED PROTOTYPE CAROTID SINUS
NERVE STIMULATOR ELECTRODES



* MANUFACTURER - MEDTRONIC, INC.
SKETCH BASED ON MEDTRONIC, INC.
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NASA DEVELOPED FLEXIBLE ELECTRODE IN CAROTID SINUS NERVE STIMULATOR SYSTEM

TRANSFER REPORTS
CAP 2

"Galvanic Skin Response Electrodes For Long-Term Application to Human Subjects"

Dr. Robert Schwitzgebel
Claremont Graduate School
Claremont, California

Problem Acquired - January 2, 1970
Transfer Made - January 31, 1970
Elapsed Time - 1 month

Description of Problem

Researchers at Claremont Graduate School, Claremont College, California are conducting experiments to determine the feasibility of employing electromechanical means for modifying behavior. One phase of this research involves telemetering the galvanic skin response (GSR) of adolescent deliquents as they interact in their natural social setting, e. g., home, school and hang-out. In the study, dry electrodes are applied to the plantar region (inner aspect of the instep) to acquire the GSR, with the signal being conducted from the foot via a connecting link concealed in the trouser leg to a transmitter placed at a convenient concealed location on the delinquent's person. Whereas effective techniques have been developed for attaching GSR electrodes to the fingers with relative ease, they cannot be used for the present application. This is for several reasons: (1) they involve some disruption of activity and (2) more importantly the delinquent's peers will not accept him within the social unit if it is obvious that he is instrumented in some manner, such as with highly visible finger electrodes. Currently, the dry electrodes (silver discs soldered to 20 ga. polyvinyl insulated copper wire) to the plantar region of the foot are being applied by investigators. These electrodes are difficult to affix for extended use, involve considerable motion artifact, and tend to be uncomfortable during walking.

The investigator asked that NASA technology be explored to see if technology relating to electrodes suitable for taking the GSR (galvanic skin response) of human adult subjects was available. The electrodes desired have to be amenable to long-term application (periods of 24-hours or longer) without impairment of sensitivity and have to minimize the occurrence of motion-induced artifacts. The electrodes have to be small enough to permit them to be worn comfortably when applied to the plantar region. Installation of the electrodes also has to be relatively simple and the cost reasonable.

Description of Solution

Upon receipt of the problem, the team performed a search of the NASA literature to identify instances of aerospace technology which had a bearing on the specialized electrode application described. Of the items retrieved from the NASA literature, one appeared to have particular application to the problem at hand: NASA Technical Note, Dry Electrodes For Physiological Monitoring, NASA TN D-3414. This document describes a method developed at the NASA Flight Research Center, Edwards, California for very rapid application of electrocardiogram electrodes by spraying a conductive mixture onto the skin.

This method, which permits rapid instrumentation of subjects in an operational environment provides a finished electrode which is dry and is less than 0.01-inch thick. The NASA-developed method of electrode application is well-suited for the active subject, such as the adolescent delinquents used in the research described above. In addition, the technique is reliable, while at the same time interfering in no way with the movement or comfort of the experimental subject. Importantly, the spray-on electrodes are resistant to motion artifacts; are non-injurious and non-irritating in prolonged use; do not require shaving prior to application; and are easy to apply. In this latter regard, NASA experience suggests that with a minimum of practice, two technicians can instrument a test subject in less than three minutes.

Successful Search Method

Search of NASA literature as contained in the STAR and IAA Indices. Benefits to be derived from the transfer.

Transfer Description

Problem Code: HUV-18

Problem Title: Microanalysis of Mucus Secreting Cells

Problem Originator: Mr. Robert Doggett

Institution : Texas Institute for Rehabilitation and Research

Biomedical Application Team Members
Responsible for Problem: Robert J. Crosby, Charles J. Laenger, Samuel G. Schiflett

Date Problem Acquired: October 30, 1968
Date Transfer Made: March 1969
Elapsed Time to Complete: 5 months

Description of Problem:

Little is known about the basic etiology of cystic fibrosis (CF). Five percent of the people in the U.S. carry this recessive gene! One out of every one thousand babies born in America are afflicted with CF. Mr. Robert Doggett wished to find a technique for analyzing the chemical constituents of microscopic portions of mucous-secreting salivary gland cell specimens from cystic fibrosis patients. The secretions of patients with this condition are known to be high in sodium compared to a "normal" patient. The abnormally high sodium concentrations form a basis for a screening test to detect the disease in its early stages.

Description of Solution and Source(s):

Investigators in the growing field of microanalyzers have pioneered in producing the scanning electron microscope and microprobe. The electron probe has the unique capability of performing chemical analysis on a micron scale by analyzing the emitted x-radiation generated by an electron beam. Because of its unique ability to analyze specimens of considerable thickness, Mr. Doggett envisioned the effectiveness of the instrument in cystic fibrosis research.

Mr. Doggett stated to Mr. Bob Crosby that he was most interested in using the electron probe analyzer and scope at the NASA Manned

Spacecraft Center. Dr. Ray Ware telephoned Mr. Albert C. Copeland, Quality Assurance Division, on 4 November 1968 and made official arrangements for Mr. Doggett to utilize the NASA facilities.

Searching Method(s): WESRAC search results for GLM-18, "Ultramicro Methods for Analyzing Biological Specimens," were evaluated by the Problem Originator. Mr. Doggett indicated that references pertaining to the scanning electron microscope/probe were current and helpful.

Benefits (Potential and Actual): The exchange of knowledge and maximum use of MSC facilities has reduced duplicity of effort in overlapping areas of research. The early diagnosis of cystic fibrosis is imperative for effective therapy. If the electron microscope/probe can be used to rapidly detect abnormality in biochemical structures and functions that are symptomatic of cystic fibrosis, then every child subjected to the diagnostic test would benefit.

Consultants: Dr. Ray Ware (SwRI) and Dr. Craig Fisher, Head of Clinical Pathology Lab (MSC)

Cost/Effort:

Professional man-hours - 13
Estimated dollar cost - $250 (assigned specifically to problem)

Comments:

The encouraging preliminary results achieved with NASA's scanning of electron microscope may lead to successful early screening of CF. Savings in dollars, man-hours and other resources are impossible to estimate. However, application of the S.E.M. to CF detection simply could not have been performed without NASA's contribution, at this time nor in the near future, because such equipment is not available in this part of the U.S.

Mr. Doggett explained that his association with Dr. Craig Fisher at MSC and 8 hours per week use of the scanning electron microprobe have been an invaluable asset in determining the feasibility of his approach of detecting CF in infants.

TRANSFER REPORT
NWR-6

"The Effects of Electromagnetic and Acoustic Fields on Living Organisms"

Dr. Arthur W. Guy
University of Washington
Seattle, Washington

Problem Acquired - November 1968
Transfer Made - December 1969
Elapsed Time - 13 Months

Description of Problem

The Problem Originator desired to learn as much as possible from NASA technology pertaining to the effects of physical fields (ultrasonic and electromagnetic) on living organisms and tissue. Based on this information, the Problem Originator anticipated formulating specific research to attack problems in this area which have not been adequately solved. He expressed interest in both thermal and non-thermal effects of these physical fields. Through the use of modern computer technology, plastic modelling techniques, and thermographic instrumentation, the investigator hoped to quantitatively improve the research approaches to these problems.

Description of Solution

Since the problem originator's requirement was primarily informational in nature, a computerized search of the NASA data bank (WESRAC) was executed to investigate and produce literature concerning the effect of non-ionizing radiation (ultrasonic, radio, radar frequencies, 20 Kc to 100 gc) on living organisms (man, animals). The search also included the effects of electric and magnetic fields. The results of the search were used by the Problem Originator to prepare a document in a study program of the Biomedical Engineering Society. Updated reports, and Russian translations provided significant contributions to the report. Federal standards in electromagnetic safety levels are being revised, and the report is expected to be an important basis for these revisions.

Successful Search Method

Computer search by WESRAC

Benefits to be Derived from Transfer

A report prepared by the Problem Originator, which included updated reports and Russian translations from the NASA data bank, is expected to play an important role in revision of Federal standards regarding electromagnetic safety levels.

TRANSFER REPORT
SFM-3

"Improved Monitoring of Heart Cell Parameters"

Mr. Harry A. Miller
School of Medicine
Stanford University

Problem Acquired - August 1968
Transfer Made - August 1969
Elapsed Time - 12 Months

Description of Problem

The researcher is investigating the effect of various pharmacological agents upon several parameters of isolated heart cell activity, such as rate of contraction. At the time the problem was submitted, observation of this cellular activity was performed visually on a periodic basis by a human observer using a phase contrast microscope. An automated system was needed to provide for continuous monitoring of the heart rate.

Description of Solution

Several avenues were utilized to effect a solution to the problem, including a computerized search of the NASA data bank and a liaison with researchers at various NASA research centers. A data search failed to yield a solution to the problem; however, it provided much valuable information for the researcher. Solution to an important portion of the problem was attained with assistance provided by Mr. John Pope, Instrumentation Division, Ames Research Center, National Aeronautics and Space Administration, who had previously developed a linear, low-frequency response cardiotachometer for employment in animal experimentation. Although in its existing form the NASA-developed tachometer failed to meet the precise requirements of the researcher, NASA was able, by some reengineering effort, to modify the equipment to meet the researcher's needs. This involved circuit modifications designed to provide a lower linear frequency limit of 10 bpm which was needed for the researcher's particular application. Prior to reengineering, the NASA tachometer's lower linear frequency limit was 30 bpm. The reengineering effort also involved the development of an improved interface between the recording apparatus and the cardiotachometer, thereby facilitating the use of the NASA-developed tachometer in the research effort.

Successful Search Method

Computer search by WESRAC

Benefits to be Derived from Transfer

Research of the nature described above, in which the effects of various pharmacological agents are evaluated upon isolated cardiac cells, is expected ultimately to lead to techniques whereby localized heart therapy will be possible. That is, instead of being constrained to treat the entire heart, the techniques will permit treatment of localized, damaged or diseased areas of cardiac musculature. In terms of benefits to the researcher, the NASA-developed and reengineered cardiotachometer facilitated research progress by providing a means for continuously, automatically monitoring the activity of isolated heart cells or clones of cells. Prior to the availability of the NASA equipment, observations were crudely performed by visual observation using a phase contrast microscope, during which time the cellular contractions were counted. Out of practical necessity, this important phase of the research had to be accomplished on a periodic rather than on a continuing basis. The NASA-provided equipment substantially increased the accuracy of observations, saved untold man-hours of observational effort, and significantly expedited progress on the overall research task. In addition, the data provided by the computerized search proved to be extremely useful to the research in proceeding toward the development of a mathematical model dealing with the force--or amount of work--involved in the contraction of cardiac cells.

TRANSFER REPORT
UTM-19

"Electodes for Measurement of
Heart Rate in Active Experimental Animals"

Dr. Sanford Topham
University of Utah
Salt Lake City, Utah

Problem Acquired - January 1970
Transfer Made - January 1970
Elapsed Time - 1 month

Description of Problem

The investigator is engaged in experiments which involve the measurement of heart rate on dogs running on a treadmill at a rate from 1 to 6 miles per hour. This requires the attachment of electrodes to the animals and hard wire leads routed to the recording instruments. Problems have been encountered in attaching the electrodes with subcutaneous, taped and strapped electrode placement techniques all proving unacceptable. They do not permit acquisition of reliable data, due to the activity of the dog either producing motion artifacts or tearing the electrodes away from the skin.

The investigator asked for any NASA technology concerning unique electrodes or electrode placement technique which would assist in overcoming the difficulties described above. The electrodes or attachment technique should be non-irritating to reduce the possibility of the dog trying to remove the electrodes.

The dry electrode method developed at the NASA Flight Research Center, Edwards, California, for EEG and ECG electrode application to active human subjects (NASA Technical Note NASATND-3414) appeared to meet the requirements outlined by the researcher. The method developed is rapid, well suited to the active subject and results in neither bulk nor significant discomfort. The experimental subject rapidly adjusts to the presence of the dry electrodes and does not notice their presence. The electrodes being non-irritating, the experimental animal is not inclined to try to pull, claw, or bite them off the skin. Accordingly, a comprehensive packet of materials concerning the electrical characteristics of the electrodes, their application, use and commercial source was provided to the investigator. After evaluating the technique, the investigator found that the NASA-developed dry electrode technique met his particular requirements.

Successful Search Method

Awareness by BATeam of existing NASA Technology.

Benefits to be Derived From the Transfer

Use of the NASA-developed dry electrode technique will permit the investigator to more adequately measure heart rate on experimental animals subjected to extreme activity on a treadmill. In the past, such measurement has been difficult to obtain because the activity of the animal interfered with adequate placement of the electrodes, and their retention in place. Major benefits to be derived from use of the technique involve increased reliability of the data gained (by minimizing motion artifacts) and saving of time to gather data (by minimizing the necessity to repeat an experimental sequence because the animal tears the electrodes off).

TRANSFER REPORT
WSM-6

"High Power Infrasonic Wave Generator"

Donald W. Baker
University of Washington
Seattle, Washington

Problem Acquired - March 1969
Transfer Made - June 1969
Elapsed Time - 3 Months

Description of Problem

Researchers at the University of Washington School of Medicine are studying the disease atherosclerosis by means of analog mechanical/fluid models. It is anticipated that such studies, which focus upon the dynamic behavior of a model of atherosclerosis, may well lead to the development of additional means of assessing the severity of atherosclerosis as the disease develops.

A primary aspect of these studies involves the correlation between the dynamic stresses generated in experimental situations and their correlation to analog methods. This in turn involves several distinct considerations: the experimental generation of stress waves, and their detection, principally in a liquid filled tube; and the analysis of the phenomena, principally leading to the numerical solution of a simulated condition. In the study emphasis has been placed on the experimental portion, particularly with regard to the generation and detection methods for dynamic stresses. Methods used to generate the required pulsatile pressure disturbances included internal pistons and wall deformation devices. However, these sufficed only to provide gross means of experimentally simulating hypothetical dynamic stress situations, often producing much confusion when attempts are made to interpret the results.

Previous methods for investigating the dynamic behavior of fluid filled tubes have always assumed that the wall properties would remain uniform over the length of the tube. Attempts to apply this information to the problem of pulse wave transmission in arteries have been successful because of the assumption of uniform wall properties. In addition, consideration was not given to the time varying properties of atherosclerosis. The possibility of obtaining diagnostic information about the composition of the arterial wall, in addition to the presently attainable geometric information, will lead to the detection of pathological situations at an earlier time in its history than can presently be done.

To solve the previously outlined problem, the investigator needed a pressure generator programmable by analog signals, and capable of producing pressures ranging from 0 to 300 mmHg, with frequencies from DC to 100 cps.

Description of Solution

Upon receipt of the problem, the team was able to make an immediate recommendation concerning a possible solution due to awareness of related technology at NASA/Ames. This installation had available a dynamic servo-controlled electromagnetic shaker capable of operation at close to the DC level and upwards to 100 cps or better with a force output of 50 pounds. The device was developed originally for study of aerodynamic flutter of wing surfaces. Arrangements were mady with NASA/Ames to have the equipment loaned on a long term basis. As a result, the investigators were enabled to generate impulses and continuous waves at force levels not previously possible.

Successful Search Method

Awareness by BA Team member (Mr. A. G. Buck) of a specialized area of technology being developed at NASA Ames Research Center.

Benefits to be Derived from the Transfer

The contribution to medicine can be seen at the present time as a study showing the relative bounding parameters for information retrieval and analysis that can be obtained with the use of ultrasonic detection equipment for the diagnosis of presymptomatic atherosclerosis. Hence, the study is designed to direct future studies in the manner that the greatest amount of information can be obtained, and to place a bounding limit on the information that can be resolved.

The future benefits that may develop are the most meaningful of all in that the study is geared around the development of a new type of diagnostic procedure for atherosclerosis that will be able to assess changes in the arterial wall at times significantly before the plaque begins to invade the lumen.

Loan of the NASA unit saved somewhere in the order of $5,000 for the University of Washington in direct costs relating to the purchase of the device. Since the project was not receiving direct support on any specific grant or budget, this amount of money would have amounted to the greatest single expense for purchase of equipment.

2. Reports on Potential Transfers

BLM-11 "On-Line Analysis of Biochemical Samples Collected Automatically from Patients"

The Problem Originator requested all available information concerning techniques associated with automatic collection of blood, urine, and plasma samples and on-line analysis of the substances contained within the biochemical sample. This data was obtained from the NASA data bank and the requirements for the problem were filled. The material is being used by the Problem Originator to prepare an application for additional funds to the National Institutes of Health regarding the development of on-line biochemical monitoring.

BLM-11a "On-Line Analysis of Biochemical Samples Collected Automatically from Patients"

The problem is to develop an automatic on-line biochemical monitoring system. A detailed report of a highly miniaturized urine analysis instrument developed by JPL for the Biosattellite III program was sent to the Problem Originator. Much of the methodology presented in this report was used in preparation of a proposal to the National Institutes of Health for further funding for improving on-line biochemical monitoring systems. The problem has been made inactive.

BLM-13 "Nonthrombogenic Material for Use as a Blood Interface"

According to the NASA flash sheets, a material applicable to this problem is in existence. However, extensive searches and contacts have failed to reveal the location of the material. The Problem Statement is presently in the process of being approved for dissemination to the NASA Centers. It is hoped that the location of the nonthrombogenic material will be brought to the attention of the SwRI BATeam from the circulation of the Problem Statement.

CAP-1 "Apparatus for Telemetering GSR in Natural Social Settings"

A device has been found which, with modification, will answer the requirements of the problem. This problem has been submitted to NASA as a candidate for reengineering.

DLM-2 "Temperature Measurement of Brain Core in the Laboratory Rat"

Material was found from a manual literature search of the NASA data bank and material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited before proceeding with the final transfer report.

DLM-6 "Measurement of Respiration Parameters of Cardiovascular Patients"

Material was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited before proceeding with the final transfer report.

DVM-4 "Automatic Atraumatic Blood Pressure Measurement"

An ultrasonic Doppler blood pressure apparatus developed by Southwest Research Institute for the United States Air Force was improved on a contract funded by NASA. This unit and a NASA/USAF document showing how to fabricate this unit was sent to the Problem Originator. He has recently stated that the method has proved very useful and that the ultrasonic method is far superior to other methods. The Problem Originator intends to build his own unit. A transfer report will be forthcoming.

GLM-14 "Repetitive Measurement of Kidney Mass in Intact Animal"

It was discovered that ultrasonic equipment and facilities which might be used in the solution of this problem was in existence at Marshall Space Flight Center. However, efforts to obtain a loan of this equipment has failed. Therefore, the problem has been closed.

GLM-15 "Respiration Volume and Rate Measurements in Unencumbered (Free) Child"

(GLM-15) A possible solution was obtained from a Center response to the disseminated Problem Statement from Electronics Research Center. However, the device, a breathing monitor developed by Electronics Research Center, will require extensive reengineering to be effective. The problem is in the process of being submitted as a candidate for applications engineering.

GLM-16 "In-Situ Tumor Mass Determination on Rat Leg"

This problem is very similar to GLM-14 and was closed for the same reason--it was discovered that ultrasonic equipment and facilities which might be used in the solution of this problem was in existence at Marshall Space Flight Center. However, efforts to obtain a loan of this equipment has failed. Therefore, the problem was closed.

NWR-1 "Motion Pattern Measurement of Patients"

The literature search was used for background information only, and no directly relevant information appears to have been located. The Problem Originator suggested that the problem be inactivated.

NWR-5 "Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section"

A probable solution was given to the Problem Originator as a result of the circulation of the Problem Statement. A final transfer report will be written as soon as an evaluation is obtained from the Problem Originator.

RNV-10 "Sensors for Measuring Foot-Floor Impact Forces"

The Problem is awaiting the results of a grant application before proceeding with the problem. Therefore, the problem was inactivated.

RNV-13 "Improved Laryngoscope for Use in Disabled Children"

A promising artical was retrieved from the WESRAC search and sent to the Problem Originator. The material

(RNV-13) was commercially available but needed slight modification to be precisely relevant to the problem. The Problem Originator's proposal for funding was accepted, and a contract for the production of the fibre-optics laryngoscope is in negotiation. Therefore, the problem is inactivated.

RNV-14 "Materials for Prevention of New Decubitus Ulcers"

Solutions have been suggested by NASA researchers in response to the circulated Problem Statement that gave an acceptable solution to the problem. However, since additional Center responses valuable to the problem solution have continued to be received, no effort has been made to close the problem or submit a final transfer report.

RNV-28 "Accelerometer for Human Motion Studies"

Information on a commercial source of applicable equipment was found via a NASA Tech Brief and the TUO at Ames Research Center. The commercial source suggested that the Problem Originator fabricate his own triaxial accelerometer from single axis units. The Problem Originator is considering this information.

SNM-4 "Improved Technique for Measurement of Skin Thickness"

Information was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited before proceeding with the final transfer report.

SNM-5 "Implantable Telemetry System for EKG"

A manual search of the NASA literature produced a document containing circuitry information for a subminiature biotelemetry unit for remote physiological investigations. Detailed information concerning this unit was forwarded to the Problem Originator who is in the process of fabricating a replica of the NASA unit which will be suitable for long term implantation in primates subjected to heart transplantation.

SWC-1 "Improved Techniques for Taking EEG in Infants and Small Children"

A device has been found which, with modification, will answer the requirements of the problem. This problem has been submitted to NASA as a candidate for reengineering.

UTM-7 "Chronic Electrode Implantation Technique for Artificial Eye Research"

Information was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited before proceeding with the final transfer report.

UTM-9 "Tidal Volume Measurements in Respiration Studies"

Information was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator. He has indicated that the information seemed very promising. He is presently fabricating a transducer for experimentation. A final transfer report will be submitted later.

WSM-7 "Sensitive Detection for Human Electric Field Application"

It was discovered that equipment and facilities applicable to this problem is maintained by Ames Research Center. Arrangements were than made for discussions between University of Washington and Ames Research Center regarding future collaborative research work. A proposal will eventually be written based upon such joint effort. The problem was closed.

3. Reports on "Impacts"

IMPACT

CAP-3 Noncomputerized Reduction of Data Recorded Via Conventional Polygraph Techniques

Behavioral scientists at Claremont Graduate School, Claremont College, California are conducting various experiments to determine the feasibility of employing electromechanical means for modifying behavior. An important phase of this research involves telemetering the galvanic skin response (GSR) of delinquent adolescents as they interact in their natural social settings, e.g., home, school and hang-out. Presently, the GSR is obtained from electrodes applied to the plantar region (inner aspect of the instep) which are connected to a transmitter via a connecting link concealed in the trouser leg. The transmitter is placed at a convenient concealed location on the delinquent's person, since the delinquent would not be accepted in the social group if it became obvious that he was instrumented. The procedure involves collection of a large amount of data which must be reduced.

Presently the data which is gained from the experiment outlined above is recorded on a conventional Beckman type RM polygraph strip chart. This involves acquisition of a substantial amount of data which, for maximum benefit, must be reduced to manageable proportions. The information of interest derived from the recordings involve the level of GSR telemetered (either on a time-sampling basis or individual indications) that a GSR of a certain magnitude occurred. The investigators require a <u>noncomputerized</u> technique (cost under $600) to reduce the data recorded on the conventional Beckman type RM polygraph strip chart, in a rapid economical manner.

Search of the NASA literature revealed a pulse-height analyzer (described in NASA Tech Brief 69-10640) which, if modified considerably, could solve the investigator's problem. However, the estimated cost involved in the modification would exceed the investigator's limit of $600 for any proposed solution. This being the case, the SwRI Biomedical Application Team was unable to effect a transfer. However, a significant service was afforded since the Biomedical Application Team was able to suggest an alternative (non-aerospace) means to solve the investigator's problem. This involved use of a special input coupler (custom-provided by Beckman Instrument Division, Offner Division) to record pulses on an unused channel of the Offner RM polygraph used by the investigator. This permits manual counting of the pulses that correspond to each division of the GSR pulse height. It also permits manual determination of duration at discrete levels.

Though a solution was not derived from NASA technology, the investigator nevertheless expressed enthusiastic support for the Biomedical Application Program, particularly with regard to the thoroughness of the literature searches provided. The present problem constitutes part of a larger problem area (three distinct problems dealing with acquisition, telemetry and reduction of GSR data of delinquents interacting in their natural social setting). The acquisition and telemetry parts of the problem area are amenable to solution via aerospace technology and are being actively pursued.

IMPACT

DVM-4 Automatic Atraumatic Blood Pressure Measurement

The investigator needs to measure blood pressure in conjunction with a variety of tests with humans. Needed blood pressure data have been difficult to obtain reliably, particularly since the Korotkoff method is difficult to automate. This latter method is also subject to artifact caused by body motion and airborne acoustical noise. The investigator expressed the need for an automatic atraumatic system to measure blood pressure which was immune to such artifacts. Use of an occlusive cuff was not specified as a limiting factor. The investigator suggested that NASA technology dealing with ultrasonics might be productive of a solution to the problem.

In reviewing the aerospace ultrasonics literature, it was determined that an ultrasonic Doppler blood pressure apparatus developed by the U. S. Air Force (and later improved under NASA Contract F33615-69-C-0126) would meet the investigator's needs. Since one of the ultrasonic Doppler blood pressure measurement devices was locally available to the SwRI Biomedical Application Team, arrangements were made to loan the device to the Problem Originator. According to the Problem Originator, the ultrasonic Doppler unit is extremely satisfactory for his research application. However, provision of the information and unit does not qualify as a transfer, since the investigator is using the equipment for the same application for which it was developed.

IMPACT

UTM-10 Compensatory Tracking

Research into conditions and techniques which allow men to best perform multiple tasks simultaneously requires much testing of attention spans, reaction times, and the ability to ignore spurious noises and random distractions. The Problem Originator wishes information on compensatory tracking devices, tracking trainers, etc., developed in the aerospace industry to determine if such devices could be applied to his research program.

In defining the problem, the Problem Originator indicated that he needed a device that would integrate the output of the tracking device to evaluate the performer's total error over given periods of time. It seemed probable that NASA technology would contain information pertinent to the problem. However, searching of the NASA data bank failed to yield a direct solution to the problem, even though a number of articles from the NASA data bank proved valuable in defining some additional experimental requirements. Failing to find a solution from the aerospace literature, Mr. Bob Wilbur, a member of the SwRI Biomedical Application Team was able to solve Dr. Johnston's problem by applying his specialized knowledge towards designing the necessary signal conditioning circuitry. The Engineering Department of the University of Utah is using the design to fabricate the needed equipment. Dr. Johnston is quite pleased with the searching and assistance provided by the Biomedical Application Team. As a result of team assistance, we expect Dr. Johnson to submit additional meaningful problems.

D. TEAM CONTACTS

VISITS TO USER INSTITUTIONS

INSTITUTION	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
Baylor University College of Medicine			6	15	21
Brook Army Medical Hospital				1	1
Cedars of Lebanon				1	1
Claremont Graduate School				4	4
Dallas Veterans Administration Hospital				9	9
Loma Linda University School of Medicine				1	1
Medical School, UCLA				1	1
Medical School, University of Southern Cal.				1	1
Northwest Handicapped Center					0
Rancho Los Amigos Hospital	2	10	1	2	15
Robert B. Green Hospital, San Antonio				1	1
Scott-White Clinic and Hospital				16	16
Stanford University Medical School					0
Texas Institution for Rehabilitation & Research	3				3
University of Arizona College of Medicine			7		7
University of California, Davis			3		3
University of California, Irvine				1	1
University of New Mexico		1	2		3
University of Oklahoma Medical School				4	4

(Cont'd)

VISITS TO USER INSTITUTIONS (Cont'd)

INSTITUTION	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
University of Texas Dental Branch, Houston		2	2		4
University of Texas Dental Branch, Galveston		1	1	4	6
University of Texas Medical School, San Antonio		2		2	4
University of Texas Southwestern Medical School		1	1	10	12
University of Utah School of Medicine			1	20	21
University of Washington School of Medicine				2	2
Veterans Administration Southern Research Support Center	4				4
Rice University			1		1
TOTAL	9	17	25	95	146

CENTER RESPONSES TO DISSEMINATED PROBLEM STATEMENTS

PROBLEM	Hdq.	MSC	LaRC	NASA Centers			MSFC	JPL	Ames	ERC	Total
				LeRC	JFK	SNPO					
BLM-10					1		1				2
BLM-14											0
GLM-3				1							1
GLM-9				1							1
GLM-14						1	1			1	3
GLM-15		1		2		1	1	1			6
GLM-19		1		3							4
GLM-20			1	1					1		3
HUV-17			1	1	1						3
NWR-5				1			1		1		3
RNV-14			4	2					1		7
SNM-3											0
SRS-8B	1		1	1	1				1		5
WSM-1	1		2	2	1						6
TOTAL	2	2	9	15	4	2	4	1	4	1	44

E. LITERATURE SEARCH EVALUATION REPORTS

1. Computer Search Evaluation Reports

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-10 Computer Programs and Systems for Analysis of the Electro-cardiogram
Problem Code and Title

WESRAC	same title, (47-424)	4
RDC	Title Search, RDC No.	No. of Hits
18 June 1969	29 June 1969	7 July 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Computer Programs, Electrocardiogram, Interface, Analysis, Screening, Systems, Diagnostic.

Team Evaluation: Several of the abstracts are applicable toward a solution of the problem; however, there were not as many documents on ECG analysis as had been expected before the search. The search was probably not as helpful as the Problem Originator expected.

Researcher Evaluation: Approximately 25% of the search materials were relevant to the problem. The search failed to cite recently published work of Cesar Caceres in the area of interest, although earlier works were included as citations.

Documents Requested by Researcher:

	A 66-24227,	N 64-31537
August 1969	(4) A 69-80204,	N 69-16349
Date:	No. of Requests, STAR Nos.	

Relevance of Information to Problem: Material did not go beyond previously available information.

Researcher's Plans for Use of Information: Retain for future reference.

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-11 On-Line Analysis of Biochemical Samples Collected Automatically from Patients
Problem Code and Title

WESRAC	On-Line Analysis of Biochemical Samples (47-431)	25 / 6
RDC	Title Search, RDC No.	Hits/Direct Hits
2 July 1969	28 July 1969	29 July 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Sampling, Analysis, Automatic, Computer, On-Line, Biochemical, Blood, Urine, Plasma

Team Evaluation: The initial screening was fair: 6 - applicable
8 - marginal
11 - not applicable

Researcher Evaluation: Excellent. Abstracts were very helpful. Researcher stated that he would gladly take advantage of a similar search when he has another project open for investigation.

Documents Requested by Researcher:

November 10, 1969	(3) N 66-26260, N 62-11697, N 62-12979
Date:	No. of Requests, STAR Nos.

Relevance of Information to Problem: Search revealed information which would not have been ordinarily available to the investigator.

Researcher's Plans for Use of Information: The documents will be used to gain ideas in assembling the biochemical system and for requesting additional NIH funding.

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-12 Flexible Material for Connecting Electrical Stimuli to Nerves Without Damage		
Problem Code and Title		
WESRAC	Flexible Material for Connecting Electrical Stimuli to Nerves Without Damage 47-466	19 Hits 4 Pertinent
RDC	Title Search, RDC No.	No. of Hits
18 Sept. 1969	3 October 1969	31 October 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Flexible electrodes, electrically conductive soft compounds, conductive particles, implanted electrodes, nerve electrode, inert conductor, Silastic conductor

Team Evaluation: The search produced four references which may be of interest to the Problem Originator. Since two probable solutions to the problem had been found before the search results came back from WESRAC, there is less than the usual amount of enthusiasm for following up the rather abstract suggestions in the references.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-13 Nonthrombogenic Biomedical Material Suitable As A Blood Interface

Problem Code and Title

WESRAC	47-497 Nonthrombogenic Biomedical Material Suitable As A Blood Interface	10 Hits 6 Pertinent
RDC	Title Search, RDC No.	No. of Hits

3 November 1969	13 November 1969	18 November 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Nonthrombogenic biomedical material, implantable materials, nonbiotoxic implantable material, blood interface, blood compatible material, thromboresistant material, non-carcinogenic blood interface, biocarbon interface.

Team Evaluation: The search yield was exceptionally small (10 citations). Approximately 60% of the citations were pertinent. A second, expanded, search is requested.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-14 A Compound Conduit for Chronically Surviving Animal
Problem Code and Title

WESRAC	47-518 Compound Conduit	9 cited 1 applied
RDC	Title Search, RDC No.	No. of Hits

2 December 1969	10 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Tetherline, Umbilical, Swivel, Union, Coupling, Implantation, Connector, Nerve, Conductor, Hydrostatic, Disconnector

Team Evaluation: This was a disappointing search in terms of both yield and pertinence of recovered documents.

Researcher Evaluation: Although a number of the documents appeared to be of interest only one of the ten references listed by the search was pertinent to the problem.

Documents Requested by Researcher: 4

12 January 1970	A69-11865, A68-82053, A66-16852, A66-29499
Date:	No. of Requests, STAR Nos.

Relevance of Information to Problem: Little of the information was directly pertinent to the problem.

Researcher's Plans for Use of Information: This information is not being used at this time.

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-15 Determination of Physical Chemical State of Ions and Water in Living Cells

Problem Code and Title

WESRAC	47-519 Location of Na Ions in living skeletal muscel fibers & other cells	16 cited 5 applied
RDC	Title Search, RDC No.	No. of Hits

1 December 1969	12 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Ions, Sodium Ions, Metal Ions, Ion Distribution

Team Evaluation: The search failed to produce information leading to transfer of NASA technology. Some information recovered proved of general interest.

Researcher Evaluation: None of the references cited by the search was pertinent to the strict request of the problem; however, several of the references appear promising for later study. Additional searching is requested.

Documents Requested by Researcher: yes; unknown

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem: Little.

Researcher's Plans for Use of Information: yes; unknown

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

BLM-16 Measurement of Electrolyte Concentrations in Renal Medulla and Papula
Problem Code and Title

WESRAC	47-526 Renal Ion Probe	17 cited 9 applied
RDC	Title Search, RDC No.	No. of Hits

8 December 1969	19 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Ion Probe, Potassium, Sodium, Chloride, Monitor, Sensor, Ion, Ion Concentration, Etc.

Team Evaluation: The search failed to provide a solution from NASA technology, though it did provide interesting and useful information.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

DVM-1 Non-Destructive In-Vivo Measurement of Mechanical Properties of Tissue
Problem Code and Title

WESRAC	same title, (47-525)	6
RDC	Title Search, RDC No.	No. of Hits
8 Dec. 1969	23 Dec. 1969	29 Dec. 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Mechanical Properties, Tissue, Tendons, Non-Destructive Testing

Team Evaluation: Considering the constraints imposed by rigidity of accession terms, the search produced some potentially useful information. A transfer on the basis of the search results alone is not anticipated.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

GLM-20 Continuous Destruction of Lymphocytes Under Sterile Conditions
Problem Code and Title

WESRAC	same title, (47-418)	
RDC	Title Search, RDC No.	No. of Hits
21 May 1969	12 June 1969	2 July 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Biological Destruction, Inactivation, Depletion, Lymphocytes, White Cell, Cell Wall Rupture, Biological Effects of Ionizing Radiation, Chylomicrons, Ultraviolet Radiation, Ultrasonic Vibration, Cavitation, Vacuole, Electric Fields, Hemolysis, Hemolytic Surfaces, Lymph

Team Evaluation: Fair - Lacking in quantity

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

RNV-21 A Wireless Synchronization Link
Problem Code and Title

WESRAC	same title, (47-520)	14 / 0
RDC	Title Search, RDC No.	Hits/Direct Hits
1 December 1969	16 December 1969	23 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Ultrasonic Generator, Telemetry, Acoustic, Sound Transmission, Command Control

Team Evaluation: None of the cited abstracts appear useful except as background material.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

SFM-6 Small Wide-Band Microphones for Sensing Heart Signals
Problem Code and Title

WESRAC	Small Wide-Band Microphones for Sensing Heart Signals:47-457	32 cited 9 applicable
RDC	Title Search, RDC No.	No. of Hits

26 August 1969	17 September 1969	18 September 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Microphone, Pressure Microphone, Sound Detector, Phonocardiography, Miniature Equipment.

Team Evaluation: Good search although microphones with the required characteristics were not found.

References cited:	32
applicable:	9
questionable:	10
not applicable:	13

Researcher Evaluation: On the whole, he found the search very useful, although it offered no solution to the problem. The Problem Originator stated that out of the 32 references cited, 6 were applicable, 7 were questionable, and 19 were non-applicable. However, several of those listed as "non-applicable" abstracts were of major use in some of his other areas of interest.

Documents Requested by Researcher: none

Date: _____ No. of Requests, STAR Nos. _____

Relevance of Information to Problem: The search was relevant to microphones but not to the specific characteristics required for this problem.

Researcher's Plans for Use of Information: none at the present time.

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

SNM-2 Methods of Electrosleep and Electroanesthesia
Problem Code and Title

WESRAC	47-521 Methods for Electrosleep and Electroanesthesia	19 cited 19 applied
RDC	Title Search, RDC No.	No. of Hits

24 November 1969	11 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Electrosleep, Electroanesthesia, Electronarcosis

Team Evaluation: The search produced pertinent information, since the problem posed was general in nature.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

SNM-3 Modification of Surface of Controlled Pore-Size Glass to Eliminate Adsorption

Problem Code and Title

WESRAC	47-522 Virus Isolation	9 cited 0 applied
RDC	Title Search, RDC No.	No. of Hits

1 December 1969	15 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Adsorption, Chromatography, Virus, Purification, Lyophilization, Etc.

Team Evaluation: The search was very poor with no relevant articles obtained.

Researcher Evaluation: None of the nine abstracts was pertinent.

Documents Requested by Researcher: None

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem: None

Researcher's Plans for Use of Information: None

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

SNM-4 Device for Obtaining Precision Measurements of Skin Thickness
Problem Code and Title

WESRAC	47-523 Measure of Skin Thickness	5 cited 0 applied
RDC	Title Search, RDC No.	No. of Hits

4 December 1969	19 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Body Fat Measurement, Skin Thickness Measurements, Measurement Recording

Team Evaluation: There was a poor search yield both on quantity and quality.

Researcher Evaluation: While not productive in solving the problem, the search results will be useful in teaching and other related research.

Documents Requested by Researcher: yes; unknown

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem: Little

Researcher's Plans for Use of Information: Possibly for teaching and additional related research.

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

SRS-53 Means of Obtaining the Velocity Spectrum of Blood Flowing in Arteries and Veins
Problem Code and Title

WESRAC	Analysis of Ultrasonic Doppler Signal (47-442)	22
RDC	Title Search, RDC No.	No. of Hits

24 July 1969	4 August 1969	5 August 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Ultrasonics, Doppler, Average Velocity, Velocity Descrimination, Sonar, Target Identification, Flow Velocity, Velocity Spectrum, Ultrasonic Flowmeters

Team Evaluation: Fair - not directly applicable.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

TCM-1 Blood Flow of Individual Red Cells in Capillaries of Living Tissue
Problem Code and Title

WESRAC	47-524 Blood Flow of Individual Red Cells in the Capillaries of Living Tissues	11 cited 5 applied
RDC	Title Search, RDC No.	No. of Hits

8 December 1969	19 December 1969	24 December 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Erythrocytes, Counting, Velocity-Measurement, Phototubes

Team Evaluation: The search failed to provide a solution from NASA technology, though it did yield some peripherally useful information.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

BIOMEDICAL COMPUTER EVALUATION REPORT
SOUTHWEST RESEARCH INSTITUTE

WSM-7 Sensitive Detector for Human Electric Field Application
Problem Code and Title

WESRAC	Detection of Very Weak Human-Body Electric Fields (47-438)	32
RDC	Title Search, RDC No.	No. of Hits
14 July 1969	1 August 1969	5 August 1969
Dates: Search Initiated	Received by Team	Forwarded to Originator

Descriptors: Magnetic Field, Electric Field, Electrostatic Field, Probe, Measurement, Instrumentation

Team Evaluation: Fair - Incomplete, lacking in quantity.

Researcher Evaluation:

Documents Requested by Researcher:

Date: No. of Requests, STAR Nos.

Relevance of Information to Problem:

Researcher's Plans for Use of Information:

2. Manual Search Reports

BLM-17 "Improved Procedure to Measure Regional Blood Flow in Kidney"

TOTAL HITS: "64"

SEARCH TERMS: biological monitoring, implant electrodes, bio-instrumentation, biological tissue, high impedance electrode, hydrogen detector, ion probe, cell biochemistry, blood chemistry

BLM-21 "Artificial Membrane Interface"

TOTAL HITS: "11"

SEARCH TERMS: artificial heart, Ostwald's electric heart, surface tension at mercury interfaces, electrolytic reactions, potassium bicromate catalysis, surface tension and electric charge, mercury-iron polarization

BLM-22 "Expired Oxygen Analysis"

TOTAL HITS: "13"

SEARCH TERMS: mass spectrometer, infrared absorption analyzer, rapidly resounding gas analyzer, oxygen analyzer, quantitative oxygen detector, oxygen meter, continuous method oxygen recorder (analyzer)

BLM-23 "Germ-Free Hamster Colony"

TOTAL HITS: "37"

SEARCH TERMS: grem free atmosphere, germ free diet, experimental animal nutrition, germ free experiment, gnotobiology, gnotobiotic diet, hamster gnotobiology, germ controlled enviornment

BLM-24 "X-Ray Exposure & Gravitational Effects on Body Functions"

TOTAL HITS: "101"

SEARCH TERMS: x-irradiation, weightlessness, zero gravity, circulatory function at zero gravity, kidney function at zero gravity, respiratory function at zero gravity, cardiac function at zero gravity

DLM-1 "Pressure Measurement of Brain Ventricals and Renal Arteries of Rat"

TOTAL HITS: "31"

SEARCH TERMS: semiconductor, pressure transducer, pressure measurement, miniature pressure transducer

DLM-2 "Temperature Measurement of Brain Core in the Laboratory Rat"

TOTAL HITS: "31"

SEARCH TERMS: temperature transducer, miniature temperature transducer, thermistors, resistance thermometer

DLM-3 "Blood Flow Measurement in Renal Artery of Laboratory Rat"

TOTAL HITS: "26"

SEARCH TERMS: Doppler flowmeter, ultrasonic probes, catheter tip blood flow transducers, electromagnetic flowmeters, electromagnetic flow transducers

DLM-4 "Doppler Probe Holder and Stand For Measurement Of Fetal Circulation"

TOTAL HITS: "1"

SEARCH TERMS: positioners, holders, flexible holders, semi-rigid positioners

DLM-5 "Measurement of Fetal Circulation From Transcutaneous Transducers"

TOTAL HITS: "20"

SEARCH TERMS: Doppler flowmeters, pulse echo measurements, time domain reflectometry, ultrasonic scanning

DLM-6 "Measurement of Respiratory Parameters of Cardiovascular Patients"

TOTAL HITS: "15"

SEARCH TERMS: pneumotachometer, tidal volume measurement, impedance ventilometer, impedance pneumograph

DLM-7 "Monitoring of Chest Wall Vibrations Related to Cardiac Activity"

TOTAL HITS: "7"

SEARCH TERMS: impedance pneumograph, pneumotachometer, cardiac microphone impedance ventilometer, cardiopulmonary dynamics, cardiac, respiratory impedance, biotelemetry, body temperature, thermistor

DLM-8 "Temperature Measurement by Telemetry of Patients During Exercise and Occupational Activities"

TOTAL HITS: "15"

SEARCH TERMS: biotelemetry, temperature measurement, body temperature telemetry, body temperature measurement, thermistors, physiological instrumentation

DLM-9 "Aerial Image-Fiber Optics Interface"

TOTAL HITS: "39"

SEARCH TERMS: indirect ophthalmoscopy, ophthamology, eye exam, fiber optics, fiber optic cable, aerial image, interface

DLM-10 "Precision Optical Plastics Fabrication"

TOTAL HITS: "14"

SEARCH TERMS: acrylic, lens, optical, instruments, eye examinations, eye pieces, plastics fabrication, plastic material, ophthalmology

DLM-11 "Improved Teaching Techniques on Medical Subjects"

TOTAL HITS: "23"

SEARCH TERMS: audiovisual, education, training, sound films, videotapes, audiotapes, information retrieval, information transfer, information communication, seminar, teaching, library, biotechnology, technology utilization, monograph, systems information

DLM-12 "Automated Circulation Control System for 100,000 Volume Medical Library"

TOTAL HITS: "5"

SEARCH TERMS: automated library, library, information retrieval, literature, computer programs

DVM-1 "Improved Measurement of Mechanical Properties of Tissue"

TOTAL HITS: "71"

SEARCH TERMS: human factors engineering, sensor, biological monitoring, tissue, mechanical properties, non-destructive strain tests, muscle function tests, stress measurement, plastic deformation, rheology

DVM-5 "Monitoring Blood Gases"

TOTAL HITS: "13"

SEARCH TERMS: pO_2 electrode, bioinstrumentation, blood gas monitoring, blood gas analysis, flexible electrode, blood gases, oxygen metabolism, blood oxygenation measurements

DVM-7 "Requirement for Special Photographic Equipment"

TOTAL HITS: "82"

SEARCH TERMS: vidicon camera, television camera, orthicon cameras, camera, lens, surveillance techniques, space surveillance, color television

GLM-22 "Ear Defenders for Industrial Workers"

TOTAL HITS: "15"

SEARCH TERMS: ear, noise injuries, noise reduction, protectors, sound attenuation, noise hazard, hazard, protective equipment, aviation medicine

GLM-23 "Determination of Attractive Forces Between Red Blood Cells"

TOTAL HITS: "94"

SEARCH TERMS: agglutination, blood flow, blood viscosity measurements, bubble flow, dispersions (flow, viscosity), erythrocyte, flow, hemorheology, poissuille flow, laminar flow, red blood cell, rouleaux formation, suspensions, viscosity

GLM-24 "Portable Stimulator for Esophageal Speech Improvement"

TOTAL HITS: "40"

SEARCH TERMS: bioinstrumentation, biotelemetry, biotechnology, conditioned response, conditioning, electric stimuli, electrode, esophagus, implantation, muscle, physiological telemetry, sensory stimulation, signal generator, speech, training

GLM-29 "Determination of Cerebral Dominance in Man"

TOTAL HITS: "55"

SEARCH TERMS: cerebral dominance, brain, indicators, vocal cords, space crew, space perception, space craft control, speech, psychomotor performance, motor system, muscle function, muscle system, muscle coordination

GLM-30 "Electrical Model for Transmission of Information Within a Single Cell"

TOTAL HITS: "27"

SEARCH TERMS: biological models, bionics, neuron modeling, rheological bass, cell, biological cell

RNV-24 " Anticipatory References"

TOTAL HITS: "20"

SEARCH TERMS: not available

RNV-29 "Manual Controls for Self-Propelled Vehicle (Wheelchair; Automobile)"

TOTAL HITS: "42"

SEARCH TERMS: aircraft control, control equipment, equipment design, human factors engineering, heliocopter controls, man-machine systems, manual control, anthropometry, walking machine, self-propelled vehicle, prosthetics

RNV-30 "Power System for Wheelchair"

TOTAL HITS: "50"

SEARCH TERMS: battery, electric battery, nickel-cadmium battery, fuel cells, storage cell, electric automobile power sources, self-propelled devices, space battery

RNV-31 "Patient Supporting Couches"

TOTAL HITS: "21"

SEARCH TERMS: couch, chair, human body dynamics, human factors engineering, ejection seat, authropometry, seat

SNM-6 "Computerization of Diagnostic X-Rays"

TOTAL HITS: "42"

SEARCH TERMS: computer programs, x-ray diagnostic techniques, radiography, radiology, x-ray analysis

SNM-7 "Information Theory (Shannon's) as Applied to X-Rays"

TOTAL HITS: "25"

SEARCH TERMS: computer design, computer methods, information theory, clinical radiology

SNM-8 "Bone Mineral Measurement Utilizing X-Ray Techniques"

TOTAL HITS: "32"

SEARCH TERMS: bone, densitometers, gamma rays, photon beam, radiation absorption, x-ray analysis, x-ray density measurement

SNM-9 "Chemical Analysis of Biological Molecules Utilizing X-Ray Fluoresence Techniques"

TOTAL HITS: "26"

SEARCH TERMS: biological molecule, biological cell, biochemistry, biophysics, microanalysis, radiobiology, x-ray microprobe analysis, x-ray flourescence, quantitative analysis

UTM-2 "Microminiature Pressure Transducer"

TOTAL HITS: "19"

SEARCH TERMS: miniature pressure transducer, miniature pressure switch, bioinstrumentation, cardio-vascular pressure transducer

UTM-3 "Proton Magnetometer for Use as a Flowmeter"

TOTAL HITS: "41"

SEARCH TERMS: magnetic resonance spectroscopy, proton magnetometer, nuclear magnetic resonance, magnetic resonance, proton resonance, magnetometer

UTM-5 "Dialysis Technique for Artificial Kidney Research"

TOTAL HITS: "28"

SEARCH TERMS: dialysis techniques, water purifiers, deionizer, adsorbant techniques, dialyzer

UTM-6 "Stress Analysis of Artificial Heart Valve"

TOTAL HITS: "45"

SEARCH TERMS: transmission polariscope, photoelastic stress measurements, environmental chambers, cryogenic stress testing

UTM-8 "Biomechanical Analysis of Biological Materials"

TOTAL HITS: "40"

SEARCH TERMS: material characteristics, material analysis, micro-analysis, biomechanics, mechanical properties of tissue, mechanical properties of bone, mechanical properties of arteries, ultrasonic measurement

UTM-10 "Compensatory Tracking Techniques"

TOTAL HITS: "35"

SEARCH TERMS: tracking, tracking trainers, visual tracking, compensatory tracking, tracking error analysis

UTM-11 "Motion Transducer for Studies on Small Animals"

TOTAL HITS: "17"

SEARCH TERMS: bioinstrumentation, biotelemetry, triaxial accelerometer, accelerometers, miniature accelerometers, microminiaturization, miniaturization

UTM-12 "Biotelemetry for Animal Tagging in Ecological Studies"

TOTAL HITS: "71"

SEARCH TERMS: biological monitoring, radio-control systems, physiological telemetry, physiological monitoring, bioinstrumentation, biotechnology, biotelemetry, electrode, free ranging telemetry, animal tracking

UTM-13 "Small Animal Posture Indicator"

TOTAL HITS: "44"

SEARCH TERMS: posture indicator, biotelemetry, bioinstrumentation, biotechnology, biological monitoring, accelerometer, miniature accelerometer

UTM-14 "Animal Position Monitor"

TOTAL HITS: "35"

SEARCH TERMS: not available

UTM-15 "Dust Mills for Aerosol Generation in Environmental Chambers"

TOTAL HITS: "39"

SEARCH TERMS: aerosal generation, particle sizing, dust mill

UTM-16 "Catalytic Heaters for Remote Environmental Chambers"

TOTAL HITS: "16"

SEARCH TERMS: catalytic heater, heat generation, heaters, chemical heater, heat source

UTM-17 "Biotelemetry and Stimulation for Free Ranging Animals"

TOTAL HITS: "65"

SEARCH TERMS: biological monitoring, biotelemetry, radio-control system, physiological monitoring, physiological telemetry, bioinstrumentation

UTM-18 "Peripheral Stimulation Devices with Electrodes"

TOTAL HITS: "8"

SEARCH TERMS: sensory stimulation, test stimulation, electric stimuli, biotelemetry, bioinstrumentation, conditioned response, conditioning

F. PROBLEM STATUS SUMMARY

1. Problems Rejected

DLM-13 "Advanced Critical Components for IBM Computer"

The problem was not accepted because the desired information could be more appropriately obtained from commercial manufacturing sources.

PLR-5 "Automatic Techniques for Identifying Arterial Branches in X-Ray Films"

It was recommended by the Team that known research efforts at MIT be investigated prior to problem acceptance.

RNV-18 "Measurement of Respiratory Volume"

The problem was rejected because Southwest Research Institute was in a unique position to realize that no help could be expected from NASA at this time.

RNV-20 "Systems Development of Patient Transportation Devices"

This problem was not accepted because it was a poorly defined problem of very large scope.

SFM-7 "Automatic Servo-Controlled Systems and Hardware for Anesthesia Administration"

A literature search for problem PLR-3 which should satisfy the request for general information was sent to the Problem Originator. A second part of the problem involved hardware design, and specialists at Southwest Research Institute believed that commercial equipment would satisfy the requirements.

SFM-8 "Study of Anomalous Reaction of Administration of Nitrous Oxide During Anesthesia"

This problem was rejected because it was a request for information only.

SFM-9 "Small, Portable, Low Frequency Tape Recorder for Recording Static Balance in Children"

This problem was rejected on the basis that commercially available equipment could be more appropriately obtained from commercial manufacturing sources.

SNM-Pre-Problem "Use of Electrical Energy to Induce Certain Behavioral Phenomena"

The problem was not accepted because it was not yet actively being pursued by the Problem Originator, and it seemed unlikely that NASA had projects in this area.

SNM-Pre-Problem "Development of Means to Identify Virus-Containing Inoculated Eggs"

The problem was not accepted because it was not yet coupled to a serious research effort.

SNM-Pre-Problem "Use of Fluid Amplifier Controls in Operating Rooms (Anesthesia)"

The problem was rejected because it was not yet well defined.

2. Problems Closed or Inactivated

BLM-11 "On-Line Analysis of Biochemical Samples Collected Automatically from Patients" (inactivated)

A thorough literature search of the NASA data bank provided the necessary material to complete the problem. The material is being used by the Problem Originator to prepare an application for additional funds to the National Institutes of Health regarding the development of on-line biochemical monitoring. The problem was inactivated.

CAP-3 "Non-Computerized Reduction of Data Recorded Via Conventional Polygraph Techniques" (inactivated)

Information sufficient to solve the problem was obtained from both NASA and a commercial source. Due to the fact that the commercial source was less expensive and required only minor revision, the NASA source was not chosen by the Problem Originator. See section C for a more complete definition of this solution.

DLM-3 "Blood Flow Measurement in Renal Artery of a Laboratory Rat" (inactivated)

Great difficulty was encountered in solving this problem due to the size restrictions placed on the transducer. This problem was inactivated until further meaningful action can be taken.

GLM-3 "Determination of Local Blood Flow, Blood Gas Concentration, and Blood pH in Small Portion of An Organ" (closed)

Since no response was received to the Medical Problem Statements disseminated 25 July 1969, this problem was closed.

GLM-4 "Implanted Blood Pressure Transducer" (inactivated)

The Problem Originator is using a commercial device. A capacitance transducer turned up by a search of the NASA literature is not commercially available and is likely to be too expensive.

GLM-5 "Chronic Intracranial Pressure Measurement in Man" (inactivated)

The Problem Originator is using a commercial device. A capacitance transducer turned up by a NASA literature search is not commercially available and is likely to be too expensive.

GLM-6 "A Model Vascular System" (closed)

The Problem Originator did not have the technical support required to use the solution to the problem. Therefore, the problem was closed.

GLM-7 "Viscosity Measurement of Minute Samples of Blood" (closed)

Although an acceptable solution was found for the problem, the Problem Originator was unable to follow-up on the suggestions. Therefore, the problem was closed.

GLM-8 "Computer Program for Electroencephalograph: Period Analysis" (closed)

Although an acceptable solution was found for the problem, the Problem Originator was unable to follow-up on the suggestions. Therefore, the problem was closed.

GLM-9 "Measurement of Local Tissue Oxygen Consumption In Vivo" (closed)

Since no response was received to the Medical Problem Statement disseminated 25 July 1969, this problem was closed.

GLM-10 "Computer Program for Flame Spectrophotometry" (closed)

Due to a lack of time on the part of the Problem Originator to pursue the solution to the problem, he suggested the problem be closed.

GLM-12 "Computer Selection and Elimination of Artifacts" (closed)

The Problem Originator is no longer at Galveston and is now in a different field of research. Therefore, the problem is closed.

GLM-13 "Multiple Cospectral Density Analysis of Time-Service Data" (closed)

The Problem Originator is no longer at Galveston and is now in a different field of research. Therefore, the problem is closed.

GLM-14 "Repetitive Measurement of Kidney Mass in Intact Animal" (closed)

It was discovered that ultrasonic pulse-echo equipment and facilities which might be used in the solution of this problem was in existence at Marshall Space Flight Center. However, efforts to obtain a loan of this equipment has failed. Therefore, the problem has been closed.

GLM-16 "In-Situ Tumor Mass Determination on Rat Leg" (closed)

This problem is very similar to GLM-14 (above) and was closed for the same reason.

GLM-17 "Respiratory Gasses Measurement" (inactive)

The Problem Originator will, for the time being, use commercial equipment. Therefore, this problem has been inactivated.

GLM-18 "Ultramicro Methods for Analyzing Biological Specimens" (inactivated)

The Problem Originator lacked the time to pursue the problem. Therefore, the problem was closed.

GLM-25 "Photographic Miniaturization of TV Alignment Charts" (inactivated)

An inexpensive, desirable solution was obtained from a commercial source which would effectively complete the problem. The problem was inactivated.

HUV-1 "Reduced Workload Environment for Physically Handicapped Patients" (inactivated)

During a telephone conversation with the institutional consultant, it was established that the main activity on this project is preparation of the final report. No further team activity is indicated until report preparation is completed. At that time, the document will be made available to the team for supplementary transfer information. Whether or not any follow-on action is indicated will be determined at that time.

HUV-10 "Instrumented Prosthetic Leg" (closed)

The Problem Originator has taken his problem to a university researcher, who has provided a solution.

HUV-16 "Novel Joint Design Applied to Assistive Devices for Human Limbs" (inactivated)

The Problem Originator's grant application was not approved; he therefore is unable to pursue the problem further at this time.

HUV-18 "Microanalysis of Mucous Secreting Cells" (closed)

Transfer information was obtained from the Problem Originator and officials at the Manned Spacecraft Center. Documentation of the transfer processes is complete, and the problem is closed.

NWR-1 "Motion Pattern Measurement of Patients" (inactivated)

The search was used for background information only, and no directly relevant information appears to have been located. The Problem Originator suggested that the problem be inactivated.

NWR-6 "The Effects of Electromagnetic and Acoustic Fields on Living Organisms" (inactivated)

Since the Problem Originator's requirement was primarily informational in nature, a thorough literature search of the NASA data bank provided the necessary material to complete the problem. The Problem Originator is now preparing a report on the basis of this new data, and the problem was inactivated.

PLR-1 "Measurement of Outer- and Inner- Diameter of Blood Vessels" (closed)

The desired technology has been judged to be beyond the current state-of-the-art. The problem was closed.

PLR-3 "Automatic Control of Therapeutic Agents" (closed)

No significant work in this field has been revealed by any search procedures; therefore, the problem was closed.

PLR-4 "Exercise Tests for Detection of Heart Disease" (closed)

A useful literature search was performed but no direct application of the material is envisioned by the Problem Originator; therefore, the problem was closed.

RNV-5 "Pressure Measurement to Aid Prevention of New Decubitus Ulcers" (closed)

The Problem Originator is proceeding with his own design solution. Therefore, the problem was closed.

RNV-10 "Sensors for Measuring Foot-Floor Impact Forces." (inactivated)

The Problem Originator is awaiting the results of a grant application. Until further action can be taken on the problem, it has been inactivated.

RNV-11 "Measurement and Telemetry of Kinesiology of Handicapped Patients" (closed)

The transfer was complete and the problem was closed. (They will purchase a device from Whittaker, a production copy of NASA/Ames 5-channel Telemetry device.)

RNV-12 "Body Temperature Regulation in Congenital Amputees" (closed)

A new researcher has taken over the project associated with this problem, and he requested during a telephone conversation with a Team member that the problem be considered closed. The researcher has no plans to pursue the problem area at this time.

RNV-13 "Improved Laryngoscope for Use in Disabled Children" (inactivated)

A contract for manufacturing the item is expected and in negotiation. Therefore, the problem was inactivated.

RNV-15 "Rapid Multiple Gas Measurement for Medicine" (inactivated)

The Problem Originator's other activities require that the problem be considered inactive for the time being.

RNV-16 "Patient Breathing Monitor" (closed)

The transfer is complete. Negotiations for a commercial device are in progress and the problem is closed.

RNV-17 "The Effect of Oxygen Poisoning on Biological Systems" (closed)

Adequate information was available in the open literature. The Problem Originator was referred to the proper sources and the problem was closed.

SFM-1 "Automatic EKG-Time Interval Measurement" (closed)

The desired techniques are beyond the state-of-the-art. The problem was closed.

SFM-2 "Automatic Techniques for Smoothing Blood Pressure Waveforms" (closed)

The desired techniques are beyond the state-of-the-art. The problem was closed.

SFM-3 "Improved Monitoring of Heart Cell Contraction Parameters" (closed)

Mr. A. G. Buck and Ames Research Center performed a series of engineering services. Technical engineering advice was given and used by the Problem Originator, and the posed problem has been solved.

SFM-3A "Heart Contraction Force" (inactivated)

Research is waiting for the results from an earlier phase. The researcher has not yet had time to evaluate the search properly. Therefore, the problem was inactivated.

SFM-4 "Early Detection of Vestibular Unbalance in Children" (closed)

The transfer was completed and the problem was closed.

SNM-1 "Enhancement of X-Ray Contrast Study Films" (inactivated)

Because of the lengthy history of this problem and no future prospects of a solution, this problem was inactivated.

WSM-1 "Ultrasonic Coupling Techniques" (closed)

The problem was closed due to the fact that the problem has not been satisfactorily solved.

WSM-4 "Simultaneous Multistress Effects on the Cardiovascular System" (closed)

The transfer was completed and the problem was closed.

WSM-7 "Sensitive Detection for Human Electric Field Application" (closed)

It was discovered that equipment and facilities applicable to this problem is maintained by Ames Research Center. Arrangements were made for collaborative research work between Ames and Washington and the problem was closed.

3. Active Problem Status Summary

BLM-10■

Title: "Computer Programs and Systems for Analysis of the Electrocardiogram"

Problem Originator: Harry S. Lipscomb, M.D., Chairman, Department of Biochemistry, Baylor University College of Medicine, Houston, Texas

Date Submitted: 9 June 1969

Description of Problem: The problem is to identify existing computer programs which provide automatic diagnostic interpretation of the electrocardiogram and to adapt portions of these programs for use on a small, multipurpose computer system which will be applicable for multiple testing of large numbers of subjects (multiphasic health screening) and more economically feasible for clinical usage.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was performed, and the screened search results were forwarded to the Problem Originator. Information on a device, developed at Mount Siani Hospital in Cleveland, that is suitable for very rapid multiphasic testing was obtained and forwarded to the Problem Originator for his examination.

Activity on Problem to Nov. 1, 1969: The results of the computer search were screened and forwarded to the Problem Originator. The Problem Originator stated that the search results were useful but not productive of a solution.

Activity on Problem to February 28, 1970: A Medical Problem Statement was approved by NASA and disseminated to the NASA Research Centers. Several responses were received, including NASA Tech Brief B69-10720 on Biomedical Bulk Data Forwarded to the Team by Mr. Clint Johnson, Flight Research Center. Information was also sent by Mr. Lee Du Goff, TUO, Kennedy Space Center, about work being done at Manned Spacecraft Center on the vectorcardiogram analysis project phase of the Apollo Applications Program which might be closely related to this problem. A communication on the Problem Statement was also received from Mr. Juan Pizarro, II, Marshall Space Flight Center. This material was forwarded to the Problem Originator for evaluation and future contact.

Title: "Flexible Material for Connecting Electrical Stimuli to Nerves, Without Damage"

Problem Originator: Gerald Glick, M. D., Associate Professor, Pharmacology and Medicine, Baylor University College of Medicine, Houston, Texas

Date Submitted: 12 September 1969

Description of Problem: The investigator requires a biologically inert, soft, flexible conducting material for use in establishing an electrical connection between the surgically exposed carotid sinus nerve and a lead from an implanted cardiac pacemaker. The purpose of the connection is to permit electrical stimulation of the carotid nerve to relieve the crippling chest pain associated with angina pectoris, which results from overworking the heart. Major constraints surrounding the problem are that the electrode material must be a good conductor, biologically inert, and suitable for long term implantation (at least 5 years duration).

Activity to November 1, 1969: The problem was accepted and a computer search of the NASA data bank was performed. The screened search results were then forwarded to the Problem Originator. Two main problem approaches have been initiated. The first involves Mr. Salvador Rositano of Ames Research Center who has used conductive silicone rubbers for sealing gaskets in microwave horns. The Problem Originator is now in contact with Mr. Rositano and they are cooperating on the development of a silver impregnated silastic for the connecting electrode. The second approach was generated by Mr. Ralph Schleicher, Southwest Research Institute, who suggested deposition of a metal film on silastic rubber to form the electrode. This technique is now under study by Mr. Roy Clark of Langley Research Center who is a specialist in film deposition. Mr. Clark has tentatively suggested attachment of the electrode by cyanoacrylonitrile cement rather than suture. He is presently awaiting photos and sketches of the present electrode to aid in his study.

Activity on Problem to February 28, 1970: Information on the existing electrode configuration was forwarded to Mr. Clark. Utilizing technology developed by NASA Ames, Mr. Rositano fabricated and forwarded several pairs of flexible, silver elastomer electrodes to the Problem Originator for use in his research program.

Additionally, NASA Ames has undertaken the development of an even more effective type of flexible electrode using platinum elastomer rather than silver to extend the electrode's useful life. A transfer report was written and included in the January monthly report.

BLM-13 ■

Title: "Nonthrombogenic Material for Use As A Blood Interface"

Problem Originator: John Hines Kennedy, M. D., Professor of Surgery, Baylor University College of Medicine, Houston, Texas

Date Submitted: 17 September 1969

Description of Problem: The investigator requires a nonthromobogenic biomedical material which is suitable for use as a blood interface. In addition, the material must be non-carcinogenic and possess physical characteristics which will permit it to be processed into various configurations suitable for surgical implantation. Since there has been considerable aerospace research effort in the area of carbon, there exists a possibility that forms of carbon may have been developed which possess unique qualities rendering them suitable for biomedical applications, including surgical implantation.

Activity on Problem to Nov. 1, 1969: Selected references available from Southwest Research Institute Biomedical Application Team files have been forwarded to the Problem Originator. A computer search statement was prepared and submitted to WESRAC.

Activity on Problem to Feb. 28, 1970: The results of the computer search were received and forwarded to the Problem Originator. The search yield was extremely small with only 6 out of 10 citations being at all pertinent to the problem. A special request was made to WESRAC to expand the search to include the terms "materials" and "body fluids compatibility." Information was received from Mr. S. F. Felder of Lewis Research Center regarding the use of alloys for implantation (hip replacement). This information, which may be very valuable in the solution to this problem, was evaluated and forwarded to the Problem Originator and to Mr. Herb Cantor. The Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

BLM-14

Title: "A Compound Conduit for Use With Chronically Surviving Animals:

Problem Originator: John Hines Kennedy, M. D., Professor of Surgery, Baylor University College of Medicine, Houston, Texas

Date Submitted: 3 October 1969

Description of Problem: The investigator requires a compound conduit (umbilical) which will provide two electric leads, two pneumatic lines, and six hydraulic flexible lines to power and monitor an artificial heart implanted within an animal. One of the electric leads will be an ECG lead. The length of the required umbilical is approximately 5 meters, with the thickness being limited to about 1 centimeter by the space between the animals ribs. The umbilical should feature quick disconnectors on both ends and provide for swival action to prevent kinking as the chronically surviving animal moves around. The two pneumatic (CO_2 pressure/vacuum) lines will run respectively at +5 psig and -2 psig, with a pulsating flow approximating 0.1 liter per second. The six hydrostatic coupling columns do not involve an appreciable flow. The electrical leads must be well shielded to reduce pickup of interference on the 1 mv source impedance ECG signal.

Activity on Problem to Nov. 1, 1969: The problem was accepted and preparations were begun to write the search statement.

Activity on Problem to Feb. 28, 1970: A computer search of the NASA data bank was made and the results were forwarded to the Problem Originator. He stated that although a number of the documents recovered appeared to be of interest, only one of the ten references listed by the search was pertinent to the problem. The Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers. Information on similar problems was obtained from both Research Triangle Institute and Midwest Research Institute as a cooperative effort between Teams. This information was forwarded to the Problem Originator for evaluation.

Title: "Determination of the Physical Chemical State of Ions and Water in Living Cells"

Problem Originator: C. F. Hazlewood, Assistant Professor, Baylor University College of Medicine, Houston, Texas

Date Submitted: 10 October 1969

Description of Problem: The problem is to determine the physical location in three dimensions of sodium ions (Na^+) within skeletal muscle fibers or other cells. The primary investigator wishes to know if NASA generated technology is or can be made available to enable measurement of this parameter.

Activity on Problem to Nov. 1, 1969: The problem was accepted and preparations were begun to write the search statement.

Activity on Problem to Feb. 28, 1970: A computer search of the NASA data bank was made and the results were forwarded to the Problem Originator. He stated that none of the references cited by the search was pertinent to the strict request of the problem; however, several of the references appeared promising for later study. Additional searching was requested. The Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Measurement of Electrolyte Concentrations in Renal (Kidney) Medulla and Papilla"

Problem Originator: Wadi N. Suki, M. D., Associate Professor of Medicine, Baylor University College of Medicine, Houston, Texas

Date Submitted: 28 October 1969

Description of Problem: To better understand the function and operation of the kidneys, a renal physiologist is investigating the microcirculation of blood in the medulla and papilla of dog's kidney. The investigator is particularly interested in acquiring concentrations of (Na^+, K^+, Cl^-) ions both in situ and in vivo by inserting a minute probe into the kidney. Physiological variations such as salt and water intake will be introduced to vary the ion concentrations in time.

Activity on Problem to Feb. 28, 1970: A computer search of the NASA data bank was made and the results were sent to the Problem Originator. The search failed to provide a solution from the NASA technology, though it did provide some interesting and useful information. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Improved Procedure to Measure Regional Blood Flow in the Kidneys"

Problem Originator: Wadi N. Suki, M. D., Associate Professor of Medicine, Baylor University College of Medicine, Houston, Texas

Date Submitted: 28 October 1969

Description of Problem: To better understand the function and operation of the kidneys, a renal physiologist is investigating the microcirculation of blood in various layers of the kidney. Present techniques utilizing the hydrogen washout method involve placing the kidney in a cup outside the body and placing rigid electrodes into the kidney with micromanipulators. The investigator desires to find suitable electrodes for implantation to measure regional blood flow *in situ* and be able to repeat observations on the animal over a long period of time.

Activity on Problem to Feb. 28, 1970: A manual search of the NASA literature was made and forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Artificial Membrane Interface"

Problem Originator: Max Valentinuzzi, Assistant Professor
Department of Physiology, Baylor University College of Medicine, Houston, Texas

Date Submitted: 10 December 1969

Description of Problem:

The investigator is studying the electrophysiology of the heart and is interested in the development of a mechanical (artificial) model of the heart. An observed electrical phenomenon relative to artificial membranes may be pertinent to the investigation; in order to proceed, the investigator desires to know the underlying physical process involved in the observed phenomenon. The phenomenon being studied is that of Ostwald's "electric heart", which is a globule of Hg in a beaker of H_2SO_4 with minute quantity of $K_2Cr_2O_7$ to color the acid light yellow and a fine iron wire or needle in point contact with the mercury but otherwise electrically insulated from ambient environment. In this configuration, the mercury globule pulsates with rhythmic waves of excitation at regular intervals, thus giving much the same appearance as a beating biologic heart. The investigator desires to know the reactions which are occurring, the energies produced, and the basic mechanism involved.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Expired Oxygen Analysis"

Problem Originator: Lee E. Baker, Associate Professor
Department of Physiology, Baylor University College of Medicine, Houston, Texas

Date Submitted: 10 December 1969

Description of Problem:

In respiratory physiology studies, the investigator requires a method for the rapid measurement of oxygen concentration (i.e., quantity or partial pressure) in gaseous mixtures. Specifically, he needs a reliable and accurate technique for the breath-by-breath analysis for oxygen, and the instrument or method employed would need a response time sufficient to follow oxygen concentrations throughout each breath pattern. Presently used oxygen analyzers such as paramagnetic type are slow responding devices and therefore inadequate. A continuously measuring instrument with a response time shorter than 40 ms would be needed, and response time (response interval) on the order of 1 to 10 ms would be desired, with a known and negligible latency interval.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Germ-Free Hamster Colony"

Problem Originator: John J. Trentin, Ph. D., Professor and Head
Division of Experimental Biology, Department of Surgery
Baylor University College of Medicine, Houston, Texas

Date Submitted: 10 December 1969

Description of Problem:

The investigator in the field of experimental biology requires germ-free experimental animal colonies which are developed by means of sterile caesarean surgery, nursed on sterile diet and maintained in sterile environments. Germ-free strains or colonies of rabbits, rats, etc., have been successfully derived; however, all such attempts when working with hamsters have failed. The reason for failure to develop germ-free hamster colonies is possibly nutritional inadequacy of the synthetic milk diet formula, but that has not been established. In order for the investigator to proceed with his work, he needs a means of hamster care in the germ-free environment.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "X-ray Exposure and Gravitational Effects on Body Functions"

Problem Originator: C. T. Liu, Ph. D., Assistant Professor
Baylor University College of Medicine, Houston, Texas

Date Submitted: 10 December 1969

Description of Problem:

The investigator is studying the effects and responses due to whole body X-irradiation. The research involves the study of the circulatory (blood) system, respiratory system, and kidney functions. The injury to the experimental animal is whole body exposure to X-rays; following this, a stress or stimulus is produced by two methods, namely, (1) changing posture by employing a tilt table and (2) changing posture accompanied by hemorrhage or other injury. The research requirements are a knowledge of the effect of gravity upon physiological changes in the X-irradiated animal. That is, the investigator desired data/information on bodily functions in the zero-gravity and/or partial-gravity environment following radiation by X-ray.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Apparatus for Telemetering GSR in Natural Social Settings"

Problem Originator: Robert Schwitzgebel, Ed. D., Ph. D., Visiting Associate Professor, Psychology Department, Claremont Graduate School, Claremont, California

Date Submitted: 9 January 1970

Description of Problem:

The researcher is presently conducting experiments to determine the feasibility of using electromechanical techniques for modifying behavior. As part of this research, the GSR (Galvanic Skin Response) is being telemetered from adolescent delinquents as they interact in their natural social settings, e. g., home, school, and hang-out. Dry electrodes applied to the plantar region (inner aspect of the instep) are used to acquire the GSR, with the signal being conducted from the foot via a connecting link (concealed in the trouser leg) to a transmitter at some convenient place on the delinquent's person. The system involves a remote two-way coded audio communications link which functions only with marginal success. Difficulties in this set up involve motion artifacts associated with the electrodes, excessive noise, and poor acceptance of the remote transmission apparatus by the experimental subjects due to its bulk.

A small, reliable apparatus which will acquire and transmit the galvanic skin response is needed. The circuitry must feature high common mode injection and be compatible with an acceptable type of GSR electrode, acceptability being defined in this context as: long-term use (24 hours or longer); free from motion artifact; and small enough to be applied comfortably to the individual's instep. The apparatus should be reasonably easy to fabricate or obtainable at reasonable costs to permit instrumentation of a larger number of individuals. The apparatus will be worn or carried by adult humans engaged in a variety of activities characteristic of natural social settings such as encountered in home, school, or hang-out.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was performed. Information on a NASA miniature biopotential telemetry system and a copy of Biotelemetry Equipment Sources was forwarded to the Problem Originator. Also, a NASA document, SP 5054, was forwarded to the Problem Originator for evaluation. The problem was considered a potential transfer based on NASA Tech Brief 66-10624, and a potential transfer report was written and submitted to NASA. The problem was submitted as a candidate for applications engineering to complete the transfer.

Title: "Galvanic Skin Response Electrodes for Long Term Application on Human Subjects"

Problem Originator: Robert Schwitzgebel, Ed. D., Ph. D., Visiting Associate Professor, Psychology Department, Claremont Graduate School, Claremont, California

Date Submitted: 9 January 1970

Description of Problem:

Several researchers at Claremont College are conducting experiments to determine the feasibility of employing electromechanical means for modifying behavior. One phase of this research involves telemetering the galvanic skin response (GSR) of adolescent delinquents as they interact in their natural social setting, e. g., home, school, and hang-out. In the study, dry electrodes are applied to the plantar region (inner aspect of the instep) to acquire the GSR, with the signal being conducted from the foot via a connecting link concealed in the trouser leg to a transmitter placed at a convenient concealed location on the delinquent's person.

The investigator requires electrodes which are suitable for taking the GSR (galvanic skin response) of human adult subjects. The electrodes must be amenable to long-term application (periods of 24 hours or longer) without impairment of sensitivity and should minimize the occurrence of motion-induced artifacts. The electrodes should be small enough to permit them to be worn comfortably when applied to the plantar region. Installation of the electrodes should be relatively simple and the cost reasonable.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was performed. Of the articles retrieved, one appeared to have particular application to the problem. The document (Dry Electrodes for Physiological Monitoring, NASA TN D-3414) describes a method developed at Flight Research Center for very rapid application of electrocardiogram electrodes by spraying a conductive mixture onto the skin. The problem was considered a transfer and a transfer report was submitted to NASA. NASA Tech Brief 64-10025 on improved electrode techniques was forwarded to the Problem Originator.

Title: "Pressure Measurement of Brain Ventricals and Renal Arteries in the Laboratory Rat"

Problem Originator: John C. Porter, Professor of Physiology
University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

Arthritis and other crippling metabolic diseases cause a great deal of misery, frustration, and discomfort to those afflicted. Investigators are actively engaged in attempting to find causes and mechanisms of these diseases through extensive research of neurohumoral mechanisms and hormone production utilizing small laboratory test animals.

To better understand the biological mechanisms, the investigator specifically wishes to monitor the pressure within the ventricals of the brain and renal arteries of rats. This requires a miniaturized pressure transducer capable of being implanted in these locations without significantly disturbing the media surrounding the transducer. The investigator wishes to know if NASA technology has possible solutions to this requirement.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originators. Additional information on the Whittaker Model 1007 pressure transducer and on supporting signal conditioning was sent to the Problem Originators at their request. The Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Temperature Measurement of Brain Core in the Laboratory Rat"

Problem Originator: John C. Porter, Professor of Physiology
University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

Arthritis and other crippling metabolic diseases cause a great deal of misery, frustration, and discomfort to those afflicted. Investigators are actively engaged in attempting to find causes and mechanisms of these diseases through extensive research of neurohumoral mechanisms and hormone production utilizing small laboratory test animals.

To better understand the biological mechanisms, the investigator specifically wishes to monitor core temperatures in the brain of rats. This requires a highly sensitive miniature temperature transducer capable of being implanted in this location without significantly disturbing the media surrounding the transducer. The investigator wishes to know if NASA technology has possible solutions to this requirement.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originators. They planned to act on the information as soon as possible. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers. On the basis of the material obtained from the search, this problem was submitted as a potential transfer. An evaluation is awaited from the Problem Originator before completing the final transfer report.

Title: "Doppler Probe Holder and Stand for Use in Chronic Measurement of Fetal Circulation"

Problem Originator: Walter W. Taylor, M. D., Assistant Professor
University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

Ultrasonic techniques are being utilized to monitor fetal blood circulation during labor and delivery to determine if any abnormal conditions arise during this critical period.

The present method of monitoring this blood flow is with a hand-held probe. For chronic measurements, a means of stabilization for the probe is desirable to reduce artifact generation by movement of the probe.

The holder and stand should hold the probe firmly but should not be so rigid as to cause pain during labor. Since the probe and holder must be positioned over women of various dimensions, the device should be adjustable.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originators. Very little related material was discovered for this problem. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Measurement of Fetal Circulation from Transcutaneous Transducers and Artery Location by Depth Measurement"

Problem Originator: Walter W. Taylor, M. D., Assistant Professor
University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

Ultrasonic techniques are being utilized to monitor fetal blood circulation during labor and delivery to determine if any abnormal conditions arise during this critical period.

The investigator is interested in acquiring flow information by a transcutaneous ultrasonic probe and using this same probe without changing probe location, determine the distance to the artery and determine the arterial diameter.

The investigator wishes to know if NASA technology is available to solve this dual problem requirement.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results, with additional material, were forwarded to the Problem Originators. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Measurement of Respiratory Parameters of Patients Suffering From Cardiovascular Disorders"

Problem Originator: G. Blomqvist, M. D., Assistant Professor of Medicine, University of Texas Southwestern Medical School Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

To determine the severity of cardiovascular disorders among patients suffering from these diseases, it is important to measure related physiological parameters. One of the functional parameters is respiration. The investigator desires to measure respiratory rate primarily and tidal volume secondarily. Since treadmill and bicycle ergometer testing are involved, the sensors must be of a low resistance type and must not interfere with the patient's activity. The investigator wishes to determine if NASA technology is available to solve this problem.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results, with additional material, were forwarded to the Problem Originators. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers. On the basis of the material obtained from the search, this problem was submitted as a potential transfer. An evaluation is awaited from the Problem Originator before completing the final transfer report.

Title: "Monitoring of Chest Wall Vibrations Related to Cardiac Activity"

Problem Originator: G. Blomqvist, M. D., Assistant Professor of Medicine, University of Texas Southwestern Medical School Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

To determine the severity of cardiovascular disorders among patients suffering from these diseases, it is important to measure related physiological parameters. One of these parameters of interest is the measurement of chest wall vibrations and relate these to cardiac activity at rest and during exercise. The investigator is interested in an instrument capable of measuring this parameter without serious impediment to the activity of the patient. Frequency response of the instrument should be from dc to approximately 2000 Hz. Does NASA have technology or hardware that satisfies the problem requirements?

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results, with additional material, were forwarded to the Problem Originators. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Temperature Measurement by Telemetry of Patients During Exercise and Occupational Activities"

Problem Originator: G. Blomqvist, M. D., Assistant Professor of Medicine, University of Texas Southwestern Medical School Dallas, Texas

Date Submitted: 1 December 1969

Description of Problem:

Comparison data on normal subjects vs. subjects suffering from cardiovascular disease is important in evaluating the functional response of the cardiovascular patients. The investigator wishes to measure body temperature either rectally or on the eardrum and telemeter this data to a tape recorder. The telemetry package must not interfere with the test subject's activity but need not be implantable. The investigator wishes to determine if NASA technology is available to solve this problem.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results, with additional material, were forwarded to the Problem Originators. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Aerial Image-Fiber Optics"

Problem Originator: William J. Stenstrom, Assistant Professor of Ophthalmic Illustration, University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 2 January 1970

Description of Problem:

The problem herein is part of an overall program to develop a more rapid, accurate and comfortable method of examination of the posterior inner part of the eye, (fundus oculi); i. e., the anterior portion of the eye, as seen through the dilated pupil of the eye. The program being developed is aimed at serving three functions; namely, patient examination, improved patient records, and medical teaching. The object of the research and development efforts is to project the desired image upon a screen to facilitate improved viewing by the physician and to provide simultaneous viewing by consultant specialists as well as medical students. The projection screen might be a conventional movie screen or it might be a TV screen (picture tube). An "interface" unit from aerial image to fiber optic cable is also needed. The interfacing unit must be relatively small in size because the image to be carried is that as seen through the pupil of the eye.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator.

Title: "Precision Optical Plastics Fabrication"

Problem Originator: William J. Stenstrom, Assistant Professor of Ophthalmic Illustration, University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 2 January 1970

Description of Problem:

A medical school ophthalmologist is working on improved methods for observation of the interior of the eye. He is designing optical mirror systems to enable a physician to examine the interior surface of the eye near the pupil; that is, to observe the posterior surface of the muscles supporting the biologic lens and to observe the retina at the region immediately adjacent to the muscles which support the lens of the eye. The investigator has designed a system of mirrors to provide the desired optical path. However, more fabrication know-how is needed to construct a mirrors-in-plastic system. The name of a fabricator who can construct the device or the technological knowledge to enable the investigator to construct the device is needed.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator.

Title: "Improved Techniques for Teaching Biomedical Research"

Problem Originator: Ernest Clay, Director of Audio-Visual Systems
University of Texas Southwestern Medical School, Dallas, Texas

Date Submitted: 2 January 1970

Description of Problem:

The Southwestern Medical School at Dallas, Texas is interested in improving the teaching of biomedical research subjects presented at the school. The faculty feels that one way to achieve this aim is to make recorded seminar/lectures presented by prominent biomedical researchers available to the students (and faculty members) bia sound films and video-tapes. Such materials can be viewed repeatedly and at a time convenient to the individual student or faculty member, thus providing valuable broadening educational experiences which would not otherwise be available.

The medical school would like to obtain information regarding, and access to, audiovisual presentations made by NASA scientists which relate to biomedical research. The materials desired could include recorded nonclassified seminars, lectures, or presentations made for in-house NASA use; presentations developed by NASA contractors in conjunction with specific projects; as well as general interest materials prepared for public release via mass communications media. Specific information needed concerns (1) the availability of materials of the nature described; (2) source from which the material may be obtained; and (3) retention period permitted.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made, but since no hits were made on the 21 citations recovered, the material was not forwarded to the Problem Originator. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Automated Circulation Control System for a 100,000 Volume Medical Library"

Problem Originator: Fred L. Christen, Director of Instructional Communication, University of Texas Southwestern Medical School, Dallas, Tx.

Date Submitted: 12 January 1970

Description of Problem :

The Southwestern Medical School maintains a 100,000 volume medical library. In the past, circulation has been handled manually. However, continuing increases in the demand for library services and in the size of the collection are making manual control procedures inadequate. A computer program is needed to automate circulation control in the library using existing hardware.

Activity on Problem to Feb. 28, 1970:

Material from a manual search of the NASA literature for problem DLM-11 was more applicable to DLM-12 and was forwarded to the Problem Originator of DLM-12. Additional information concerning the conversion of retrospective catalog records to machine-readable form and other information concerning computerization of a book circulation system from Manned Spacecraft Center were forwarded to the Problem Originator. A Problem Statement was written and submitted to NASA for approval to disseminate to the NASA Centers.

DVA-1 ■
DVA-2 ■

Title: "Automated Techniques and Instrumentation for Administration and Analysis of Diagnostic Psychological Tests"

Problem Originator: Walter Penk, Ph. D., Department of Psychology, and A. J. Jernigan, Ph. D., Head, Department of Psychology, Veterans Administration Hospital, Dallas, Texas

Date Submitted: 27 February 1970

Description of Problem:

Standard psychological diagnostic and therapeutic techniques, such as free word association and projective testing, require a great amount of time to administer, score, and analyze. Also, to obtain reliable and valid assessments, independent subjective judgements from several counselors are required. The investigator needs automated administration techniques for mass screening and therapeutic tests to rapidly and objectively diagnose and treat psychological impairments. He also needs methods and instrumentation to reduce and analyze these large quantities of data obtained from diagnostic and therapeutic psychological tests.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

DVM-1 ■

Title: "Improved Measurement of Mechanical Properties of Tissue"

Problem Originator: Worden Waring, Ph. D., Associate Professor, School of Medicine, University of California at Davis, Davis, California

Date Submitted: 6 October 1969

Description of Problem: The investigator requires a non-destructive measurement scheme for determination of the mechanical properties of human tissue such as muscle and tendon. It is desired to measure such properties as stress, strain, relaxation, viscosity, and hysteresis of muscles and tendons in both normal and abnormal states. A method is needed for live testing of (human) patients, which can be done repeatedly and without pain to the patient.

Technology concepts for testing composite materials such as fiber-reinforced plastics may possibly be applicable. As an alternative to non destructive testing, a biopsy sample as minutely small as possible may be acceptable.

Activity on Problem to Nov. 1, 1969: The problem was accepted and preparations were begun to write the search statement.

Activity on Problem to Feb. 28, 1970: A computer search was made of the NASA literature by WESRAC. The results were evaluated and forwarded to the Problem Originator. However, since few promising references were recovered, a manual search was made of the NASA literature. The new information recovered looked promising and was forwarded to the Problem Originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to the Research Centers.

Title: "Collimation of X-Particle Beam"

Problem Originator: Robert H. Brownson, Ph. D., Professor and Vice Chairman, Department of Human Anatomy, University of California School of Medicine, Davis, California

Date Submitted: 18 December 1969

Description of Problem:

The proposed research objectives are designed to obtain basic information about the biological activity of granule cells (microneurons) and their precursor cells in the fascia dentata of the neonatal rat hippocampus. Specific use will be made of cyclotron accelerated particle irradiation to induce selective and localized necrosis among the undifferentiated granule cell population of the fascia dentata and subependymal layer of the lateral ventricles. The function of radiosensitive immature granule cells and adult granule cells in visceral brain are presently under investigation by the Problem Originator. In this facet of the investigation of the developing hippocampus, it is planned to search the identity, origin and cell kinetics (cytogenesis) of the adult granule cell and immature dark cell comprising the neonatal fascia dentata and the subependymal region of the rat brain. A better understanding of these fundamental cells is necessary for further study of the interaction of the adult granule cells with pyramidal cells in the limbic lobe.

Activity on Problem to Feb. 28, 1970:

A Problem Statement was written and sent to NASA for approval to disseminate to the Research Centers.

Title: "Telemetry for Free-Ranging Cats and Baboons"

Problem Originator: J. W. Havstad, Research Pharmacologist
Department of Pharmacology, University of California
School of Medicine, Davis, California

Date Submitted: 18 December 1969

Description of Problem:

A 4-8 channel telemetry system for acquiring EEG and EMG information from cats and baboons is needed. The range required is less than 50 ft. A subcutaneous package may be required but attempts to use a back pack would be made.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was written and sent to NASA for approval to disseminate to the Research Centers.

Title: "Automatic Atraumatic Blood Pressure Measurement"

Problem Originator: David McCusker, Development Engineer
Human Physiology, University of California School of Medicine
Davis, California

Date Submitted: 29 December 1969

Description of Problem:

The Problem Originator needs to measure such physiological parameters as temperature, heart rate, ECG, and blood pressure in a variety of tests with humans.

A means for measuring blood pressure without penetrating the skin is required. The method should be amenable to automatic operation with a high degree of immunity to artifact caused by acoustical noise. The method should also be resistant to motion artifact. Use of an occlusive cuff is permissible. The Problem Originator suggests the use of an ultrasonic Doppler device.

Activity on Problem to Feb. 28, 1970:

An ultrasonic Doppler blood pressure apparatus developed by Southwest Research Institute for the United States Air Force was improved on a contract funded by NASA. This unit and a NASA/USAF document showing how to fabricate this unit was sent to the Problem Originator. He has recently stated that the method has proved very useful and that the ultrasonic method is far superior to other methods. The Problem Originator intends to build his own unit. This problem was identified as a potential transfer.

Title: "Monitoring Blood Gases"

Problem Originator: Phillip Yarnell, M. D., Department of Neurology, University of California at Davis, California

Date Submitted: 19 January 1970

Description of Problem:

The investigator is doing research on the continuous monitoring of blood and CSF gases to assure an adequate level of cerebral oxygenation. A catheter tip pO_2 transducer is needed to measure spinal fluid or blood oxygen tension. This transducer should be able to pass through a #15 gauge needle and should be sterilizable.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

DVM-6 ■

Title: "Measurement of Acceleration of the Human Head"

Problem Originator: Phillip Yarnell, M. D., Department of Neurology, University of California at Davis, California

Date Submitted: 19 January 1970

Description of Problem:

A substantial number of young men are killed or injured in athletic events, particularly football, in the United States each year. Thirty-six football players died as a result of injuries and many more received permanent brain damage due to head, neck, and spine injuries. Study of the accelerations experienced by certain anatomical sites of these players could lead to better understanding of causes of injuries, better helmet designs and development of tolerance specifications. In this study, a small, light and rugged accelerometer which can be mounted on a headband when the subject is wearing a football helmet is needed. The researcher needs to measure linear and rotational "g" forces.

Activity on Problem to Feb. 28, 1970:

A NASA Tech Brief (66-10534) on triaxial accelerometers and data on a BM-1 activity monitor for head blows were forwarded to the Problem Originator. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Requirement for Special Photographic Equipment"

Problem Originator: Phillip Yarnell, M. D., University of California at Davis, California

Date Submitted: 19 January 1970

Description of Problem:

Investigators at the University of California Medical School at Davis, California are engaged in a broad program of research dealing with injuries sustained in body contact sports such as football. The aim of the research is to obtain information to include recommended changes in game rules, if indicated. Of particular interest to the researchers is the occurrence of head injuries among football players. To study this particular aspect of the research the investigators need a photographic apparatus (motion picture or television camera) which will provide 100% surveillance of a football field, with the resultant recorded image featuring an exceptionally high level of clarity and fidelity. This image should enable the investigators to observe the actual traumatic event in detail, clearly show the occurrence of immediate post trauma reactions, facial expressions, facial color, plus reflex actions occurring as the injured player is removed from the field. The photographic apparatus should be automatic, particularly with regard to exposure control. It should function well under extremes of lighting conditions --- from the glare of full sunlight encountered during daylight games to reduced illumination encountered during night games conducted under artificial lights.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Wireless Telemetry for Accelerometer Information:

Problem Originator: Phillip Yarnell, M. D. , University of California at Davis, California

Date Submitted: 19 January 1970

Description of Problem:

A substantial number of young men are killed or injured in athletic events, particularly football, in the United States each year. Thirty-six football players died as a result of injuries and many more received permanent brain damage due to head, neck and spine injuries. Study of the accelerations experienced by certain anatomical sites of these players could lead to better understanding of causes of injuries, better helmet designs and development of tolerance specifications. Such knowledge would also be useful in developing safer aircraft and automobiles. In order to make this study feasible, a telemetry transmitter design capable of sending three channels of accelerometer output information from any site on a football field to a receiver located in a press box is needed.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was written and sent to NASA for approval to disseminate to the Research Centers.

Title: "Respiration Volume and Rate Measurements in Unencumbered (Free) Child"

Problem Originator: Roy D. Wilson, M. D., Assistant Professor, Department of Anesthesiology, University of Texas Medical Branch and Shrine Burn Center, Galveston, Texas

Date Submitted: 19 August 1967

Description of Problem: A method is needed for measuring the rate and depth of breathing of children who are suffering from severe burns on the upper half of their bodies. The method should not involve connecting tubing to the nose or throat, nor enclosing the body in a plethysmograph. The ideal method would allow measurement of the tidal volume (the volume of air moved into and out of the lungs with each breath) without adding any resistance to the airway and without touching or irritating the skin.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made and the search results were forwarded to the Problem Originator. No new information was obtained from the search results. It was learned that Electronics Research Center had a respirometer which might be of value in this problem. The device was loaned to the Problem Originator by Mr. Fred A. Hills of the Technology Utilization Office. The applicability of the device was negative since it appeared to have pick-up and calibration problems. The respirometer was returned to Electronics Research Center. A Medical Problem Statement was printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to Nov. 1, 1969: Responses to the circulated Medical Problem Statement were received from Marshall Space Flight Center, Lewis Research Center, Jet Propulsion Laboratory, Space Nuclear Propulsion Office, and Manned Spacecraft Center. It was discovered that impedance pneumography hardware (from Gemini and/or Apollo) might be made available to the Problem Originator. Correspondence with the Electronics Research Center stated that no further development work is planned for their respiration monitors.

Activity on Problem to Feb. 28, 1970: Negotiations are in progress to submit this problem as a candidate for applications engineering.

GLM-19

Title: "Measurement of the Velocity of Myocardial Contractions by Noninvasive Means"

Problem Originator: Quang X. Nghiem, M. D., Assistant Director, Pediatric Cardiology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 10 October 1968

Description of Problem: The contractility of the myocardium is an ill defined characteristic that refers to several aspects of the act of shortening of the myocardial muscle. A method of detecting the velocity of motion of the heart wall without application of intravascular contrast media or surgery is needed. The means of measurement or observation would ideally be performed in the manner that the physician usually listens to heart sounds with the stethoscope. Information on the use and applicability of pulse-echo and Doppler detection methods utilizing ultrasonic or other type energy is required.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made, and the results were screened and sent to the Problem Originator. The Problem Originator stated that the search results were not helpful. The Problem Originator indicated that he would like to try the Kubichek method in evaluating the condition of the myocardium. Efforts were begun to borrow Kubichek equipment for the Problem's use. Meanwhile, a Medical Problem Statement was printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to November 1, 1969: Four responses to the Medical Problem Statement were received, studied, acknowledged, and forwarded to the Problem Originator. The Biomedical Application Team made arrangements for the Problem Originator to borrow Kubichek Impedance Cardiography equipment from Manned Spacecraft Center as suggested by Mr. R. E. Smylie of Manned Spacecraft Center in his Medical Problem Statement response. The Problem Originator obtained the equipment and is preparing to perform tests in his laboratory.

Projected Problem Activity: Document the Medical Problem Statement responses. Since the Problem Originator is using NASA related equipment in research work and no further action is necessary by the Team, the problem will be classified as inactive, but technology transfer will be documented as the work progresses.

GLM-20■

Title: "Continuous Lymphocyte Destruction under Sterile Conditions"

Problem Originator: G. H. Smith, M. D., Medical Director, Chronic Home Dialysis Center, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 28 April 1969

Description of Problem: Organ transplant candidates need to have their body's immune protective mechanisms suppressed so that they will not destroy the transplanted organs. What is needed is a way to selectively destroy the functioning of human lymphocytes without harming the salty, aqueous solution of plasma proteins and emulsion of fat globules which are the other constituents of the lymph. It is desirable that the destruction take place in a continuous, in-line process rather than in a batch process, and that the destroyed lymphocytes remain in the patient's circulation so that his lymphocyte production will not be stimulated by depletion of curculating lymphocytes.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made, and the results were sent to the Problem Originator. An evaluation of the search results is still pending. Several approaches to the problem, such as radioactive sources of ionizing radiation and extra-corporeal irradiation of blood, were discussed and commercial devices were suggested. A Medical Problem Statement was printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to November 1, 1969: Two responses to the Medical Problem Statement suggested the use of ionizing radiation, an approach which the Problem Originator does not favor. No formal computer search evaluation has been received, but the results have not proved to be useful to the Problem Originator.

Activity on Problem to February 28, 1970: Two responses from the circulated Problem Statement were received. One was from Mr. Emanual Rind at Langley Research Center who sent two articles on beta bracelets, and the other was from Mr. H. H. Grimes at Lewis Research Center. This information was forwarded to the Problem Originator.

Title: "Steady Convective Dispersal in Parallel with Developing Diffusive Dispersal as in Blood Capillaries"

Problem Originator: Otto G. Brown, Ph. D., Visiting Research Professor University of Texas Medical Branch, Galveston, Texas

Date Submitted: 8 December 1969

Description of Problem:

When a dye indicator is introduced into a stream flowing through a tube in laminar fashion, the dye is dispersed by two flow mechanisms acting in parallel: that of convection and that of diffusion. Theoretical formulations of dye delivery in the simple convective case have been made and verified experimentally. Diffusive effects are magnified when flows are very slow and the tube cross-section is small as in capillaries. Although the dye is transported axially in concentric annuli by convection, particles of dye are also transported radially by the mechanism of diffusive mass transport. For this case, the pattern of axial dispersion and of dye delivery from the tube effluent have been theoretically formulated and experimentally tested. This latter case holds when the ratio of tube length (L) to centerline velocity (V_o) greatly exceeds the ratio of tube radius squared (R^2) to 14.44 times the diffusion coefficient (D). However, in the early stages of tube washout, steady convective dispersal occurs parallel with a developing diffusive dispersal. In such a case, the ratio L/V_o is not far removed from the magnitude of $R^2/14.44D$. Rich and Goodman show illustrations of solutions for two known cases; the intermediate case obviously lies between the two graphs they present. This intermediate case has been considered. Numerical solutions are presented but the application is restricted. Thus a theoretical solution for the intermediate case has not been established. It is this solution which is desired.

Activity on Problem to Feb. 28, 1970: No activity

Title: "Ear Defenders for Industrial Workers"

Problem Originator: David W. Granitz, Director
Audiology and Speech Clinic, University of Texas Medical Branch
Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

Observation of so-called high intensity industrial noise, whether continuous, interrupted, or shot-like, is injurious to hearing. "Permissible noise exposures" appear not to afford an adequate measure of safety (analogous to that used for radiation tolerance and safety regulations). Frequency spectrum of the acoustical energy extends throughout the normal audible range (20 to 20,000 hertz). In many instances, the frequency range extends above and below the audible range. Ear plugs are more acceptible to the worker but a combination ear plug-ear muff apparatus provides more protection.

Better quality sound absorbent materials are sought. The materials must be convenient to shape and form and must be comfortable to wear if it contacts tissue. Materials for both earplugs and ear muffs are desired. The researcher intends to generate new designs.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Determination of Attractive Forces Between Red Blood Cells"

Problem Originator: Dr. Henry A. Germer, Jr., Assistant Professor
Department of Physiology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

It has been found experimentally that as a result of various types of trauma, e. g., decompression sickness, the effective viscosity of blood increases. The objective of this problem is to develop methods whereby changes in the attractive forces between red blood cells may be determined. In this study it is proposed to take the strongest available theories of dispersion viscosity, examine their suitability to the study of blood, modify the theories as required for the specific application, and then analyze available blood viscosity data.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Portable Stimulator for Esophageal Speech Improvement"

Problem Originator: Glen Tinsley, Speech Pathologist, Audiology and Speech Improvement, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

Patients who have had their vocal cords removed surgically have difficulty learning esophageal speech because the thoracic contractions that are used to produce the esophageal speech at the same time cause air to "blow" out of their tracheal opening which overwhelmingly masks the speech. This blowing sound is worsened by the normal partial contraction of the cricopharyngeal muscle which partially constricts the trachea during attempted speech. With much training the patients can learn to contract the cricopharyngeal muscle completely, and before speech, to close off the trachea, thereby avoiding this undesirable sound.

A portable stimulator for use in training the patients for esophageal speech and which would cause the muscle to contract is needed. Also, both a surface electrode and an electrode to be implanted chronically for several months is needed.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Signal Averaging and Sampling"

Problem Originator: Dr. James H. Pirch, Assistant Professor
Department of Pharmacology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

It is possible to record DC potentials from the brains of animals; a pronounced, slow change is seen in response to electrical stimulation. Since the DC potentials occur in addition to faster, ongoing, EEG activity, the latter is electronically filtered out. However, very slow voltage changes do occur in spite of the filtering. Following the stimulation, the DC potential change that occurs lasts about 3 to 5 seconds. It is desired to sample this at least every 1/2 second and to obtain the voltage change from the "set-point" level so as to average the signal intensity without introducing the error caused by a varying DC level at the time the stimulus is given. A total of each 20 shocks (trials; DC shifts) is to be averaged before a new set of 20 is given. Shock intervals vary from 30 to 90 seconds in each set. Electronics used are the Low Level DC preamplifier and DC Driver Amplifier of a Grass, Model 7, Polygraph which has an IRIG output jack that allows for 3 volts output to a signal averager.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers. A possible problem solution is being reviewed.

Title: "Repetitive Photography of Animal Behavior"

Problem Originator: Dr. James H. Pirch, Assistant Professor
Department of Pharmacology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

It is desired to photograph the response of an animal (rat) following an electric shock while a recorder is providing evidence of a DC voltage change in the brain, in order to correlate responses, avoid artifacts, and aid the study of drug action. The photographic mechanism must be quiet, so as not to introduce sound stimulation, and automatically advanced, and the film must be sensitive to dim light.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers. A possible problem solution is being reviewed.

Title: "Animal Rewarding Keyed to Magnitude of Response"

Problem Originator: Dr. James H. Pirch, Assistant Professor
Department of Pharmacology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

Electric shocks applied to rats produce DC responses recordable from the brain that are of variable amplitude and last 3 to 5 seconds. They occur superimposed on a background DC level which slowly rises and falls. It is desired to trigger a reward-giving apparatus (food pellets) each time the DC shift, in response to a stimulus, is of a sufficient amplitude independent of the background DC voltage level. By rewarding an animal when his response is not only correct but of sufficient magnitude, certain drug studies can be facilitated and the animal may be conditioned to give a larger response.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Determination of Cerebral Dominance in Man"

Problem Originator: Glen Tinsley Speech Pathologist, Audiology and Speech Clinic, University of Texas Medical Branch, Galveston, Tx.

Date Submitted: 26 December 1969

Description of Problem:

Patients with aphasia (loss of power of speech) can be retrained under some conditions but occasionally the improvement of speech is accompanied by loss of ability to write, for example. There appears to be a relation to cerebral dominance, since the areas of the brain for speech appear to be present only on the dominant side.

It is desired to obtain valid means to determine cerebral dominance and to be informed of what means NASA uses for this determination since it would appear that this influences the location of spacecraft controls and/or crew selection.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Electrical Model for Transmission of Information Within a Single Cell"

Problem Originator: Dr. F. H. Rudenberg, Associate Professor Department of Physiology, University of Texas Medical Branch, Galveston, Texas

Date Submitted: 26 December 1969

Description of Problem:

A model is needed for understanding how contact information obtained at one end of a protozoan cell reaches the other end.

The 200 um Paramecium cell is propelled by hundreds of cilia over its surface. Upon contact with a mechanical obstruction or a chemical toxin it "instantaneously" reverses direction of movement, presumably by reversing the direction of beat of the cilia. Since forward motion is in a spiral, and reverse motion is in a reverse spiral, this presumption is valid. In spite of other investigator's discreditation of an impulse hypothesis, new evidence by electron microscopy indicates that there is a continuous fibrous network located beneath the surface of the cell which could serve to pass information rapidly from one end to the other. Analogy with function of a nerve cell is poor for many reasons. Newer understanding of solid-state electronics may aid in forming a concept of how simple information may be translocated to rapidly cause ciliary reversal thereby permitting construction of a model.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers. A copy of a recent article from Science on "Ciliary Orientation Control" was sent to the Problem Originator.

Title: "Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section"

Problem Originator: Arthur W. Guy, Ph.D., Assistant Professor, Department of Physical Medicine and Rehabilitation, University of Washington, Seattle, Washington

Date Submitted: 23 September 1968

Description of Problem: For medical applications, it is desired to predict the heating in tissue due to the application of diathermy or ultrasound. The various layers encountered are fat, muscle, and bone, with cross sections that do not match the classical shapes such as cylinders and rectangles. Heat dissipation and transfer in these various layers determines the temperature rise. The use of numerical techniques for the solution of these problems will allow greater flexibility with regard to the boundaries and should also be more easily programmed for a computer solution.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made, and the results were sent to the Problem Originator. The Problem Originator stated that the search results were most useful and informative but not directly applicable. A Medical Problem Statement was then printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to November 1, 1969: Responses to the disseminated Medical Problem Statements were received from Lewis (Plum Brook) and Langley Research Centers. Personnel at Ames Research Center also showed interest in the problem. The most appropriate, specific, and detailed potential solutions are those proposed by Mr. John H. Lynch, Reactor Division, Plum Brook Station; these were forwarded to the Problem Originator. The responder has also been communicating directly with the Problem Originator. Mr. Lynch's contributions are now being assayed by members of the Problem Originator's staff. Several communications have been sent to the Problem Originator by Biomedical Application Team members, citing the needs for follow up evaluations.

Projected Problem Activity: It is anticipated that the programs offered by Mr. Lynch will solve the problem. The evaluations by the Problem Originator will have to be completed, and actual use of the computer programs is expected. The problem will constitute a transfer, which will be documented.

Title: "Indirect Blood Pressure Measurement - Without Occlusive Cuff"

Problem Originator: Paul Stein, M. D., Assistant Chief, Cardiology Section, Oklahoma Veterans Administration Hospital, Oklahoma City

Date Submitted: 17 February 1970

Description of Problem:

Both accepted indirect methods for taking blood pressure, the Korotkoff and the ultrasonic Doppler method, require the use of an occlusive cuff. An indirect method for measuring arterial blood pressure without the use of an occlusive cuff is needed. The apparatus should be applicable to operating room and intensive care environments. The number and size of encumbering wires should be minimal. Cost should be less than $2,000 and the method should function in normal room acoustical noise environment and should be reasonably immune to motion artifact.

Activity on Problem to Feb. 28, 1970:

A preliminary Problem Statement was written.

Title: "Measurement of Lung Compliance"

Problem Originator: L. J. Greenfield, M. D., Chief, Surgical Service, Oklahoma Veterans Administration Hospital, Oklahoma City

Date Submitted: 17 February 1970

Description of Problem:

One means of assessing function of the lungs is to measure lung volume-pressure relationship by having the patient breathe into a closed system. Acquisition of these data is time consuming, involves the use of bulky equipment and is difficult when the patient is ill. The indications are suitable bases for gross diagnoses, but subtle abnormalities or changes are not readily detectable. A reliable, convenient and atraumatic method for measuring pulmonary compliance of the lung by signaling rate and volume of airflow is needed. The transducer or sensor head must be sterilizable and temperature and moisture insensitive. It can be attached to a standard endotracheal tube through which the patient breathes or is ventilated by a respirator. The use of acoustic or mechanical vibration may be applicable.

Activity on Problem to Feb. 28, 1970:

A preliminary Problem Statement was written.

Title: "In Situ Measurement of Surface Tension of Lungs"

Problem Originator: L. J. Greenfield, M. D., Chief, Surgical Service, Oklahoma Veterans Administration Hospital, Oklahoma City

Date Submitted: 17 February 1970

Description of Problem;

Surface tension at the fluid-tissue interface in the lungs is an indication of the condition and efficiency of the lungs. A suitable means for measuring this parameter in the lungs of human patients is needed. The technique should provide means for rapidly and atraumatically measuring this parameter. The equipment must be reliable and safe to use and should be amenable to automated readout. Little restriction is imposed on the concept, but ultimately the apparatus should be portable for clinic and hospital ward use and the cost should be less that $15,000.

Activity on Problem to Feb. 28, 1970:

A preliminary Problem Statement was written.

RNV-14 ■

Title: "Materials for Prevention of New Decubitus Ulcers"

Problem Originator: E. S. Stauffer, M. D., Ph. D., Chief, Spinal Cord Injury Service, Rancho Los Amigos Hospital, Downey, California

Date Submitted: 22 September 1968

Description of Problem: Spinal cord injury patients with sensory loss develop pressure sores over the bony areas of the sitting surface while sitting in a wheelchair. These sores take from two weeks to four months to heal. Some need surgical closures. The estimated average cost of a pressure sore is $15,000. Some type of cushion material is needed which would successfully eliminate the factor of pressure sores developing, possibly by redistributing the pressures so as to eliminate high pressure points on the patient's body. The material should be somewhat compressible, light, possibly a gel, and have properties generally described as visco-elastic.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made, and the results were sent to the Problem Originator. The Problem Originator classified the search results as pertinent, direct, and immediately useful. Six documents were ordered from the search center by the Problem Originator. Materials were then purchased and cushion research was begun. A Medical Problem Statement was printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to November 1, 1969: Responses to the Medical Problem Statement were received from Langley Research Center. The suggestions from Langley were forwarded to the Problem Originator requesting an evaluation.

Activity on Problem to February 28, 1970: Investigations have been made into a special resin which might be used to construct special pads to prevent decubitus ulcers.

Title: "A Wireless Synchronization Link"

Problem Originator: William J. Crane, Electrical Engineer, Rancho Los Amigos Hospital, Downey, California

Date Submitted: November 14, 1969

Description of Problem:

The investigator is helping stroke patients to walk by stimulating muscles to correct for "dropfoot." Patients suffering from this ailment tend to drag the effected foot because the muscles that raise the foot at "stepoff" do not function.

Researchers at Rancho Los Amigos Hospital are electrically stimulating the appropriate nerve in the leg by the use of implanted electrodes and inductively coupled radio frequency energy. Basic parts of the stimulator system are as follows: (1) a waist-belt-mounted radio frequency generator package, (2) an r.f. transmitting coil for external use, (3) an r.f. receiver coil and integral passive circuitry for surgical implantation, (4) nerve stimulating electrodes mounted on silastic and suitable for surgical implantation, (5) a shoe-heel mounted switch which truns on the r.f. generator when the patient "steps-off" with the effected foot. The stimulator electrodes, receiver package, and their connecting wire are surgically implanted. But the wire that extends from the heel switch to the r.f. generator package located at the waist of the patient is a source of mechanical failure; it interferes with ambulation and is a cosmetic liability. The researchers want to replace the hard wire link between the shoe-heel switch and the r.f. generator package with a wireless link. This synchronization link should require little or no battery power and should be mountable in the heel of an ordinary shoe.

Activity on Problem to Feb. 28, 1970:

A computer search was made of the NASA data bank and the results were forwarded to the Problem Originator. However, none of the cited abstracts appeared useful except as background material. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Overload Protection for P. M. /D. C. Motors Used in Orthotic Devices"

Problem Originator: James R. Allen, Project Director
Attending Staff Associate, Rancho Los Amigos Hospital
Downey, California

Date Submitted: 24 November 1969 (reported last month without description of problem)

Description of Problem:

Rancho Los Amigos Hospital develops special powered orthotic devices for paralyzed patients. The small motors used in these units are battery driven, usually with a storage battery mounted under the wheelchair. These busy researchers have not developed electrical overload protection for the motors which sometimes stall and burn out.

Suitable means for protecting small permanent magnet d. c. motors against excessive stall or blocked rotor current is required.

Activity on Problem to Feb. 28, 1970:

A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Analysis of Human Motion Patterns"

Problem Originator: Dan Antonelli, Project Engineer and Attending Staff Associate of Rancho Los Amigos Hospital, Downey, Calif.

Date Submitted: 12 December 1969

Description of Problem:

The Kinesiology Department of Rancho Los Amigos is performing human motion pattern studies on patients who have difficulty in walking in order to plan corrective surgery and to refine and improve bracing techniques. "Normal" motion or gait patterns have not been adequately and conveniently defined. Techniques are required for correlating and analyzing acceleration data generated at selected body sites. The objective is to handle and display these data in a manner that will make it possible to clearly recognize "normal" motion patterns and to determine the timing manner and degree to which "abnormal" motion patterns differ.

Activity on Problem to Feb. 28, 1970:

Mr. Al Green, field engineer for Endevco, contacted the SwRI Team stating that he had a suitable triaxial accelerometer. He further stated that he is interested in developing this medical product line and will be happy to cooperate in development programs. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Anticipatory Reference"

Problem Originator: Dan Antonelli, Project Engineer and Attending Staff Associate of Rancho Los Amigos Hospital, Downey, Calif.

Date Submitted: 12 December 1969

Description of Problem:

Restoration progress of muscles in paralyzed or otherwise impaired patients might be determined by measuring electromyographic potentials. These voltages will be meaningful, however, only if the degrees of stress and motion imposed are repeatable.

An anticipatory reference generation method which would permit a patient to move a limb or perform a physical function in "time" with a rate or speed reference is required.

Activity on Problem to Feb. 28, 1970:

Information on Medtronic stimulation equipment and reference material by McNeil and Wilemon were forwarded to the Problem Originator. A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Determination of Precise Orientation of the Spine"

Problem Originator: Dan Antonelli, Project Engineer and Attending Staff Associate of Rancho Los Amigos Hospital, Downey, Calif.

Date Submitted: 12 December 1969

Description of Problem:

Orthopedic surgeons must know the precise orientation of the spine in order to formulate the optimum surgical plan. Utilization of the best x-ray procedures by the most competent radiologists does not result in sufficiently accurate location of the unusual geometry of the malshaped spine. It is often necessary to plan and modify plans for surgical procedures as the surgery progresses.

A better approach to visualizing and accurately plotting the geometry of the spine. The problem originator suggests the possibility of acoustic holography.

Activity on Problem to Feb. 28, 1970:

It was decided that a literature search would not be productive for this problem but that distribution of a Problem Statement to the Centers was required. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers. An article on ultrasonic holography was forwarded to the Problem Originator.

Title: "Angle Measurement in Knee Prosthetics"

Problem Originator: Dan Antonelli, Project Engineer and Attending Staff Associate of Rancho Los Amigos Hospital, Downey, Calif.

Date Submitted: 12 December 1969

Description of Problem:

In order to enable the physician to assess conditions and capabilities of particular muscles and muscle groups, it is desirable to measure muscle potentials developed under repeatable degrees of static and dynamic stress. A simple method for repeatedly measuring the angle between the upper and lower parts of the leg relative to the knee joint is required. This joint is a cam type instead of a pin type joint.

Activity on Problem to Feb. 28, 1970:

Background information was obtained for the preparation of a Problem Statement.

Title: "Intramyocardial Electrode"

Problem Originator: Robert B. Pearson, M. D., Neurophysiologist
Rancho Los Amigos Hospital, Downey, California

Date Submitted: 18 December 1969

Description of Problem:

The Problem Originator is performing research in mathematical modelling of the electrocardiogram. Measurements of intramyocardial electrical impulse maps (voltages at sequential layers of tissue in the heart muscle) are necessary in order to make realistic assumptions about the heart as an electric field generator. A method for fabricating such an electrode or a source from which such an electrode may be obtained is needed.

Activity on Problem to Feb. 28, 1970:

A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers. Information on a similar problem was obtained from Research Triangle Institute and was forwarded to the Problem Originator.

Title: "Accelerometer for Human Motion Studies"

Problem Originator: Dan Antonelli, Project Engineer and Attending Staff Associate of Rancho Los Amigos Hospital, Downey, Calif.

Date Submitted: 12 December 1969

Description of Problem:

The Kinesiology Department of Rancho Los Amigos is performing human motion pattern studies on patients who have difficulty in walking in order to plan corrective surgery and to refine and improve bracing techniques. "Normal" motion or gait patterns have not been adequately and conveniently defined. With proper data acquisition and analysis, it may be possible to evaluate and diagnose orthopedic cases and problems in an "on line" manner. Small, light and rugged triaxial accelerometers are needed.

Activity on Problem to Feb. 28, 1970:

Information on a commercial source of applicable equipment was found via a NASA Tech Brief and the TUO at Ames Research Center. The commercial source suggested that the Problem Originator fabricate his own triaxial accelerometer from single axis units. The Problem Originator is considering this information.

Title: "Manual Controls for Self-Propelled Vehicle (wheelchair; automobile)"

Problem Originator: John E. Rogers, Jr., Program Director Patient Transportation, Rancho Los Amigos Hospital, Downy, California

Date Submitted: 20 January 1970

Description of Problem:

The overall research and development project is one of providing transportation to patients undergoing rehabilitation and able to use a wheelchair. The development of self-propelled wheelchairs up until the present time has been evolutionary rather than by system design. The status of the research program by this investigator is currently evaluating patient transportation needs and objectives; then devices will be developed. Controls for powered wheelchairs are being designed from a "systems" approach, obviating the obsolete constraints imposed by early model wheelchairs. The human-machine interface is being given paramount consideration in the program; thus a wheelchair more suited to the needs and comfort of the patient should be the desired result.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Power System for Wheelchair"

Problem Originator: John E. Rogers, Jr., Program Director Patient Transportation, Rancho Los Amigos Hospital, Downey, California

Date Submitted: 20 January 1970

Description of Problem:

This problem is part of the overall project on developing patient transportation in various types of self-propelled devices. Specifically, the investigator is working on the development of a self-propelled wheelchair. The current research project is an effort to give due consideration to all problems and bed-wheelchair-automobile interactions for a wholly compatible transportation system. Design and performance data on fuel cells for purposes of electrical power generation is needed. Also needed is design and performance data on high energy storage cells, rechargeable, preferably dry type. A wet cell would also be acceptable if the unit is non-spillable.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Patients Supporting Couches"

Problem Originator: John E. Rogers, Jr., Program Director Patient Transportation, Rancho Los Amigos Hospital Downey, California

Date Submitted: 20 January 1970

Description of Problem:

The main development of suitable patient transportation and supportive devices such as wheelchairs, stretchers, hoists, cars, etc., has been evolutionary. In the past, little consideration has been given to the compatibility of the chair, couch, or bench with the anatomy of the patient; and no effort has been devoted to patient comfort, either psychological or physiological. In essence, the development of all of these devices has been without regard to the man-machine interface. For example, wheelchairs have been built to minimize weight or to fold up for storage, but only superficially to fit the anatomy of the patient. Therefore, the investigator is engaged in an overall research program to evaluate the supportive-cushioning needs of the patient and to design and construct prototype equipment.

The researcher at this time is evaluating overall patient transportation needs with a "systems" approach. The objective is to include all of the factors affecting the patient in the bed, chair, and car. Information is needed to facilitate the design of seats and couches for the support of the patients in (1) supine (lying on the back) position, (2) erect (sitting up) position, and (3) intermediate positions between supine and erect.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Small Wide-Band Microphones for Sensing Heart Signals"

Problem Originator: N. Ty Smith, M.D., Assistant Professor of Anesthesia, Stanford University Medical Center, Stanford, California

Date Submitted: 14 July 1969

Description of Problem: The Problem Originator is trying to show that nondestructive microphonic sensing techniques can produce as much reliable and valid data concerning the function of the heart in man as a traumatic procedure. Small flat circular microphones (1-2 mm thick and 1 cm in diameter) and small oval-shaped microphones (0.5 cm x 1.5 cm) are needed to sense cardiac sounds and pulse waves in man. The frequency response of the microphones should be from DC-500 Hz with the output leading into an amplifier of moderate impedance.

Activity on Problem to August 1, 1969: As a first step in processing the problem, the Problem Originator was furnished a copy of Southwest Research Institute's Technology Utilization Survey of microphones compiled by Dr. Raul San Martin.

Activity on Problem to November 1, 1969: The Problem Originator stated that the Survey of microphones supplied to him by the Team was excellent but did not contain a solution to his problem. A computer search statement was prepared. The search results were screened, sent to the Problem Originator, and his evaluation was requested. Abstracts of related technical articles and available information on potentially applicable commercial devices were forwarded to the Problem Originator. A Southwest Research Institute engineer who specializes in applications for accelerometers and microphones reviewed the problem and search results and recommended that the Problem Originator consider using an Endevco Corporation microminiature accelerometer.

Activity on Problem to February 28, 1970: The Problem Originator's evaluation of the computer search of the NASA data bank was received. He stated that the search was very useful, although no solution was found from the search results. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Methods for Electrosleep and Electroanesthesia"

Problem Originator: N. L. Wulfson, Associate Professor of Anesthesiology, University of Texas Medical School at San Antonio, Texas

Date Submitted: 6 November 1969

Description of Problem:

This investigator is concerned with obtaining information concerning the latest state-of-the-art with regard to instrumentation for inducing electrosleep and electroanesthesia and its use. Since there have been repeated reports of Russian utilization of the technique with regard to space flights, it is possible that NASA is also investigating the phenomenon either on an in-house or contract basis. Any information concerning instrumentation, techniques, behavioral, physiological effects, applications, etc. with regard to electrosleep and electroanesthesia would be extremely useful. The investigator is conducting both human and animal experimentation.

Activity on Problem to February 28, 1970:

A WESRAC computer search was performed and the results were forwarded to the Problem Originator. The search produced pertinent information, since the problem posed was general in nature. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Modification of the Surface of Controlled Pore-Size Glass to Eliminate Adsorption"

Problem Originator: C. W. Hiatt, Ph. D., Chairman, Department of Bioengineering, University of Texas Medical School at San Antonio

Date Submitted: 10 November 1969

Description of Problem:

This investigator is perfecting the use of controlled pore-size glass to purify viruses by exclusion chromatography for vaccine production. He is presently using porous glass with pore sizes in the range 50-200 mμ When this glass is crushed, screened and packed into columns, it becomes an ideal matrix for exclusion chromatography with certain viruses, e.g., polio virus. However, it cannot be used with other virus, such as the rabies virus, because of excessive adsorption of the virus to the glass surface. This adsorption occurs at pH's wherein the net charge of the virus is negative. The investigator needs a method of modifying the glass surface so as to eliminate adsorption without rendering the glass surface hydrophobic or plugging the pores.

Activity on Problem to February 28, 1970:

A WESRAC computer search was performed and the results were forwarded to the Problem Originator. The search was very poor with no pertinent articles being obtained. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Improved Technique for Measurement of Skin Thickness"

Problem Originator: Richard G. Domey, Professor of Biostatistics
University of Texas Medical School at San Antonio

Date Submitted: 14 November 1969

Description of Problem:

In the biomedical sciences, the measurement of body fat and skin thickness is performed indirectly by measuring skin fold thickness over body fat tissue with calipers. Inordinately measurements of skin thickness by this manner lack precision needed for the reproduction of reliable research data.

A new method is required for accurate and precise skin thickness measurements. The new device must be compatible with procedures of obtaining skin thickness measurements as a function of time. The instrument must be portable and designed to be useful in field research under changing environmental conditions, as well as in hospital environments. Moreover, the device must provide a permanent record of collected data, simple to operate and sufficiently precise to minimize experimental error.

Activity on Problem to February 28, 1970:

A computer search of the NASA data bank was performed with only 5 references recovered, none of which were pertinent to the problem. Information was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited. This problem is classified as a potential transfer. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Implantable Telemetry System for EKG"

Problem Originator: Leo Cuello, M. D., Head
Division of Thoracic and Cardiovascular Surgery
University of Texas Medical School at San Antonio, Texas

Date Submitted: 26 December 1969

Description of Problem:

The researcher requires a small implantable telemetry system capable of continuously transmitting electrocardiographic data from chronically surviving primates who have received cardiac transplants.

The telemetry system required must be small, implantable, biocompatible, have a useful life of approximately sixty days and an effective range of approximately twenty feet.

Activity on Problem to February 28, 1970:

A manual search of the NASA literature produced a document containing circuitry information for a subminiature biotelemetry unit for remote physiological investigations. Detailed information concerning this unit was forwarded to the Problem Originator who is in the process of fabricating a replica of the NASA unit which will be suitable for long term implantation in primates subjected to heart transplantation.

Title: "Computerization of Diagnostic X-Rays"

Problem Originator: Robert G. Waggener, Ph. D. Assistant Professor of Radiology, Radiology Department University of Texas Medical School, San Antonio, Texas

Date Submitted: 12 January 1970

Description of Problem:

Computer science has found application in practically every area of endeavor not necessarily as data processors, but as experimental tools. However, there appears to be a lack of computer technology in X-Ray diagnostic techniques. This may be caused by the reasonably constant dose rate over long periods of time in conventional X-ray therapy units. The operators of the units are provided with charts and tables showing times for different tumor doses. Most of the computer techniques, however, involve X-ray therapeutic application and not diagnostic uses. Selected bits of computer technology are desired which may be integrated so that an arrangement may be devised to simplify, standardize, and make maximum use of all diagnostic radiographic information and X-ray techniques in a radiology clinic.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made. The search results, NASA Tech Brief 69-10139 with its Technical Support Package, and other pertinent references were forwarded to the Problem Originator for his consideration. The Problem Originator indicated that the information was very helpful and may be a key to the solution of the problem. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

SNM-7 ■

Title: "Information Theory (Shannon's) as Applied to X-Rays"

Problem Originator: Robert G. Waggener Ph. D., Assistant Professor of Radiology, Radiology Department University of Texas Medical School, San Antonio, Texas

Date Submitted: 12 January 1970

Description of Problem:

The information theory is a mathematical theory of communication regarding a set of finite messages or events about a situation. When one message or event is randomly selected, all choices being equally likely, the most natural choice is a logarithmic function. In this case, log to the base 2 has been accepted. The information theory was developed in 1948 by C. E. Shannon with assistance from previous work of Nyquist and Hartley.

While the information theory has found application in several fields, e. g., art, music and psychology, etc., the field of clinical radiology does not appear to be enjoying the use of this theory. The investigator wishes to determine whether advanced studies have been sufficient enough to disqualify or qualify the application of the information theory in clinical radiology, and if there are any advantages of explaining the design of a computer based on the statistical sequencing of a finite set of symbols that may characterize various radiology techniques.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made. The search results and an article from Scientist, "Mathematics with Light," was forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Bone Mineral Measurement Utilizing X-Ray Techniques"

Problem Originator: Robert G. Waggener, Ph. D., Assistant Professor of Radiology, Radiology Department University of Texas Medical School, San Antonio, Texas

Date Submitted: 12 January 1970

Description of Problem:

The concept of bone mineral content determination is fundamental to interactions of X or gamma radiation with matter. The problem requirement is for an X-ray machine and/or technology that will provide a well collimated monoenergetic beam of X-rays with minimum scatter and a suitable method for detection of the amount of absorbed radiation in bones. Results of mineral determinations must be accurate and reproducible.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results, with articles and Tech Briefs relevant to problems SNM-6, 7, 8, were sent to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Chemical Analysis of Biological Molecules Utilizing X-Ray Fluorescent Techniques"

Problem Originator: Robert G. Waggener, Ph. D., Assistant Professor of Radiology, Radiology Department University of Texas Medical School, San Antonio, Texas

Date Submitted: 12 January 1970

Description of Problem:

The investigator is performing in the field of X-ray diagnosis and relaxed application of X-ray energy in the life sciences. X-ray fluoresence has been gainfully employed in physical and mechanical sciences for elemental analysis. In his study, the investigator is trying to find a way in which X-ray fluoresence can be a practical analytical tool in biochemistry. He requests information or references concerning the technology of X-ray microprobe analysis of biological molecules. Insight into advanced technology may provide development of X-ray intensities in quanitative analysis with selective excitation of molecular structures.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Portable Recording Stethoscope"

Problem Originator: B. D. Fremming, DVM, University of Texas Medical School, San Antonio, Texas

Date Submitted: 18 February 1970

Description of Problem:

The investigator is seeking a small portable stethoscope which is capable of recording cardiac and respiratory sounds on a permanent record (e. g. , magnetic tape) that could be used to provide playback of such phenomena for comparative longitudinal studies. Such an instrument, which could also help to improve diagnostic techniques in areas where heavy equipment is not readily transportable, also has the potential for making important contributions to teaching, research, and diagnosis.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood Flow in Free-Ranging Dogs"

Problem Originator: Joseph E. O. Newton, M. D. Research Physiologist, VA Hospital, NLR Division, North Little Rock, Arkansas

Date Submitted: 21 October 1968

Description of Problem: Two strains of bird dogs are under study by researchers. One strain is designated "normal" and the other strain is designated "nervous." The immediate objective is to determine how such physiologic parameters as heart rate, blood pressure, and blood flow of the normal and nervous dogs compare. The ultimate objective is to learn to understand the differences between the normal and the nervous dogs; it is felt that such knowledge would be useful in understanding and treating mental illness in humans.

Wireless telemetering equipment suitable for backpack mounting is required. Transmission range should be one mile, and two channels capable of handling the blood pressure waveform and blood flow velocity must be provided. The sensors used must be implantable and must be usable with portable telemetry equipment. Service life of the system should exceed one week.

Activity on Problem to August 1, 1969: A telemetry information package from NASA/Ames Research Center was furnished to the Problem Originator. An updating NASA computer search on telemetry was performed and the screened results were forwarded to the Problem Originator. Ten documents from the updated search were ordered by the Problem Originator, who stated that he had decided to use ultrasonic Doppler equipment for measuring and telemetering blood flow velocity information. A copy of the document search for Telemetry of Body Kinesiology (RNV-11) was then sent to the Problem Originator.

The Problem Originator reported success in surgically implanting transducers around the aorta and coronary arteries and that good records of blood velocity (coronary) were being obtained. He later reported severe errors in measurement of flow velocity that the transducers did not perform properly *in vivo*, and that the telemetry system was noisy.

"Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood Flow in Free-Ranging Dogs" (Cont'd) SRS-8A ■

Activity on Problem to November 1, 1969: The Problem Originator and a Biomedical Application Team member, who was in the area on other Team business, visited Dean Franklin and other members of the staff at Scripps Institute and discussed methods of use of the ultrasonic Doppler method for measuring blood flow velocity. Telemetry techniques and specific equipment functions were also discussed. Additional current technical information on performance of the ultrasonic flowmeter was sent to the Problem Originator. Requested information on the Electronics Research Center Tunnel Diode pressure transducer was sent to the Problem Originator who stated that such a device might prove useful in the solution of their blood pressure measurement problem.

A funding hiatus was experienced by the Problem Originator during part of this quarter.

Projected Problem Activity: The researcher has received new grant funds and work is in progress. Since no further action is necessary by the Team, the problem will be classified as inactive but technology transfer will be documented as the research work progresses.

Title: "Methods of Signal Categorization"

Problem Originator: Joseph E. O. Newton, M. D., Research Physiologist
VA Hospital, NLR Division, North Little Rock, Arkansas

Date Submitted: 21 October 1968

Description of Problem: Electrocardiograms from two strains of dogs are being obtained. Broadly speaking, there appear to be differences between the two categories which are observable through visual inspection by a human. What is sought is a suitable technique for quantifying this visible difference.

Activity on Problem to August 1, 1969: A computer search of the NASA data bank was made, and the results were sent to the Problem Originator. The information referenced in this search was not immediately utilized because the project had not as yet progressed to the state where methods of signal categorization was required. A Medical Problem Statement was then printed and sent to the Sponsor for dissemination to the NASA Research Centers.

Activity on Problem to November 1, 1969: Two responses to the Medical Problem Statement, which was disseminated during this quarter, were received, studied, acknowledged, and forwarded to the Problem Originator. The Biomedical Application Team and the Problem Consultant discussed the applicability of the search results to diagnostic use in speech analysis. A funding hiatus was experienced by the Problem Originator during part of this quarter.

Projected Problem Activity

Document the Medical Problem Statement response evaluations. Classify the problem as inactive and document the use of transferred technology as the research work progresses.

Activity on Problem to February 28, 1970: A copy of the search results and Problem Statement was sent to Research Triangle Institute for its possible applicability to a similar problem. A response to the disseminated Problem Statement was made by Mr. John C. Fakan at Lewis Research Center.

Title: "Improved Techniques for Taking EEG in Infants and Small Children"

Problem Originator: Dr. L. H. Dieterman, Biophysicist, Scott White Clinic and Hospital, Temple, Texas

Date Submitted: 29 January 1970

Description of Problem:

Investigators at Scott-White Clinic and Hospital, Temple, Texas are perfecting a technique for using the EEG to test hearing of small children. Today thousands of children classified as mentally retarded are believed to be suffering not from mental retardation, but rather from hearing difficulties which have cut them off from auditory interchange and their environment, which is needed to develop their intellect. The investigators are convinced that if they can identify hearing defects early in infancy and initiate appropriate remedial measures they can prevent many youngsters from becoming functional mental retardates. What is needed is an instrumented helmet, with EEG electrodes in place; a helmet, particularly if equipped with earphones from administering the auditory signal, would substantially assist in identifying hearing defects in young children who cannot verbally communicate information regarding whether they hear an auditory stimuli and to what degree they hear it.

Activity on Problem to Feb. 28, 1970:

A device was found which, with modification, will answer the requirements of the problem. A potential transfer report has been written and this problem has been submitted to NASA as a candidate for applications engineering. Copies of NASA Tech Brief 66-10536 and USAF Publication ARL-TR-69-17-6571, which provided the basis for the reengineering effort, were sent to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Cortical Audiometry Measurements"

Problem Originator: Dr. L. H. Dieterman, Biophysicist, Scott White Clinic and Hospital, Temple, Texas

Date Submitted: 29 January 1970

Description of Problem:

Investigations on cortical audiometry or evoked cortical response with infants and small children are in process to determine deafness or hearing impairment. The Problem Originator is interested in the development of an automatic instrument utilizing state-of-the-art circuiting or modules to replace his existing prototype system.

Activity on Problem to Feb. 28, 1970:

A conference was held with the Problem Originator to obtain additional information on the problem for the preparation of the Problem Statement.

Title: "Differentiation Between Normal and Abnormal (Tumor) Tissues By Using Ophthalometric Techniques"

Problem Originator: Dr. R. D. Cunningham, Opthalmology Department, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

The investigator desires to apply sensitive thermistors, infrared detecting devices and/or pressure and flow transducers to determine differences in temperature, pressure, and flow-rate of blood in the internal carotid artery and in eye lesions (tumors). This is related to his overall research goal of developing improved clinical diagnostic tools which can be used with the approximately 30% of patients having eye tumors who constitute problems in diagnosis. Accurate diagnosis and early treatment of these cases is at times hampered by inadequate diagnostic techniques. Accurate diagnostic techniques will not only permit earlier initiation of treatment, but may also lead to development of suitable preventive measures.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Information Retrieval System for Clinical Records"

Problem Originator: Dr. N. C. Hightower, Department of Research and Development, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

The investigator desires a means to retrieve information from a bank of one-half million clinical records maintained by a medium-sized hospital and clinic having 80,000 admissions per year. He particularly desires access to information contained on the records which can be tapped to augment information related to specific medical treatment; enhance disease prevention; and for identifying trends in medical treatment. Ultimately, the desire is to perfect techniques for providing guidance in treatment of cryptic diseases by computer analysis. The hospital has sophisticated data processing equipment (IBM Computer Model 360) but lacks software programs to accomplish the task outlined. It is conceivable that information retrieval systems devised by NASA can be adapted to meet the particular needs of the medical treatment facility.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Technique for Recovery and Separation of Amylase from Polyacrylamide Gels"

Problem Originator: Dr. Hall, Department of Biochemistry, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

The investigator is conducting an extensive research program centering upon detection, treatment and prevention of gastrointestinal tumors. An important problem now facing the investigator is to develop a method for the recovery and separation of amylase (enzymes) from polyacrylamide gels. There is some possibility that NASA technology associated with electrophoresis may contribute to solution of the researcher's problem.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Apparatus for Micropuncture of Pancreatic Gland"

Problem Originator: Dr. W. C. Dyck, Department of Research and Development, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

The investigator is conducting a program of basic research relative to cystic fibrosis as it affects children. To proceed with his important research, the investigator requires a subminiature electronic device which can be employed for micropuncture of ducts and cells of the pancreas, so as to permit *in vivo* chemical analysis of various inorganic ions and enzymes.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Improved Scan Resolution of Radioisotope Filled Organs"

Problem Originator: Dr. F. C. Pitty, Department of Radiology Radioisotopes, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

The fundamental purpose of a radioisotope imaging system is to produce an image of such quality that the physician can recognize diagnostically significant detail. However, it is often difficult to delineate radioisotope-filled organs by radioisotope scanning, for purposes of clinical diagnosis. For this reason, the investigator desires to explore new scanning techniques and to consider new isotopes which can be used to provide greater detail or image resolution, while at the same time subjecting the patient to minimal injurious radiation.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

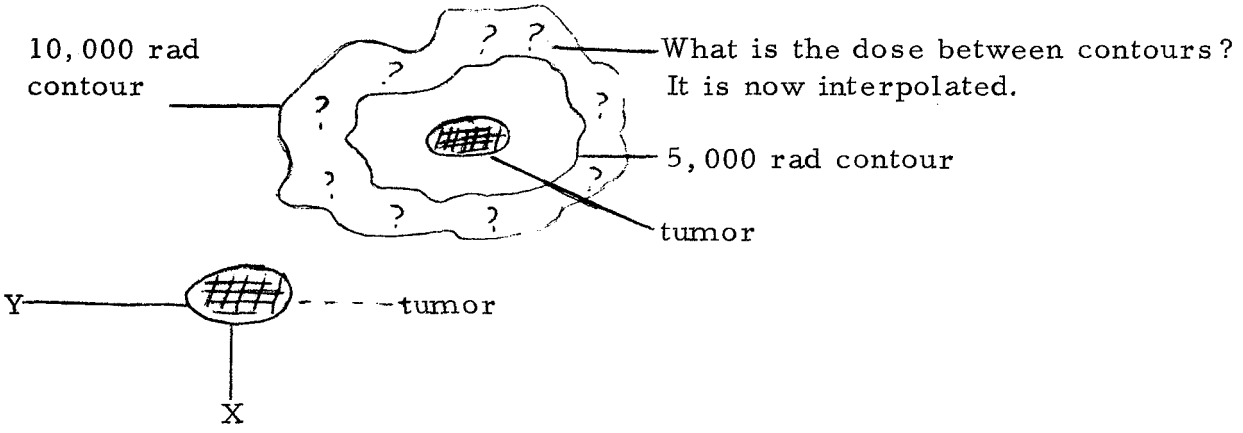
Title: "Improved Method for Computing X-Ray Dosage"

Problem Originator: Dr. L. H. Dietermann, Department of Radiology Therapy, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

When administering radiation (x-rays) for therapeutic purposes, such as treatment of a tumor, the radiologist normally computes an x-ray dose distribution. This involves delineation of contours which circumscribe a body area and which set forth dosage along the curves (see fig. 1). However, this technique does not take into adequate account the absorbed tissue dose between contours, with this generally being derived by interpolation. As a consequence, precision and accuracy may often be lacking in determining the absorbed tissue dose. The investigator desires a computer technique which is capable of performing an x, y plot of the dose between contours (at any depth).



Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Noise Level Correction for Audiometry Measurements"

Problem Originator: Dr. L. H. Dietermann, Department of Radiology Therapy, Scott-White Clinic and Hospital, Temple, Texas

Date Submitted: 21 February 1970

Description of Problem:

Audiometry measurements require the repetitive recording of the EEG waveshape and integrating the signals. Noise signals are somewhat cancelled by the averaging process but since the signals are in the microvolt range they still present themselves as an appreciable signal, reducing the signal-to-noise ratio of the instrument.

Activity on Problem to Feb. 28, 1970:

This is a new problem.

Title: "Blood Flow of Individual Red Cells in the Capillaries of Living Tissue"

Problem Originator: Paul C. Johnson, Ph. D., Professor and Head, Physiology Department, University of Arizona College of Medicine, Tucson, Arizona.

Date Submitted: 30 October 1969

Description of Problem: The researcher's problem is to measure the velocity of individual red cells as they pass through the capillaries in thin tissues such as the mesenteric membrane of the intestine and certain thin skeletal muscles which can be readily visualized. Present equipment requires that as a single red cell passes two photomultiplier tube windows, identical signals must be generated. This is not always the case since the red cell may change shape or orientation as it progresses along the capillary. A better way is needed to measure the time interval between the two signals generated as the red cell passes the two phototubes, or alternatively, a different type of approach to the problem might be considered.

Activity on Problem to Nov. 1, 1969: The problem was accepted and preparations were begun to write the search statement.

Activity on Problem to Feb. 28, 1970: A computer search of the NASA data bank was made and forwarded to the Problem Originator. The search failed to provide a solution from NASA technology, though it did yield some peripherally useful information. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Advanced Cross-Correlation Techniques and Equipment"

Problem Originator: Paul C. Johnson, Ph. D. , Professor and Head, Physiology Department, University of Arizona College of Medicine, Tucson, Arizona.

Date Submitted: 27 November 1969

Description of Problem: Hematological studies include the measurement of the velocity of erythrocytes in capillary beds by photometric means. Photomultiplier tubes focused on two slits measure the time expended for the erythrocyte to pass these two slits. As the erythrocyte changes orientation in the capillary, different signals are received. One method of accurately analyzing these signals is with cross-correlation techniques. The Problem Originator's present correlator is not sensitive enough for his sensing equipment and does not trigger accurately upon the passage of an erythrocyte. The Problem Originator is interested in determining if NASA has techniques and portable equipment suitable for interfacing into photomultiplier tube outputs to enhance accuracy of velocity measurements.

Activity on Problem to Feb. 28, 1970: Soon after the problem was accepted commercial material became available (published in a magazine) and information on this material was given to the Problem Originator for evaluation. A Problem Statement was written and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Physiologic Data Handling--Systems Approach"

Problem Originator: W. Sanford Topham, Ph. D., Assistant Professor Biophysics and Bioengineering, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 18 December 1969

Description of Problem:

The Problem Originator is establishing a data acquisition and reduction center in an Artificial Heart Test and Evaluation Facility. Large amounts of data will be acquired in the Facility and will come from varied sources. The artificial heart or heart assist device will be tested for its electrical and mechanical properties, subjected to environmental tests, evaluated in mock circulations, physiologically evaluated in animals and finally implanted in human patients. Physiological parameters will be monitored during surgery and twenty-four hour monitoring will continue for weeks while the animal's condition is being evaluated. Later it will be necessary to monitor the human patients. It will be necessary to also continuously monitor some of the in vitro tests for long periods of time for failure analysis and plans call for automatic control of many tests including the electrical and mechanical tests. Information on the following points is needed: a) interfacing a large number of analog variables to the computer, b) continuous monitoring of physiological parameters and methods of real time data reduction, c) file structure of data storage and methods of retrieval d) automatic control of evaluation tests, and e) automatically determining when a failure has occurred or may occur.

Activity on Problem to Feb. 28, 1970:

A copy of NASA Tech Brief 69-10720, with information on the transmission of medical signals for computer analysis, was forwarded to the Problem Originator. Negotiations are in progress to arrange for the Problem Originator to visit Manned Spacecraft Center to discuss their system of handling physiological data. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Microminature Pressure Transducer"

Problem Originator: Kent Backman, Research Engineer
Division of Artificial Organs, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 15 December 1969

Description of Problem:

In the development of ventricular assist devices related to artificial heart research, control systems are required to sense vital physiological functions and control the operation of the assist device. The problem originator wishes to monitor ventricular pressure at the site of blood removal with an inexpensive pressure transducer or switch. Detection of zero crossing will enable accurate pump control eliminating over pressures created by the pump.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Proton Magnetometer for Use as a Flowmeter"

Problem Originator: Kent Backman, Research Engineer
Division of Artificial Organs, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 15 December 1969

Description of Problem:

Research into the development of an artificial heart includes blood flow studies of both the coronary arteries and the peripheral arterial system. Present techniques and equipment, both ultrasonic and electromagnetic devices, limit flow measurements to the larger arteries because of transducer size constraints.

The problem originator wishes information on the measurement of flow in liquids by nuclear magnetic resonance techniques and particularly the supporting signal conditioning necessary to acquire and display the information.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Detection of Blood Clot Formation in Artificial Arteries by Pulse Echo Techniques"

Problem Originator: Jerrold L. Foote, Research Engineer
Division of Artificial Organs, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 15 December 1969

Description of Problem:

Artificial heart research includes investigations into biocompatible materials and their ability to resist clot formation on their blood contacting surfaces. The Problem Originator wishes to investigate numerous materials (some new) by pulse echo techniques and wishes to know if NASA technology includes non destructive testing techniques which measure thicknesses to 0. 1 mm with accuracy.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Dialysis Techniques for Artificial Kidney Research"

Problem Originator: Roger L. Kirkham, Project Engineer
Division of Artificial Organs, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 15 December 1969

Description of Problem:

Present artificial kidney machines are large and costly, requiring patients to remain close to a permanently located machine or dialysis center. They are also quite costly to buy and maintain. It would be beneficial to these patients if low cost portable machines could be made available to uremia patients for use in their homes or offices to allow patients more freedom of movement. The Problem Originator wishes to determine if NASA technology exists in dialysis, water purification, and deionization of liquids that may be applied to this problem. Information is also needed on adsorbants or converters which could remove urea, uric acid, and creatine.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Stress Analysis of Artificial Heart Valves"

Problem Originator: Roger L. Kirkham, Project Engineer, Division of Artificial Organs, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 15 December 1969

Description of Problem:

Patients with heart valve disorders have the possibility of having these defective valves replaced with artificial valves which permits better operation of the heart. Since these valves fail after prolonged use, investigators are searching for better valve design and more durable materials to further improve valve operation and durability. The Problem Originator wishes to undertake photoelastic stress analysis on material samples formed into spheres, discs, and leaflets to determine optimum materials and configuration for heart valves. Two and three dimensional photoelastic methods are needed to properly analyze these samples. The Problem Originator wishes to know if NASA technology has been developed which will assist in this analysis problem. Technology on transmission polariscopes to analyze slices taken from the models is also needed.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made. The search results, with 4 NASA Tech Briefs and the address of a commercial vendor on transmission polariscopes were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Chronic Electrode Implantation Techniques for Artificial Eye Research"

Problem Originator: William H. Dobelle, Project Manager, Division of Artificial Organs, University of Utah School of Medicine Salt Lake City, Utah

Date Submitted: 16 December 1969

Description of Problem:

Research into the development of an artificial eye where a TV camera will be wired directly into the brain is in the formulative stages and many problem areas exist where basic research must be done to define neural and electrical parameters to successfully interface the brain to a TV camera.

The problem originator wishes information on NASA techniques relating to chronic implantation of electrodes and materials used which remain relatively inert when subjected to long term exposure in body fluids and tissue.

Activity on Problem to Feb. 28, 1970:

Information was found from a manual literature search of the NASA data bank and from material on hand which will possibly meet the requirements of the problem. The data was forwarded to the Problem Originator and his evaluation is being awaited before proceeding with the final transfer report. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Biomechanical Analysis of Biological Materials"

Problem Originator: Glenn Secor, Assistant Professor, Civil Engineering, University of Utah School of Medicine Salt Lake City, Utah

Date Submitted: 16 December 1969

Description of Problem:

In the development of an artificial heart, investigators must know the biomechanical characterization of bone, soft tissue, arteries, and muscle to better define materials requirements for an artificial heart. NASA technology is desired on theoretical and experimental methods on characterization of materials in general and information on characterization of biomaterials.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Tidal Volume Measurement in Respiration Studies"

Problem Originator: W. Sanford Topham, Ph. D., Assistant Professor Biophysics and Bioengineering, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 16 December 1969

Description of Problem:

Studies relating to definition and diagnosis of emphysema and other respiratory diseases require information on tidal volume (i.e., volume of air inhaled) in conjunction with other physiological parameters. The problem originator is currently measuring tidal volume in a laborious manner and wishes to acquire this information more efficiently and quickly. The investigator is also interested in technology related to low resistance (free airway) transducers.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and an in-house search was made at Southwest Research Institute to acquire a complete information package on tidal volume air monitoring. This information and a Technical Support Package on spray-on electrodes was forwarded to the Problem Originator. He has indicated that the information seemed very promising. He is presently fabricating a transducer for experimentation. This problem was classified as a transfer, and a transfer report will be written soon. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Compensatory Tracking Techniques"

Problem Originator: William A. Johnston, Associate Professor Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Research into conditions and techniques which allow men to best perform multiple tasks simultaneously requires much testing of attention spans, reaction times, and the ability to ignore spurious noises and random distractions. The Problem Originator wishes information on compensatory tracking devices, tracking trainers, etc., developed in the aerospace industry to determine if such devices could be applied to his research program.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made but failed to yield a direct solution to the problem. However, a member of the Team at Southwest Research Institute was able to design the necessary signal conditioning circuitry. This design is being used to fabricate the needed equipment. This problem was classified for reporting purposes as an "impact."

Title: "Motion Transducer for Studies on Small Animals"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

With increased population density in urban areas, human ecology research is receiving increased attention. One phase of this research area is the formulation of animal model studies simulating the human ecological situation. Specifically, this problem entails the measurement of posture and reaction time of birds receiving electrical and chemical stimuli adverse to their well being. A device to measure three dimentional movement such as a miniature accelerometer is needed.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Biotelemetry for Animal Tagging in Ecological Studies"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine
Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Human ecology studies using models with animals in their natural habitat include studies of animal reactions to the presence of other animals and the introduction of adverse stimuli. The first phase of the program is to determine the ranging habits of each of the animals as they approach foreign objects.

The problem originator wishes to know if NASA has developed miniature telemetry transmitters for possible use on small rodents and can withstand the normal environmental elements.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Small Animal Posture Indicator"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine
Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

To better understand aggressive behavior in human ecology studies, small animals and birds are subjected to confrontations with others of their species in crowded conditions. These animals react in different methods and strike various poses which are indicative of certain psychological conditions. The Problem Originator needs motion transducers or gimbal resistors that could be adapted for use in this experiment.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Animal Position Monitor"

Problem Originator: Dr. Richard F. Smith, Assistant Professor Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Human ecology experiments using animals as models include experiments which determine the position of a rodent or bird in his cage as adverse stimuli (other animals, chemical or electrical stimuli) are applied. The test subject moves into specific areas to eat, sleep, and retreat when confronted by an adverse stimuli. The Problem Originator needs technology on systems including photo-cell bank, capacitive or pressure sensors that may be utilized in this experiment.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers. The Team members have been in correspondence with Research Triangle Institute for an exchange of information on similar problems.

Title: "Dust Mills for Aerosol Generation in Environmental Chambers"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine
Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Small animals being used as models for human ecology research are subjected to various dust aerosols to observe their behavior and reaction to these pollutants. The test subjects such as pigeons, mice, and voles are placed in environmental chambers both singly and in groups and the dust particles are injected by hand and observations are made. The Problem Originator needs technology relating to the generation of uniform particles from blocks or chunks of solid material.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Catalytic Heaters for Remote Environmental Chambers"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine
Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

A remote ecological preserve in a national forest is presently being used for human ecology studies. Small chambers randomly located provide shelter for the small animals and control the environment while the animal is in the chamber. Several controls such as access, noise level, space, and light are present. The Problem Originator is able to control all the necessary experimental parameters except temperature. He wishes to be able to provide additional heat to the chamber to study the temperature parameter and its correlation to the other variables in the experiment. His present trend is toward a catalytic heat source in view of the basic restriction by the national forest forbidding the use of electrical devices due to fire danger.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the Research Centers.

Title: "Biotelemetry and Stimulation for Free Ranging Animals"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Free ranging animals on an ecology preserve are being used as models for human ecology studies. They need to be monitored for pertinent physiological parameters, and it would be desirable to be able to stimulate the animals by radio control to elicit certain responses at certain times. The Problem Originator desires information on multichannel telemetry systems and radio control systems capable of monitoring and stimulating six animals.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title: "Peripheral Stimulation Devices with Electrodes"

Problem Originator: Dr. Richard F. Smith, Assistant Professor
Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 17 December 1969

Description of Problem:

Laboratory tests on adverse stimuli experiments with pigeons, guinea pigs, rats, and other small animals include the application of various electrical stimuli in different body locations to elicit different responses. Research to date has been to place wires across cages electrically charges so that the animal touches them when he moves. This does not satisfactorily localize the stimulus so the Problem Originator wishes information on function generators and electrodes to localize these stimuli.

Activity on Problem to Feb. 28, 1970:

A manual search of the NASA literature was made and the results were forwarded to the Problem Originator. A Problem Statement was prepared and submitted to NASA for approval to disseminate to the NASA Research Centers.

Title : "Electrodes for Use in Measuring the Heart Rate in Active Experimental Animals"

Problem Originator: Dr. Richard F. Smith, Assistant Professor Department of Psychology, University of Utah School of Medicine, Salt Lake City, Utah

Date Submitted: 3 January 1970

Description of Problem:

Experiments involving the measurement of heart rate on dogs running on a treadmill at a rate from 1 to 6 miles per hour require the attachment of electrodes to the animals and hard wire leads routed to the recording instruments. The problem lies in the electrode attachment. Subcutaneous, taped, strapped electrodes have all proved unacceptable for acquisition of reliable data due to the activity of the dog. The investigator wishes to know if NASA has developed any unique electrodes or electrode attachment technology that will assist him in his experiments.

Activity on Problem to Feb. 28, 1970:

Data concerning spray-on electrodes was sent to the Problem Originator. He evaluated the material and stated that it was exactly what he was looking for. This problem was classified as a potential transfer with the transfer report in preparation.

Title: "High Power Infrasonic Wave Generator"

Problem Originator: Donald W. Baker, Technical Manager, Bioengineering Program, University of Washington, Seattle, Washington

Date Submitted: 18 March 1969

Description of Problem: The essential aspects of the problem are concerned with the analysis of the transmission of a stress wave along fluid filled tubes. The primary problem is the correlation between the generated dynamic stresses in experimental situations and their correlation to analog methods. What is needed now is a pressure generator that can be programmed by analog signals. The required pressures range from 0 to 300 mm Hg and with frequencies from DC to 100 cps.

Activity on Problem to August 1, 1969: It appeared from the outset of this problem that NASA technology at Ames Research Center would have real potential in the solution of the problem. Arrangements were made to borrow electro-dynamic shaker equipment from Ames Research Center for the Problem Originator's use. Mr. Jon Jacobsen, Engineer, Department of Mechanical Engineering, University of Washington, was then placed in charge of this research. A preliminary transfer report was written and submitted to Southwest Research Institute Biomedical Application Team.

Activity on Problem to Nov. 1, 1969: It was learned that the low frequency shaker which was loaned to the Problem Originator was used at Ames Research Center in aerodynamic flutter studies and in arterial heart pulsation modeling studies. A follow up letter was sent to the Problem Originator soliciting additional information needed to write the final transfer report.

Activity on Problem to Feb. 28, 1970: Electro-dynamic shaker equipment was borrowed from Ames Research Center for the Problem Originator's use. The equipment proved adequate for the solution of the problem. However, additional information and evaluation must be obtained from the Problem Originator before the final transfer report can be written.

4. Problem Statements Disseminated to Centers

MEDICAL PROBLEM STATEMENT

Prepared for the National Aeronautics and Space Administration's Biomedical Applications Program by Southwest Research Institute

Problem Number BLM-10 Problem Title Automatic Diagnostic Analyses of Electrocardiograms

Problem Background

A critical aspect of developing multiphasic health screening centers involves the need for a technique which will enable the automated analyses of electrocardiograms. The analyses of electrocardiograms has been accomplished classically on a manual basis by personnel skilled in reading the electrocardiographic tracing—a process which involves substantial error. In this regard, for electrocardiograms derived from the conventional 12-lead apparatus, the published error involved in interpreting tracings approaches 20%, with the error involved in reproducing readings of the tracings exceeding 25-30%.

Progress of Research to Date

Some early results suggests that computer assisted analysis of electracardiograms can reduce the error factor for interpretation to approximately 10%, with the error involved in reproducibility being reduced to virtually zero level.

The work which has been accomplished in this area involves interpretative programs which must be used on medium to large size computers. Unfortunately, however, such computers are not routinely available for clinical utilization by the practitioner.

What is Needed from NASA Technology

What is needed is a computer program adaptable to smaller multipurpose computer systems typically encountered in the medical environment which will permit automatic diagnostic analysis of electrocardiograms.

The availability of such a program would: (1) eliminate the need for manual visual interpretation; (2) reduce the amount of time required for the analysis; (3) reduce the error factor involved; and (4) reduce the number of skilled personnel required to perform interpretive analyses.

Limitations Regarding Proposed Solutions

The program should be applicable to a small general purpose computer. Photopic automated readers and A-D conversion may be acceptable. The final print-out may be some form of information retrieval process in which a listing of possible diagnoses is presented.

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MEDICAL PROBLEM STATEMENT

Prepared for the National Aeronautics and Space Administration's Biomedical Applications Program by Southwest Research Institute

Problem Number BLM-14 Problem Title Compound Conduit (Umbilical) For Use With Chronically Surviving Animals

Problem Background

The investigator is engaged in research which has as its overall goal the development of an artificial heart suitable for implantation in humans. At the present stage of the research effort, artificial hearts and left ventricular assist devices are being implanted within animals (calves) and then connected to external pneumatic and hydraulic power sources and various monitoring devices. An important aspect of the research involves developing a suitable means for interconnecting the implanted heart and the relatively large, complex power and monitor components.

Progress of Research to Date

At the present time, the investigator employs separate flexible conduits, such as conventional electrical wiring and tygin and silastic tubing. However, these are subject to kinking, twisting and being bitten by the chronically surviving animal, thereby interfering with conduct of the experiment. It is possible that technology associated with fabrication of astronaut umbilical devices can provide suggestions for an improved flexible compound conduit between the implanted artificial heart and external control and monitoring devices.

What is Needed From NASA Technology

What is needed is a compound conduit (umbilical which will provide two electric leads, two pneumatic tubes and six hydraulic flexible tubes to power and monitor an artificial heart implanted within an animal. One of the electric leads will be an ECG lead. The length of the required umbilical is approximately 5 meters, with the thickness being limited to about 1 centimeter by the space between the animal's ribs. The umbilical should provide for swivel action to prevent kinking as the chronically surviving animal moves around. The two pneumatic (CO_2 pressure/vacuum) lines will run respectively at +5 psig and -2 psig, with a pulsating flow approximating 0.1 liter per second. The electrical leads must be well shielded to reduce pickup of interference on the ECG signal, particularly from the building lighting system or extraneous power supplies. It would be advantageous if the umbilical incorporated a quick disconnect feature on both ends, though such is not absolutely necessary for the intended application.

Limitations Regarding Proposed Solutions

Thickness of the required umbilical or compound conduit is limited to about 1 centimeter by the space available between the calve's ribs; its length should be approximately five meters; it should provide for swivel action to prevent

kinking as the free ranging animal moves about its enclosure; and electrical (ECG) leads incorporated into the compound conduit should be well shielded to minimize pickup of interference from extraneous sources (lighting systems and power supplies)

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17 July 1969

Determination of Local Blood Flow, Blood Gas Concentration, and Blood pH in Small Portion of An Organ

GLM-3

What Is Needed

Sensors which can be implanted in a small portion of the brain of a small laboratory animal such as the rat, which will permit the measurement of regional blood flow, pH, and concentrations of oxygen and carbon dioxide.

Background

The investigator needs to measure blood flow velocity, blood pH, and partial pressure of oxygen and carbon dioxide in the blood which is circulating to a small region of the brain of an experimental laboratory animal. The sensor must be suitable for long-term implantation in the rat's brain, so that the rat will have time to recuperate from the trauma of the operation of implantation. The sensors must be sturdy because the instrumented rat will be subjected to a sharp blow to the head to produce a brain concussion in order to simulate what happens to a human being in an accident. By following the fluctuations in regional blood flow, pH, and metabolic consumption of oxygen and production of carbon dioxide, the investigator hopes to obtain a clearer picture of the response of the human brain to the trauma of a concussion. This should lead to improved techniques for treating patients with head injuries.

The rat's brain occupies a volume of approximately 2 cubic centimeters. The total flow to the entire brain is approximately 1 milliliter per minute, and it is desirable to measure a regional flow of about 10 percent of the total flow or 0.1 milliliter per minute. The normal blood pH range is between pH 7.3 and pH 7.5. The partial pressure of oxygen in blood ranges between 100 millimeters of mercury and 37 millimeters of mercury. The concentration of carbon dioxide in the blood ranges between 39 millimeters of mercury and 45 millimeters of mercury. The desired accuracy of measurement is ± 2% for flow, ± 0.01 pH unit for blood pH, and ± 1 millimeter of mercury for the partial pressure of oxygen and CO_2 in the blood. The implanted sensors should last for at least 4 weeks, and the maximum required depth of extension of the electrodes into the rat's brain is about 2 centimeters from the outer surface of the skull. Electrical connections to the sensors will be made through a flat cable with a subminiature connector fastened to the rat's skull.

Present Approaches

Radioactive gases have been used recently for blood flow estimations, but the size and location of the perfused region are not well defined with present techniques. Investigators have analyzed average arterial and venous blood pH and gas concentrations for the entire brain, but it is desirable to detect regional differences in perfusion. Blood flow in large vessels can be measured through the use of an electromagnetic blood flow transducer, by an ultrasonic Doppler technique, or by thermal methods. The blood pH is measured with a special glass electrode and a sensitive high input impedance millivoltmeter. The partial pressure of oxygen is measured with a membrane polarigraphic technique. The partial pressure of CO_2 in the blood cannot at present be measured directly. Presently available probes are fragile and suffer from poor long-term accuracy because of the coating of tissue which the body deposits on foreign substances. All of the presently available techniques are extremely difficult to miniaturize to the extent needed to explore the regions of the 2-cubic centimeter rat brain.

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Measurement of Local Tissue Oxygen Consumption In Vivo

What Is Needed

The investigator needs to measure oxygen concentration and oxygen uptake in localized regions of the brain and other tissues in experimental animals and in men under varying conditions of stimulation, trauma, and disease. These measurements will be made simultaneously with other electrophysiologic recordings such as the electroencephalogram.

Background

All tissues consume oxygen in the process of metabolizing their nutrients, and the rate of oxygen consumption is a measure of metabolic activity. The investigator hopes to gain a clearer understanding of the response of the brain and other tissues to experimental conditions which simulate those occurring because of disease or injury. This should lead to better therapeutic techniques for treating patients with head injuries or brain disease, with consequent saving of life.

The ideal sensor would measure oxygen consumption directly; however, it would be permissible to measure the difference between the oxygen concentration in the arterial and the venous blood and the regional blood flow. The sensors should be less than 0.5 millimeter in diameter, to reduce the damage done to tissues in inserting the probe. The alkalinity of normal blood is pH 7.4 ± 0.1, and the temperature is $37°C \pm 1°C$. The partial pressure of oxygen in normal arterial blood is 100 millimeters of mercury, while that in the venous blood is 37 millimeters of mercury. An accuracy of ± 2 millimeters of mercury is desired. To be useful, the life of the probe must be at least 4 weeks so that chronic studies can be performed. A response time of 1 second is desirable.

Present Approaches and Limitations

The best available technique for measuring oxygen tension in tissues involves a platinum or gold fiber sensor and a sensitive millivoltmeter. Its response time to changes in oxygen concentration is too slow. It requires that the tissue being analyzed be isolated from the electrical ground which prevents the simultaneous use of the electroencephalograph and other neurophysiological instrumentation.

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23 May 1969 | Repetitive Measurement of Kidney Mass in Intact Animal | GLM-14

What Is Needed

A method for periodic measurement of the mass of the kidney in a live animal is needed. To study the mechanisms of compensatory hypertrophy after unilateral nephrectomy (surgical removal of one kidney), it is desired to obtain data on the mass changes in the remaining kidney during the process of hypertrophy.

Background

It is a general observation that after removal of one of a pair of organs the remaining organ increases in size and function and compensates for the loss. This is true of the kidneys and is termed compensatory hypertrophy.

The present method for the study of this phenomenon necessitates the sacrifice of the animal subjects at various periods of time following the removal of the first kidney. The remaining kidney is removed and weighed after sacrifice, and its increase in weight and/or volume is a measure of the extent to which hypertrophy has taken place. As normal kidneys in the same animal are already of different size, the procedure must be done on a large number of animals in order to determine the average normal kidney size and to set up a statistically sound experimental series. It would be much more exact to use each animal as its own control; this can be achieved if the kidney mass could be monitored in the live, intact animal. An instrument for making such measurements may develop into an important diagnostic tool, where changes in the shape and size of the kidney, including those provoked by tumors, could be established.

It may be that there exists some method employing radioisotopes or scintillation counting to provide extreme sensitivity, yet not affect the normal progress of growth or compensatory hypertrophy. If at all possible, X-ray measurements should be avoided, as the radiation may alter normal function of the animal's kidney in unpredictable ways. Ultrasonic techniques currently in development may prove applicable. Momentum and G measurements might prove to be feasible.

Whatever technique may be suggested, it must be useable in the living animal (in vivo), must not disturb the test animal's normal functions, and must provide for consecutive measurements of kidney mass or volume. The transducer, if one is employed, cannot encapsulate or drastically disturb the kidney, as this causes hypertension.

RSM/RJC/CJL

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23 May 1969 | Respiration Volume and Rate Measurement for Burned Children | GLM-15

What Is Needed

A method is needed for measuring the rate and depth of breathing of children who are suffering from severe burns on the upper half of their bodies. The method should not involve connecting tubing to the nose or throat, nor enclosing the body in a plethysmograph.

Background

Present methods of measuring respiration require that the patient breathe through a mouthpiece such as that used by scuba divers or that the patient remain in a plethysmograph (an airtight chamber equipped for pressure and volume measurements). These procedures are undesirable because they restrict the airway or impair the freedom of motion of the patients and are not well tolerated by sick children. The ideal method would allow measurement of the tidal volume (the volume of air moved into and out of the lungs with each breath) without adding any resistance to the airway and without touching or irritating the skin.

Although the change in chest volume does not exactly equal the tidal volume (because of inertia and airway resistance), it may be necessary to compromise accuracy of measurement for the convenience and comfort of the patient by inferring tidal volume from chest motion.

Provision of a suitable method for measuring respiratory volume would casue an increase in the recovery rate of burn victims. Suffering and pain would be lessened, and the enormous expense involved in treating such patients would be reduced.

RJC/RSM/CJL

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June 1969 GLM-19

Measurement of the Velocity of Myocardial Contraction By Non-Invasive Means

What is Needed

A method for measuring the instantaneous pressure in the chambers of the heart without puncturing the skin.

Background

Suppose that your child was one of the approximately 50,000 children in the United States whose life is in danger because his heart valves are defective. Your doctor knows that, thanks to the development of open heart surgery, it is now possible to replace your child's defective heart valves with artificial ones. The danger is that the operation may do more harm than good. Your child will benefit from the valve replacement only if his myocardium (heart muscle) is in good condition; otherwise, the valve replacement may not help his heart's performance, and will expose him unnecessarily to the danger of a serious operation. The doctor needs to assess the condition of your child's myocardium along with the severity of the valve impairment and weigh these factors carefully in his decision on recommending valve replacement. He also needs to measure the progress of healing after the operation, in time to stop possibly fatal complications.

Present techniques for obtaining the necessary information about the heart valves and myocardial condition require the danger and discomfort of cardiac catheterization. The doctor who first catheterized a human heart (his own) was criticized for performing such a foolhardy experiment. Through the years, new techniques and safety devices such as defibrillators have been developed to reduce the hazard, but it is still not a procedure to be undertaken lightly.

In performing a cardiac catheterization, the doctor uses local anesthesia and cuts through the skin of an arm or leg to expose the large artery and vein, punctures them, and inserts a 2 mm diameter hollow plastic catheter about 1 m long into the vessels. He observes the position of the catheter tip with a fluoroscope, and guides it along the blood vessels until it enters one of the chambers of the heart (Figure 1.). The pressure pulsations are transmitted through a fluid in the catheter to a pressure transducer, and its output is displayed along with the electrocardiogram (ECG) on a strip chart recorder, (Figure 2).

The cardiologist diagnoses the condition of the heart valves and the myocardium from an analysis of the pressure tracings. When the myocardium starts to contract, there is a period of isovolumic contraction, during which the inlet valve has closed, and the pressure in the ventricle is increasing but has not yet caused the outlet valve to open by exceeding the pressure in the aorta. During the isovolumic contraction period, the volume of the ventricle does not change because the closed valves isolate it from the rest of the circulatory system. At present, the best measure of myocardial condition is the rate of change of pressure in the ventricle during isovolumic contraction, which is not affected by the condition of valves or blood vessels. Another important diagnostic parameter is the time delay between the Q wave of the ECG and the peak of the dP/dt curve. The better the heart, the shorter this delay is.

The dangers of cardiac catheterization include unintentional puncture of the blood vessels

or heart walls, formation of blood clots which can be fatal if they stop circulation to the brain or lungs, and ventricular fibrillation, a convulsive, unsynchronized fluttering of the myocardium which is not effective in pumping blood and is fatal within a few minutes if it is not stopped by a powerful electric shock. These hazards are faced every day in the more than 500 hospitals in the United States with active catheterization laboratories, and each of the 16 large laboratories reported in Reference 1 performed an average of 386 catheterization procedures per year. The chances of death from the catheterization procedure is 6% for infants under two months of age, and is 0.45% for the average population.

Is there a way to avoid the dangers of cardiac catheterization and still measure the myocardial contractility, pressure in the ventricles, or time delay between the Q wave of the ECG and the peak of the dP/dt curve?

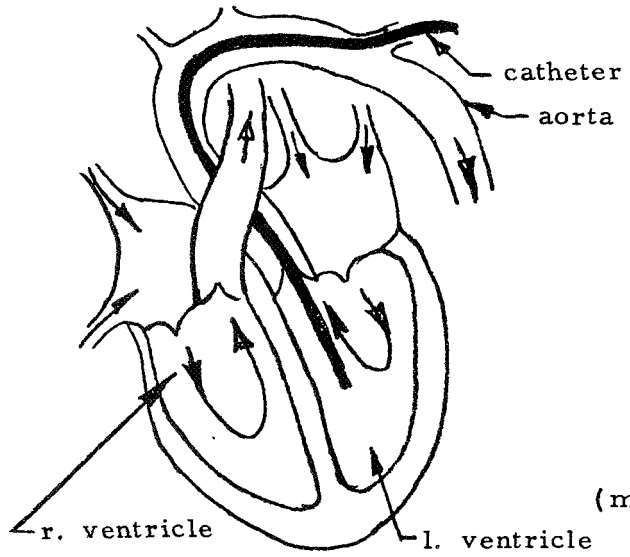

Figure 1. Schematic diagram of the chambers of the heart, with a catheter in the left ventricle.

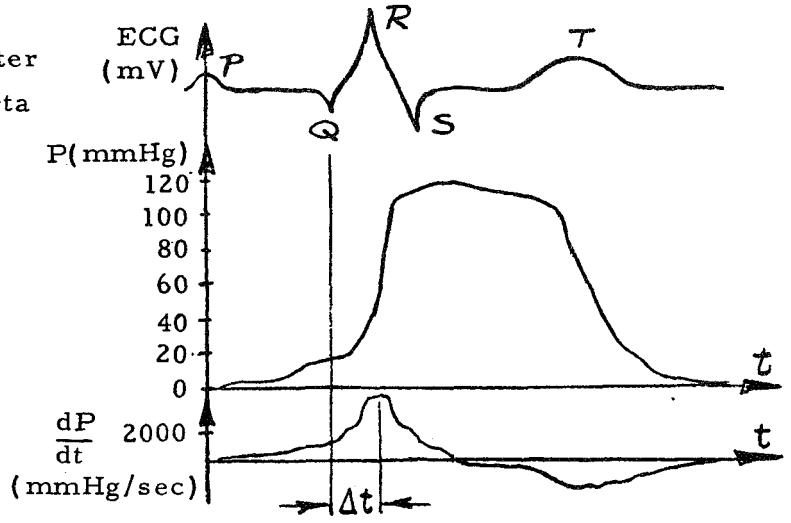

Figure 2. ECG, left ventricular pressure, and first time derivative of pressure.

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17 July 1969 Continuous Destruction of Lymphocytes -- GLM-20
Under Sterile Conditions

Introduction

When a person's life depends on his receiving a transplant of vital organs such as the heart or kidneys he must go through a process which will improve the likelihood of his body's accepting the organ instead of destroying it by immune rejection. One of the best ways to suppress the immune reaction is to destroy the patient's lymphocytes (a type of white blood cell which attacks foreign proteins). Present procedures for accomplishing this destruction require that the patient stay in the hospital for a preparation period of about 2 months before the transplant operation, during which time his lymphocyte supply is depleted. This adds a great deal of expense to the already high cost of the actual operation. It is an inefficient use of the hospital facilities, because the only reason for the patient to be there is to have some of his lymph drained periodically, centrifuged, and the lymphocyte-free plasma and proteins returned to his body under sterile conditions to prevent infection. Sterility is essential because lymph is an excellent nutrient for germs, and the already weakened patient's immune defenses, which would normally protect him from infection, are being suppressed in preparation for the organ transplant.

Specifics of Problem

Find a way to destroy the effectiveness of an organ recipient's lymphocytes, while leaving their damaged fragments circulating in the lymph so that the body will not be stimulated to make new lymphocytes. Continuous rather than batch processing is preferred, and the process must maintain the sterility of the lymph without destroying the plasma proteins.

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What Is Needed

A system is desired to automatically describe, in three dimensions, human motion patterns. Applications would pertain to the analysis of normal individuals and patients with various forms of motor disorders. The therapeutic goal is to restore the normal pattern of motion to an affected individual. It would be desirable to measure the patient before, during, and after therapy and to analyze and relate the described motions to a normal pattern of movement. The method of pattern analysis must be completely external to the patient and void of any extraneous sensory input which would bias the validity of the observed patterns, i.e., no restricting physical connection to the patient.

Background

Proposed solutions have involved attaching signal transducers on selected body surfaces and recording incidence times and accelerations in analog form and processing the data either on-line by computer or by hand. However, the attached measuring transducers were unwieldly, uncomfortable, produced extraneous stimulation, and restricted movements which interfered with "natural" motion patterns.

Other approaches to the problem involve photography and video recording of a subject in motion. Each successive picture frame of data is analyzed by measuring distances from fixed reference points on the photograph to specific points on the body such as the knees, toes, wrists, and elbows. The cost of the data reduction process in three dimensions is prohibitive. Video recordings have been made in a single plane of certain "marked" portions of the body while the subject was in motion. Although the analysis is quite laborious, the results can be correlated with other dynamic variables. The limitations are low sampling rate and burdensome data handling procedures.

The sought-for technique should be capable of measuring the kinematics of body segments by noncontacting methods or low inertia "markers." The system should include a means of automated data processing in order to obtain a complete space-time history of selected locations on the body surfaces.

LB/SGS/RSM

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23 May 1969 | Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section | NWR 5

What Is Needed

Numerical methods for the solution of differential and integral equations for electromagnetic waves, ultrasonic waves, and heat transfer problems in layered media of arbitrary cross section.

The problem has previously been treated by the classical method, but the classical boundaries do not offer a close match to those encountered in the human anatomy. The use of numerical techniques for the solution of these problems will allow greater flexibility with regard to the boundaries and should also be more easily programmed for a computer solution.

Background

For medical applications, it is desired to predict the heating in tissue due to the application of diathermy or ultrasound. The various layers encountered are fat, muscle, and bone, with cross sections that do not match the classical shapes, i.e., cylinders, rectangles, etc. Heat dissipation and transfer in the various layers determines the temperature rise.

LSB
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17 July 1969 Material for Prevention of New Decubitus Ulcers RNV-14

Brief Description

Spinal cord injury patients with sensory loss, while sitting in a wheelchair, develop pressure sores on the sitting surfaces over bony areas. These sores may take from 2 weeks to 4 months to heal, and some require surgical closure. The estimated average cost of a pressure sore is $15,000.

Many different types of cushions are manufactured today which claim to prevent development of pressure sores, yet sores still develop.

Specifics

The most important predisposing causes of ulcers decubitus are protracted pressure from infrequent movement of the patient, trauma and maceration of the skin, and malnutrition. First, the more sensitive subcutaneous and deeper tissues are damaged, and later the skin becomes necrotic. Traumatic pressure on the skin from ill-adjusted supports, or from wrinkled seatcovers or clothing, may cause small breaks in the epidermis, through which infection is introduced. Maceration of the skin often follows soaking of the seat and clothing by perspiration or from urinary or fecal incontinence. Chronic anemia, protein deficiency, or vitamin deficiency, particularly of ascorbic acid (vitamin C), reduce the ability of tissues to resist breakdown under constant pressure or to repair damage when the stress is removed.

Three stages of decubitus are recognized: (1) THREATENED DECUBITUS is indicated by a skin redness which disappears on pressure--the skin and underlying tissues are still soft; (2) INEVITABLE DECUBITUS is diagnosed by a hardening of the underlying tissues with a blue tint or vesicle formation on the overlying skin; (3) ULCER DECUBITUS is characterized by tissue death with slow breakdown and separation from living tissues. When the process is complete, it may reveal enormous destruction, sometimes with exposure to the bone. Infection is common at this latter stage.

Present Practices

The best preventative measure is alertness to the development of decubitus in debilitated patients whose daily exercise is difficult or impossible. Pressure points should be checked at least once a day in an adequate light, and the attending physician should be notified at the earliest evidence of undue redness or trauma. Oversedation should be avoided and mental activity encouraged.

Local measures that lower the incidence of decubitus include change of sitting position, transfers from wheelchair to bed and back, cleanliness and dryness (control of incontinence), relief of pressure, and physiotherapy.

The patient's position is changed every 3 to 4 hours, if conditions permit. An operative turning frame (Stryker frame) facilitates turning paraplegic patients in bed.

Cleanliness and dryness help to prevent maceration. Clothes are changed frequently and are made of materials which are soft, clean, and free from wrinkles and particulate matter. Essential hygienic measures are sponging the skin in hot weather, thorough drying after baths, and cleansing and gentle massage with a hexachlorophene-type antiseptic lotion. An indwelling catheter may be used to control urinary incontinence. Minimizing fecal incontinence by means of enemas is especially important.

Relief of pressure on sensitive areas may be accomplished by using molded foam rubber, air mattresses, water cushions, air cushions, and silicone gel. Lying on sheepskin keeps the patient's skin in good condition and, in some instances, prevents decubitus.

None of these measures is completely satisfactory. Many different types of cushions are manufactured which claim to eliminate the stress forces and lessen the incidence of decubitus pressure sores, but, at best, they only lessen or delay their formation.

What Is Needed

Recommendations are needed for a material and/or design approach which would eliminate the pressure concentrations around bony areas which lead to decubitus. The solution should not cause high shear stresses on skin surfaces. Vertical compressibility, homogeneous pressure distribution, or gradient increases of pressure away from bony surfaces and proper redistribution of forces upon changing of position are desired. Further, lateral stability must be maintained to prevent toppling or dumping of a patient while eliminating concentrated vertical pressure points.

The materials should be lightweight, able to breathe, elastic or reformable when a patient shifts position, and add to his overall comfort.

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MEDICAL PROBLEM STATEMENT

Prepared for the National Aeronautics and Space Administration's Biomedical Applications Program by Southwest Research Institute

Problem Number SNM-3 Problem Title Modification of the Surface of Controlled Pore-Size Glass to Eliminate Adsorption

Problem Background This investigator is perfecting the use of controlled pore-size glass to purify viruses by exclusion chromatography for vaccine production. He is presently using porous glass with pore sizes in the range 50-200 millimicrons. When this glass is crushed, screened and packed into columns, it becomes an ideal matrix for exclusion chromatography with certain viruses, e.g., polio virus. However, it cannot be used with other virus, such as the rabies virus, because of excessive adsorption of the virus to the glass surface. This adsorption occurs at pH's (range 5-8) wherein the net charge of the virus is negative.

Progress of Research to Date The investigator is using glass (rather than plastics, etc.) due to other considerations in the project. Many substances have been reported to adsorb to glass surfaces, such as protein, heparin (an acid), etc. In the present studies, he has found that certain virus particles are adsorbed to the glass.

What is Needed from NASA Technology The investigator needs a method of modifying the glass surface so as to eliminate adsorption without rendering the glass surface hydrophobic or plugging the pores.

Limitations Regarding Proposed Solutions The packed glass column (and porous glass) must remain permeable to water. Virus particle sizes involved are 0.025 microns to 0.30 microns.

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Background

Electrocardiograms from two strains of dogs are being obtained. Broadly speaking, there appear to be differences between the two categories which are observable through visual inspection by a human. What is sought is a suitable technique for quantifying this visible difference.

What Is Needed

There are several standard techniques for quantifying and comparing time series signals. The most common of these (spectral analysis, auto and cross correlation) may not uncover quantitative information which is fairly simple and uniquely related to the geometric properties of a two-dimensional signal (such as the EKG shape on a strip chart recorder). We are looking for techniques which would be applicable to this problem situation (the situation where available signals are broadly categorizable). What new approaches have been developed to aid both qualitatively and quantitatively in this categorization procedure?

It is hoped that what will be turned up are new concepts of signal categorization which are applicable to the above problem, as well as possibly applicable to similar types of categorization problems. A digital computer is available for signal processing. At the early stage of this problem, actual computer programs are of secondary, although not trivial, interest.

LSB

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What Is Needed

A device or material which will improve the efficiency of coupling of ultrasonic energy between the low acoustic impedance of human flesh and the high acoustic impedance of a piezoelectric ceramic transducer.

Background

Ultrasonic energy is a powerful diagnostic tool. It has several advantages over X-rays for examining human tissue. It can be used in the pulse-echo mode to produce real time information displays similar to radar Type A, B, or PPI scans. With Doppler techniques, it can provide velocity information such as heart wall or valve motion, blood flow velocity, and, in conjunction with a standard occlusive arm cuff, indirect blood pressure. Unlike X-rays, it is well suited for visualizing soft tissues, and, at diagnostic levels, it does no harm to living tissue.

Ultrasonic diagnostic techniques would be more sensitive and have a better signal-to-noise ratio if the impedance match between the piezoelectric transducer and the flesh could be improved. Most modern ultrasonic transducers are made of a piezoelectric ceramic such as lead-zirconate-titanate, which has a characteristic acoustic impedance of about 30×10^5 gm/cm^2 sec, while that of flesh is about 1.5×10^5 gm/cm^2 sec. As a result of this severe mismatch, much of the ultrasonic energy is reflected instead of being transmitted through the interface between ceramic and flesh. The sound power transmission coefficient is given by

$$\alpha_T = \frac{4Z_2Z_1}{(Z_2 + Z_1)^2}$$

In a typical case, $\alpha_T = \dfrac{4 \times 30 \times 105 \times 1.5 \times 10^5}{(31.5 \times 105)^2} = 0.181$

where

Z_1 = characteristic acoustic impedance of flesh.

= (density $\times$ conduction velocity) = 1 g/cm$^3 \times 1.5 \times 10^5$ cm/sec,

= 1.5×10^5 g/cm^2 sec

Z_2 = characteristic acoustic impedance of piezoelectric ceramic.

= 7.7 gm/cm$^3 \times 3.9 \times 10^5$ cm/sec = 30×10^5 g/cm^2 sec.

This calculation shows that 82 percent of the incident ultrasonic power is reflected and only 18 percent passes the interface to be used for carrying

information. This loss occurs in both transmitting and receiving, but it is more serious at the receiver interface because the returning echo is usually very weak.

For pulse-echo applications, it is important that the transducer have a low Q (ratio of energy stored to energy lost per cycle) so that it will respond quickly to short pulses, which contain a broad band of frequency components. Present techniques for lowering the Q involve wasting the ultrasonic energy by backing the transducer with a lossy material. The Q could be reduced more efficiently by improving the transfer of energy between the transducer and flesh by coupling them through an acoustical impedance transformer.

A lossless impedance transformer can be made from a quarter-wavelength plate of material which has a characteristic acoustic impedance $Z_t = \sqrt{Z_1 Z_2}$, but the thickness is correct for only one frequency, so this could work for C. W. Doppler, but not for broadband pulse-echo operation.

A better coupling method is needed and sought. If appropriate techniques could be developed, one solution would be a plate of low-loss material with a characteristic impedance which changed gradually from 1.5×10^5 to 30×10^5 gm/cm^2 sec, in a fashion analogous to a tapered electrical transmission line.

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RJC

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G. PARTICIPATION IN SYMPOSIUMS AND MEETINGS

Members of the Southwest Research Institute Biomedical Application Team have participated in several symposiums and meetings during the reporting period. A chronology of these activities follows:

Mr. Louis Berger attended the Sixth Space Congress (Theme: Space Technology and Society), 17-19 March 1969, and presented a paper entitled "Interdisciplinary Dissemination of Aerospace Technology--A Holistic Approach." This paper is included on pp. 219-226.

Mr. C. J. Laenger, Sr. attended the National Institutes of Health, National Heart Institute, Artificial Heart Program Conference, 11-13 June 1969, Washington, D. C. Highlights of the meeting are presented on pp. 227-228.

Dr. Ray Ware attended the Arizona Hospital Association Meeting at Phoenix, Arizona, 2-3 October 1969. Dr. Ware's function in the meeting was to acquaint the attendees with the Biomedical Application Program.

INTERDISCIPLINARY DISSEMINATION OF AEROSPACE TECHNOLOGY - A HOLISTIC APPROACH

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The ideas which I should like to present were stimulated by the tasks posed to us as members of a Biomedical Application Team sponsored through NASA's Technology Utilization Program. It therefore is appropriate to set the stage by a brief description of the Biomedical Application Program's goals and methodology. These NASA programs were established at three institutions, Midwest Research Institute, Research Triangle Institute, and Southwest Research Institute, to help bring about a highly desirable but difficult to accomplish aim, namely, to transfer applicable aerospace generated research products to the field of biomedicine. Suitable ideas, concepts, techniques and designs were to be sought in all varieties of aerospace research programs. It was an important premise of the project that the quest for biomedically useful technology not be restricted within biologically oriented research programs. That is, our special challenge was to locate biomedically applicable technology among the products of research carried on in areas which might at first glance seem to be totally unrelated to biology. Indeed, relevant research was on occasion discovered in remote technological areas. For example, one of the research hospitals associated with our project is currently engaged in an extensive program to evaluate clinical applications of a device originally developed at Langley Research Center as a reduced (lunar) gravity simulator.

This somewhat unusual "information retrieval" project task has forced us to grapple with fundamental problems in information science. We have accordingly been encouraged by our sponsor to spend a modest proportion of project time on basic studies in this area, and this paper reflects the results of our analyses.

A starting point for our discussion is the thesis that the unexamined, uncritical usage of words may cause extensive and unrecognized mischief. We grow up immersed in our language; it is so much a part of us that, to some extent at least, we are unable to recognize that it significantly affects the way we perceive the world.

For example, a recent journal article[1] explores the way in which we perceive color. As might be expected, different cultures have different names for the various colors. Perhaps more surprising is the impact on the perception of these various color names: the differences in verbal labels induce the members of various societies to perceive colors in different categories—they carve up the visible spectrum in different ways. Not only do the color boundaries occur at different spectral locations, but the number of distinct colors that are recognized varies from culture to culture.

There is by now a substantial literature in the theoretical discipline of general sematics which amplifies this idea; several standard references are listed at the end of the paper.

It may not yet be apparent how this discussion relates to the problem of transferring of information. Perhaps the relevance can be revealed by posing some familiar questions in the conventional way, and then trying to

see to what extent we have prejudged the possible answers by our mode of questioning. Here are the questions in their customary form: What are the problems of transferring information? What is information? How do you store it? How do you retrieve it? And how do you properly describe the information content of a document?

In the light of the comments on the effects of language on perception, let up stop and look at the ways we have worded the problems. Isn't it possible that some of the difficulties of information transfer are due to the word ("information") that is used and in the "thingness" that it implies? Consider these comments by Bois[2]

> "The main trouble is that we often believe that what is <u>going on</u> is what <u>we say is going on</u>. It works fairly well in simple cases, but it often creates unnecessary problems. The hidden implications of what we say cause us to look for things that are not there. Poincare gives an example which has become classical: In the days when very few chemical elements were known, scientists were trying to isolate the element heat. Why did they look for heat as an element comparable to sulphur, oxygen, or mercury? Because it has a name that belonged grammatically (and therefore logically) to the same class as that of elements, the class of nouns or substantives. By implication, substantives referred to substances (or elements), and consequently, the scientists were looking for the substance heat, or phlogiston. But it was not there. Back of that substantive was a process, not a permanent element like sulphur, oxygen, or mercury. What the language said and implied was not what was going on."

Applying this point of view to our problem area, let us then assume that the word "information" has the same limited reality as does the word "phlogiston." If this assumption has merit, it is possible then that we may be misled by accepting the reality of the entity of "information" without reservation: If it is a thing, something that the seeker of "information" is looking for, it should be extractable from documents, be capable of being labeled, stored, retrieved, packaged, and delivered to the consumer. We also are led to ask questions such as: Who is best qualified to perform the various operations of extracting, storing, and retrieving it? What sort of systems and subsystems should we use to carry out the various subtasks which "obviously" need to be carried out? These are some of the questions raised if we ascribe material reality to the apparently innocuous word "information."

In addition, these kinds of questions even imply along what lines the systems which handle information should be designed: the notion in the documentation sciences that information is a thing which can be packaged and transported from originator to ultimate consumer suggests that information systems be designed around the traditional model of a goods transportation system: it suggests that a system which handles information be like other delivery or distribution systems, essentially unidirectional, designed to handle packaged goods which remain invariant while they are being maneuvered through the various way stations of the delivery (and storage) process.

This traditional notion of information has been useful, but we believe that the time has come to consider an alternative description and structuring of the "information transfer" activities: we propose to view the so-called

exchange of information as an overall communications process, involving the originator of thoughts and "facts," various stages of symbolization and transformation of the originator's initial thinking, perception, and experience, and finally involving a user who must deal with some aspect of the symbolic communication. This reformulation in focusing on the communication aspect of the process provides a fresh basis for locating the true difficulties of the process and, at the same time, suggests new approaches to old difficulties.

When we approach the "handling of information" as a problem in communication, our familiarity with impediments to the communication process in other contexts immediately can be applied here to reveal and define problem areas. For instance, since the area of symbolism is a notoriously troublesome one in the general field of communication, we would expect it to be a source of difficulty here also. In addition, we would expect to find problems related to the inevitable entropy-like deterioration of the original communication each time it is retranscribed: the symbols refer to broader and broader categories, and the specific structure of the original communication continually is degraded in this retranslation. We would also expect to encounter special problems when attempting "information transfer" across disciplines—in addition to the well-known language barriers, we would also anticipate communication barriers stemming from different professional backgrounds with their concomitant differences in attitudes, values, and problem solving techniques[3]. Yet another problem area revealed by the communication approach is the area of constraints associated with the

communication channels; we would expect that certain intrinsic features of a channel such as its single mode capability might impede the communication flow. As these examples show, the communication viewpoint is useful in structuring new problem areas.

A second significant advantage of this point of view for the information sciences is that we may expect to obtain help from disciplines that study communication. We would use the models, techniques, and insights achieved by social scientists, logicians, and others engaged in the study of communication processes to generate new approaches which would facilitate the exchange of knowledge. To cite a few examples:

We learn[4] that good communication thrives on dialogue. We would therefore expect to derive extensive benefits from providing a system which somehow incorporated bidirectional communication channels.

Another feature of good communication is multi-modality. We therefore might consider using systems with parallel information channels, perhaps providing a combination of the traditional written form of notational mode together with an audio or video channel.

Incidentally, to refer once again to the NASA Biomedical Application Programs, I might mention that as we have been forced to cope with novel "information exchange" situations in these programs, we have intuitively gravitated toward the techniques just mentioned. For instance, we are beginning to experiment with some multi-modal documents as possible replacements for the more traditional written document.

Finally I should like to suggest that some of the questions which have been mentioned here might with profit be investigated in more detail. First, how can communication be improved, and which disciplines should be consulted for guidance in this area? Secondly, how can we better define and cope with the problems related to the symbolism which is interwoven with the communication process? Third, how can we help the user of the system—the seeker of knowledge—to efficiently and effectively structure his quest? Finally, what are the systems implications of viewing the process as one of communication? Can we develop unique types of systems for the various different kinds of communication exchanges which we encounter in the information sciences? It is hoped that these speculations and thoughts will suggest additional new approaches to the traditional formulation of the "information transfer" problems and that the reformulations which follow from the new point of view will ultimately lead to solutions to some old problems.

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Acknowledgement

It is a pleasure to acknowledge the contributions, through many stimulating discussions, of my colleagues at Southwest Research Institute, particularly Drs. R. W. Ware, C. G. Gardner, and W. L. Anderson.

Mr. C. J. Laenger, Sr. attended the National Institutes of Health, National Heart Institute, Artificial Heart Program Conference, 11-13 June 1969, Washington, D.C.

Highlights: Particular attention was given to papers in sessions which related to existing problems and pre-problems in the Biomedical Application Program. Comments on some of the presentations follow:

(1) A Miniature Catheter Tip Capacitance Pressure Transducer by Tom Corbin of Corbin-Farnsworth, Smith Cline Instruments, Inc. This is a transducer developed by NASA/Ames by Mr. Grant Coon under the direction of Mr. Demiff. NASA let a contract to Corbin-Farnsworth to develop fifty units of the capacitance transducer which will be distributed by NIH. These units should be completed within 60 to 90 days. Mr. Corbin said that the units should be reusable a hundred times and that the cost should be under $500 when they go into mass production. He further stated that much of the circuitry has been redesigned and improved.

This work would be of particular interest to Mr. Jack Johnson at Little Rock and to Mr. Joe Canzoneri of TIRR. It would also be of interest to several researchers at the University of Texas Medical School in Galveston.

(2) Chronically Implantable Pressure Transducers by Mr. Jack Chambers of Statham Instruments, Inc. The work discussed had to do with the development of chronically implantable pressure transducers. The possibility of the implant using a thoracic reference was discussed. Information on pressure transducers has been sought by a number of researchers and institutions who utilize the Biomedical Application Team.

(3) Development of a Continuous Blood pO_2 Measuring System. The objective of this development program, which is being performed by Westinghouse Electric Corporation, is to develop a continuous in vivo blood pO_2 measuring system. The system would not be usable or desirable or applicable to Biomedical Application Program problems that SwRI has received because response time is much too slow. It is from 1/2 hr to, at very best, 1 min.

(4) Improved Diagnostic Accuracy in Acute Myocardial Infarction with Multichannel Electrocardiographic Data Acquisition and Analysis. This paper was given by Texas Instruments of Houston. It had to do with a study designed to correlate electrocardiographic and other physiological data. This should be of interest to Dr. Lipscomb at Baylor and to Dr. Rudenberg at Galveston.

(5) Implantable Fuel Cells. Several papers were presented on this subject. We have no problem submissions in this area but a number of potential Problem Originators have expressed interest in the subject.

(6) Energy Transmission Through the Intact Skin. Several papers regarding transmission of and storage of energy through the intact skin by various methods were presented. Again, we have no problem submissions in this area but a number of potential Problem Originators have mentioned interest and potential problems in this area.

(7) Circulatory Assist Devices. Eighteen papers dealing with circulatory devices and physiological effects caused by them were presented. Familiarity with these devices, their functions, and physiological effects was gained. We can anticipate problems relating to these devices and to instrumentation applicable to the artificial heart development in the future. A speaking knowledge of these devices and the program in general will be useful when communicating with such researchers.

This conference is held annually by NHI so that researchers whom they fund can discuss their progress and problems in the presence of others who are receiving funds from the same source. Attendance of this meeting provided a good opportunity to learn of many of the problems faced by many researchers. It also provided an opportunity to learn of solutions that might be applicable to existing problems under consideration by the various Biomedical Application Teams. We would do well to cover this meeting every year.

H. COMMERCIAL PRODUCT AND/OR APPLICATION ENGINEERING ACTIVITY RESULTING FROM TEAM OPERATIONS

Seven problems were screened, evaluated, and submitted for applications engineering. These problems were ones where engineering, hardware fabrication, hardware modification, engineering test, or equipment provision would materially assist the Problem Originator. None of these candidate reengineering problems, which were compiled prior to the Reengineering Procedural Guidelines Conference at the University of Virginia, survived the screening for the reasons shown in the chart below. Two additional candidates for applications engineering (CAP-1 and SWC-1) were submitted following the Reengineering Procedural Guidelines Conference. The write-ups on these two problems may be found on the following pages of this report section.

Problem No.	Equipment or Activity	Reason it is Not Appropriate
1. GLM-15	ERC Respirometer. Convert to volumetric.	A fundamental development of large magnitude.
2. SRS-8A	Validation and improvement of Ultrasonic Blood Measurement.	A development program requiring extended effort.
3. SRS-8A	Reduce co-channel interference in commercial version of NASA/Ames Telemetry.	Commercial problem. Task should be performed by the Problem Originator or a commercial concern.
4. GLM-5, SRS-8A et. al.	Tunnel Diode Transducers, ERC.	Equipment provision.
5. SFM-6	Reduce size and Mass of Phonocardiograph pickup, NASA/Ames.	A development program requiring extensive effort.
6. SRS-8A & SRS-1	Wanted - A dual channel ultrasonic Doppler blood pressure system.	Equipment provision.
7. GLM-14 GLM-16	Wanted - Ultrasonic Bone Scanner, MSFC.	Equipment fabrication.

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APPLICATIONS ENGINEERING PROJECT CANDIDATE

I. Problem Number: CAP-1 Title: Apparatus For Telemetering GSR In Natural Social Settings

II. Problem Synopsis:

The researcher is presently conducting experiments to determine the feasibility of using electromechanical techniques for modifying behavior. As part of this research, the GSR (Galvanic Skin Response) is being telemetered from adolescent delinquents as they interact in their natural social settings, e.g., home, school and hang-out. Dry electrodes applied to the plantar region (inner aspect of the instep) are used to acquire the GSR, with the signal being conducted from the foot via a connecting link (concealed in the trouser leg) to a transmitter at some convenient place on the delinquent's person. The system involves a remote two-way coded audio communications link which functions only with marginal success. The present transmitter is poorly accepted by the experimental subjects due to its bulk. In this regard, cosmetic appearance of the device is extremely important since the delinquent individuals will refuse to cooperate in the study if their peers are able in any way to detect evidence that they are instrumented. Also, the present transmission system does not provide the range desired (100 meters) when transmission is accomplished from the desired body region (ankle area).

III. NASA Technology Suggested For Applications Engineering To Solve the Problem

NASA has developed a small reliable biopotential telemetry system which, with minimal re-engineering, could solve the investigator's problem.

IV. Problem Definition and Justification

A. What is the specific problem which the applications engineering project would solve?

Provide a means for monitoring behavioral parameters as adolescent delinquents interact in their natural social setting. The investigator needs a subminiature telemetry apparatus that can be easily concealed on the subject's body, which can transmit GSR data 100 meters, preferably from the ankle area.

B. How would the Problem Originator make use of the end item?

It would be incorporated into the researcher's experiments to determine the feasibility of using electromechanical techniques for modifying behavior, e.g., administering aversive stimuli such as electrical shock as a means of discouraging perpetration of asocial acts. It is conceivable that telemetered behavioral data such as the GSR could function as a means of alerting the investigator concerning the likelihood that an asocial act is about to be committed. Electromechanical techniques for modifying behavior could then be brought into play (such as aversive stimulation) to prevent the occurrence of undesirable behavior. Encouragement regarding the potential of such attempts to modify behavior is provided by the results being obtained in animal research, particularly in the area of conditioning and reenforcement.

C. What are the medical and/or social benefits of solving the problem or contributing to its solution?

If successful means of modifying behavior are developed from the investigator's research, the substantial monetary losses sustained each year due to delinquency and the social disruption involved could be reduced.

D. Are there organizations and/or researchers other than the Problem Originator which are either (1) aware of the specific problem to be solved, (2) aware of the proposed project or (3) engaged in a related project?

None specifically concerned with using electromechanical techniques to modify human behavior.

V. Proposed Solution(s)

A. Solutions Based On Aerospace Technology

1. What is the aerospace solution applicable to the problem and how was it identified?

NASA has developed a subminiature, high performance, biotelemetry system which, if modified to improve the range and antenna characteristics, would provide an effective solution to the problem. The system is described in NASA Tech Briefs 64-10171 and 66-10624.

2. Where (and for whom) was it originally developed, and for what purpose?

   The system was developed by NASA to simplify measurement of biopotential responses in humans or experimental animals and to remove the presence of encumbering electrical leads and bulky amplifying equipment.

3. What are its current capabilities and limitations relevant to the problem?

   As presently developed, the biotelemetry system is sufficiently small for the purposes needed (being 0.74 inches in diameter, 0.20 inches thick, and weighing 2 grams). However, its range is only a maximum of 100 feet versus the required distance of 100 meters. Also, it is desired to transmit from the ankle region, requiring improvement of antenna characteristics. Presently, the transmitter has a two-day operating life with a 100-foot range while operating in one mode; and a 48-day operating life with a 10-foot range in a second mode. The investigator desires a 300 foot range, with a seven day operating life. However, a shorter operating life is acceptable if the 300 foot range can be obtained. In this case, replacement of the power source should be easy to accomplish.

B. Other Potential Solutions

1. Are there other potential solutions, aerospace or non-aerospace, which are currently available?

   No—existing equipment tends to be too bulky or does not possess the range required.

2. If so, what are they and what are their advantages and limitations relative to the problem and the proposed aerospace solution?

   Not applicable

3. Has the Problem Originator been made aware of them and, if so, what were his reactions?

   Not applicable

VI. Engineering Requirements

Describe the nature of the adaptive engineering effort which may be required to produce desired end item, including:

(1) detailed engineering specifications

The basic circuitry described in NASA Tech Briefs 64-10171 and 66-10624 needs to be modified so as to increase the effective transmission range to 100 meters from the ankle region with an operating life of seven days. Increase in size to achieve these aims is acceptable up to the size of a pocket transistor radio (approximately 3 x 4 x 1 inches).

(2) diagrams/drawings if required

The basic circuit diagrams are contained in referenced NASA publications.

(3) environmental constraints, e.g. biocompatibility with specific systems, tissues, etc.

The telemetry system should be rugged since it will be subjected to considerable motion as the subject moves about (walking and running) during normal daily activity of an adolescent.

(4) any other pertinent restrictions or constraints

Size should not exceed 3 x 4 x 1 inches. Battery life desired is seven days. Transmitter should have an effective range of 100 meters. Transmission from the ankle region is desired. Battery replacement should be easy to accomplish.

(5) an estimate of the manpower resources required.

Modification of the NASA developed circuit to perform at the desired level should require minimal redesign. Less than one week of engineering and fabrication effort is envisioned for the task.

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APPLICATIONS ENGINEERING PROJECT CANDIDATE

I. Problem Number: SWC-1 Title: Improved Techniques For Taking EEG in Infants and Small Children

II. Problem Synopsis:

The investigator is perfecting a technique for using the EEG to test hearing of small children. Today thousands of children classified as mentally retarded are believed to be suffering not from mental retardation, but rather from hearing difficulties which have cut them off from auditory interchanges with environment. Such interchanges are needed to develop their intellect. The investigator is convinced that if hearing defects can be identified early in infancy and appropriate remedial measures initiated (e.g., hearing aids), many youngsters can be prevented from becoming functional mental retardates. The investigator has developed instrumentation to provide averaged EEG signals during periods of auditory stimulation, which quite effectively reflects whether a child hears when such stimuli is administered. The greatest difficulty is in securely affixing the EEG electrodes to the infant's or young child's head. They tend to tug at the electrodes and frequently yank them off, disrupting the screening procedure. What is needed is an instrumented helmet, with EEG electrodes in place. A helmet, particularly if equipped with earphones for administering the auditory signal, would substantially assist in identifying hearing defects in young children who cannot verbally communicate information regarding whether—and to what degree—they hear an auditory stimulus.

III. NASA Technology Considered as Pertinent For Applications Engineering To Solve The Problem

NASA has developed a helmet system for broadcasting electroencephalograms of the wearer. The unique electrodes involved, if incorporated into an audio helmet fitting infants and small children, would solve the important problem described above.

IV. Problem Definition and Justification

A. What is the specific problem which the applications engineering project would solve?

Solution of the problem would provide a means for accurately testing the hearing of infants and small children who are unable to verbalize a response regarding whether or not they heard an acoustically presented stimulus.

B. How would the Problem Originator make use of the end item?

He would use it as part of his technique for testing the hearing of infants and small children, which is based upon use of modified, conventional EEG equipment.

C. What are the medical and/or social benefits of solving the problem or contributing to its solution?

Today, thousands of children classified as mentally retarded suffer not from mental retardation but from hearing defects which have cut them off from interaction with their environment. Perfection of the EEG hearing analysis technique will permit such children to be identified and given appropriate remedial assistance.

D. Are there organizations and/or researchers other than the Problem Originator which are either (1) aware of the specific problem to be solved, (2) aware of the proposed project or (3) engaged in a related project?

There is general recognition of the relationship between hearing defects and retardation of intellectural development. However, Scott-White Clinic and Hospital is conducting the only known investigations using the EEG to test auditory perception.

V. Proposed Solutions(s)

A. Solutions based on aerospace technology

1. What is the aerospace solution applicable to the problem and how was it identified?

NASA Tech Brief 66-10536 describes a helmet system for monitoring EEG, which features a unique electrode that does not require cementing to the scalp. The helmet is placed on the subject's head and contact made without difficulty. This helmet would prevent the infants and small children from tearing the electrodes away. The NASA EEG helmet, modified to provide for auditory input as described in Air Force Publication ARL-TR-69-17, "A Closed System Audio Helmet For Monkeys (6571st Aeromedical Research Laboratory) will provide a solution to this important problem. Both items of aerospace technology were identified as a result of Biomedical Application Team awareness of existing NASA technology.

2. Where (and for whom) was it originally developed and for what purpose?

   The EEG helmet was developed by NASA Ames for obtaining EEGs of pilots and astronauts performing tasks under stress. The closed system audio helmet was developed to determine auditory sensitivity in primates by the New Mexico State University under contract to the U. S. Air Force (Contract No. F29 600-67-C-0029, Project 6893).

3. What are its current capabilities and limitations relevant to the problem?

   The two items as they stand will not solve the problem: the NASA EEG helmet is for adults and has no earphones; the USAF audio helmet has no provision for EEG electrodes. Combining the two items of aerospace technology will permit provision of a solution to the problem.

B. Other Potential Solutions

1. Are there other potential solutions, aerospace or non-aerospace, which are currently available?

   None have been identified

2. If so, what are they and what are their advantages and limitations relative to the problem and the proposed aerospace solution?

   Not applicable

3. Has the Problem Originator been made aware of them and, if so, what were his reactions?

   Not applicable

VI. Engineering Requirements

Describe the nature of the adaptive engineering effort which may be required to produce desired end item, including:

(1) detailed engineering specifications

Basically, the task involves taking the NASA EEG helmet and modifying it so that it will (1) be usable with infants and small children and (2) feature a means for introducing auditory stimulation, such as described in the U.S.A.F. document. The NASA EEG helmet comes in three sizes;and by selection of liner size and length of replaceable sponge, it may be possible to adapt the existing helmet to the smaller head configuration of the intended users. Judgements regarding the extent of adaptive engineering can best be accomplished by obtaining one of the NASA helmets for Dr. McCartney to evaluate. The modification required would seem to be relatively straightforward.

(2) diagrams/drawings if required

Appropriate diagrams are shown in the attached publications .

(3) environmental constraints, e.g. biocompatibility with specific systems, tissues, etc.

None

(4) any other pertinent restrictions or constraints

None—the audio characteristics specified in the USAF Publication (ARL-TR-69-17) are acceptable, as are the EEG provisions specified in NASA Tech Brief 66-10536.

(5) an estimate of the manpower resources required.

Providing one of the existing helmets can be made available by NASA (the smaller size), modification could probably be accomplished with two weeks or less of man effort. Some guidelines are suggested by the audio helmet fabrication effort: the cost of fabricating the helmet totaled $11.50, including $4.50 for the speakers. The NASA helmet features special electrodes which have already been developed, which should greatly reduce the manpower resources required to accomplish the reengineering task.

I. INSIGHTS

During the reporting period, the Team placed continuing emphasis upon developing techniques for facilitating the transfer of aerospace-related technology to researchers in the biomedical community. A considerable portion of this effort was in the direction of motivating investigators to take advantage of the program. The Team evaluated, among others, such techniques as writing personal letters to researchers which outlined the program and its goals, following up the letters with personal visits; presenting formal seminars to investigators assembled for this purpose at selected institutions; and scheduling individual conferences with investigators to acquaint them with the general nature of the program. Results obtained with the various approaches were generally comparable, which suggests that the interpersonal communicative process itself--and not the particular technique--constitutes the most important dimension in generating investigator interest in the program. Experience gained to date on the program also suggests that in order to obtain even a modest number of high impact aerospace technology transfers, it is necessary to identify and process a considerable number of problems. This is necessary for several reasons: (1) Irrespective of how carefully problems are screened and how rigid acceptance criteria are, only a very small percentage of problems eventuate in technology transfer; and (2) participation in the program by biomedical investigators, that is, their willingness to submit problems, evaluate and utilize solutions offered from aerospace technology, is in a large measure dependent upon their conviction that the program is in fact designed to help them in their research. If the Team imposed an evaluative dimension, which in essence told the investigator that "Yes, you do have an important problem--and we could possibly solve it via aerospace technology--but we cannot accept it because it would not stand out," the flow of problems, some of which might well eventuate in desirable high impact technology transfers, would be severely curtailed. It appears necessary that to function effectively and generate and sustain wide support for the program within the biomedical community, the Team must accept--and produce solutions for--biomedical problems which might be categorized as suboptimal with regard to the visibility potential of any resulting technology transfer.

As alluded to above, a continuing problem which has faced the Team centers upon the matter of motivating biomedical researchers to (1) utilize the program, (2) evaluate, on a timely basis, potential solutions provided from aerospace technology, and (3) provide the minimal feedback needed regarding utility of solutions offered. The latter two considerations constitute a considerable source of difficulty and operate to inject a significant time delay in achieving technology transfer. The Team is seeking to reduce this delay by improved follow-up surveillance of active problems, both in a motivational sense to stimulate investigator follow-through and by providing more active consultation regarding means by which the suggested aerospace technology might be applied to solving an investigator's problem. At times, the physician-researcher may be ill-equipped to

evaluate complex solutions offered from aerospace technology. An interactive relationship in which the Team provides consultation when needed may well expedite the technology transfer process and help produce the positive results which constitute the aim of the program and against which its efficiency is measured.

The Team continues to find that one of the most important dimensions of the project centers upon the human factor. For example, in interacting with the biomedical research community to stimulate use of the Biomedical Applications Program, one encounters a variety of attitudes ranging from enthusiastic positive support to extreme negative bias against the program. A significant degree of interpersonal skill is required to generate and sustain the long-term interest required to make the technology transfer program a success. Also, many biomedical researchers consider themselves as the experts in their particular fields. As such, they are proud of their own capabilities and are at times resistant to the use of ideas originating elsewhere. Additionally, some investigators resist seeking help to solve a problem until it is essentially too late for applicable aerospace technology to have an optimal impact on solving their particular problem, whereas, if aerospace technology had been called upon at an earlier stage, substantial savings of time and funds may have resulted. In a small number of cases, such reticence can be attributed to proprietary considerations--to the fear that an innovative research effort might be compromised or seized upon by others as a result of dissemination via formalized program reports. These circumstances, which function at times to suppress participation by investigators who could conceivably make significant contributions to the program, are amenable to modification by skilled utilization of the communicative process during the interpersonal exchange which typically occurs between the investigator and Team member. In the Team's experience, it is this--the interpersonal dimension--which constitutes the critical link in the chain of events leading to technology transfer and not, as one might expect, in identification of biomedical problems suitable for consideration by the program.

A task for the future centers upon development techniques for more adequately tapping the expertise available within the NASA research facilities. Of particular importance is the need to access the concepts or developments which could help solve significant biomedical problems but which have not found their way into a technical paper or report, but remain in the minds of NASA engineers or scientists. In this regard, there seems to have been a tendency in the past to view the technology transfer effort as hardware oriented, e. g. , in making an ultrasonic scanner used in the nondestructive testing of welded tube joints available for medical use to test for bone density and integrity. While such an outcome of the program is desirable, to focus upon hardware solely would severely restrict the program's input. It would seem more

appropriate to take a broader view of the term aerospace technology, looking upon it as a combination not only of end-items resulting from the aerospace effort but also of facts, skills, and techniques drawn from science and engineering which led to development of the end items. This view brings to mind many types of technology which can be transferred: processes and procedures on research, engineering, and manufacturing. The technology could consist of designs for end items, tools, and test equipment; analytical methods and techniques, and equally as important, of capability for problem solving, analyzing, inventing, designing, and testing. While generally this technology is stored in files, models, capital equipment or computerized data banks, much remains within the individual researchers; and this type of technology can be equally as important for the program as more formal types. A mechanism is needed to bring such potential contributions to light and direct them to appropriate users. Circulation of problem statements by Technology Utilization Officers at the various NASA research centers does not seem to constitute an optimal means for matching required NASA expertise with biomedical problems submitted by the Teams, due to the large number of active problems involved and personnel limitations at the center TUO level. It is hoped that the experimental program at Manned Spacecraft Center, in which a Team member spends extended periods of time onsite interacting with NASA scientists, will develop into an effective means for channelizing NASA expertise toward solution of problems facing the biomedical research community. If the MSC experimental program proves successful, it could then be expanded to embrace the other NASA research centers and have even greater impact upon the overall technology transfer effort.

It is expected that the experiences gained by the Team during the reporting period, plus revised internal management techniques and availability of new tools for effecting technology transfer (RECON), will permit the Team to function more effectively in the future.