R T I

RESEARCH TRIANGLE INSTITUTE

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"Biomedical Applications Team"

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Quarterly Progress Report
15 June 1967 to 14 September 1967

29C. QPR-1 END

Prepared for

National Aeronautics and Space Administration
Technology Utilization Division
Washington, D. C. 20546

CONTENTS

1.0 INTRODUCTION

1.1 General

This report covers the activities of the Research Triangle Institute's Biomedical Applications Team for the quarterly period June 15, 1967 to September 14, 1967. These activities were supported by NASA Contract No. NSR 34-004-045. The Biomedical Application Team is directed by Dr. J. N. Brown, Jr. The other members of the Biomedical Applications Team and their areas of specialized interest are Mr. Ernest Harrison, Jr., physics and materials science; Dr. Harold Richter, physical and radio chemistry; and Mr. James W. Murrell, physics. Others who devote less than one-half of their time to this project but who are used in specialized instances are:

Mr. James Tommerdahl, systems engineering and instrumentation and

Mr. Robert Beadles, computer programming, hardware and software.

In addition, the consultants from the medical and bioengineering schools which contribute to this program are Dr. M. K. Berkut, University of North Carolina Medical School; Dr. George Malindzak, Wake Forest University, Bowman-Gray School of Medicine; and Dr. E. A. Johnson, Duke University, School of Medicine.

1.2 Travel

Travel during the quarter consisted of three trips by Dr. Brown. On June 19,20 and 21 Dr. Brown attended the "7th Annual San Diego Biomedical Engineering Symposium", and on June 26 and 27, he attended the "Conference on Image Processing" sponsored by the Society of Photo-Optical Instrumentation Engineers in Washington, D. C. On July 19 Dr. Brown visited Ames Research Center to discuss their work in measuring and processing physiological data. Mr. George Edwards, TUO, was very helpful in arranging meetings with Mr. Tom Fryer, Dr. Max Anliker and others at Ames. Mr. Fryer described several hybrid integrated circuits, which have been designed and evaluated at Ames, that are applicable to a number of problems we have identified in the medical field. For example, Ames has developed a pressure monitoring and telemetering system which could be implanted in the body. This system represents a solution to problems HSS-1 and HSS-2 which involve monitoring forces applied to broken bone joints and monitoring pressure on the surface of prosthetic hip joints. Additionally, Ames has developed "Bioamplifiers" which would be very appropriate for use in EKG monitoring systems. We have not been able to utilize these circuits because (1) they are not commercially available and (2) no mechanism exists for having prototypes of these circuits fabricated for evaluation by medical researchers.

Dr. Anliker described an optical pressure transducer which represents an excellent approach to problem VA-3 and DU-11. This particular approach to measuring pressure in fluids appears to be simple to fabricate, potentially inexpensive, and reliable in operation. No tech brief or other information has been made available by NASA at this time. We have, however, discussed this device with a number of biomedical researchers and clinicians, and they are very anxious to obtain this instrument for evaluation in their research programs. These individuals are willing to pay for fabricating sample pressure transducers, but at present, parts for these transducers require facilities which exist only at Ames.

During this period, we invited Mr. James Beal, who is in Nondestructive Testing at Marshall Space Flight Center, Huntsville, Alabama, to come to RTI and give a presentation to members of the Biomedical Team on nondestructive testing techniques. He discussed the possible uses of nondestructive testing techniques in biomedical applications. Several different techniques, including liquid crystals as applied to various types of medical thermography, were discussed. We feel, and our views were supported by Mr. Beal, that the nondestructive testing approach to obtaining data from materials and objects has much in common with the requirements for non-harmful information extraction from the human body. To become more familiar with the state-of-the-art techniques and apparatus as used in nondestructive testing in NASA, plans are underway for a visit by members of the Biomedical Applications Team to the Marshall Space Flight Center during the latter part of September.

1.3 Information Searches

To improve the quality of service which we have been obtaining from the North Carolina Science and Technology Research Center, we have contracted their services for the 12-month period from 15 June 1967 to

14 June 1968. This arrangement will permit us to obtain large quantities of information more quickly and efficiently than in the past. For example, individual documents can be obtained and searches can be made more quickly, and the cost of individual items will be reduced since the necessity to pay for each individual service has been eliminated. Further, perusual of the current literature in areas of interest to members of the team will be greatly simplified by the maintainence at STRC of interest profiles and monthly literature searches in these specified areas. The following general interest areas have been selected for review and continuous updating:

(1) Radiation Detection and Effects
(2) Imaging Techniques
(3) Surveys-Program Reports
(4) Metrology and Measurement
(5) Image Processing
(6) Computer Analysis and Simulation Techniques
(7) Physiological Data
(8) Materials
(9) Instrumentation and Control Systems
(10)Environmental Factors .

The searches under these general topics will be tailored to the specific interest subtopics applicable to the research programs of the medical researchers involved in interaction with the Biomedical Applications Team as well as the specific interest area of the individual Biomedical Applications Team members.

1.4 Limitations to the Biomedical Applications Team

A factor which involves the productivity of the Biomedical Applications Team has been recurring with sufficient regularity in our activities that we feel it is worthy of comment. It involves that point in the transfer process which lies chronologically between the time when an acceptable solution to a problem has been found and the time when the solution is applied by the researcher; i.e. the transfer. We have on a number of occasions been able to reach the point where seemingly acceptable solutions to problems have been found, but because we have not been able to obtain or to fabricate demonstration equipment, the researcher, who generally is unwilling to invest his grant money in anything until he is absolutely certain of its usefulness to his project, has not used the solutions. This is understandable because the researcher's grant money is carefully allocated and does not include a surplus for instrumentation development. Biomedical researchers are very anxious to apply and evaluate new equipment or concepts. Unfortunately, this has not generally been possible because the devices or instruments cannot be obtained, and we have no means for fabricating prototypes. We feel that our efforts would be greatly enhanced if such a facility existed. Further, if we had the means for supplying such prototypes, it seems logical that the biomedical investigators would be more inclined to invest a greater part of their time and effort in the overall program.

2.0 Review of Team Activities

2.1 New Contacts

In September Dr. W. P. Webster of the UNC Dental Research Center was contacted to determine his research interests and to explore ways in which the Biomedical Applications Team might interact with him in order to further his research program. Dr. Webster's research interests are in the areas of blood clotting, bioassay techniques, and hemophilia. As an initial activity, we are conducting a search of aerospace literature in this area.

At the Bowman-Gray School of Medicine Dr. George Malindzak, consultant for the Biomedical Applications Team, arranged a discussion with Dr. C. E. Rapela and Dr. C. I. Porciuncula. We discussed their field of interest, vascular flow and vascular volume. With an experimental model of an ideal flow system, that is used in their research, they demonstrated the measurement methods which they currently employ and graphically demonstrated some of the problem areas in the present apparatus. Further discussions are required before the problem can be completely specified.

Another problem involving instrumentation was presented by Dr. Rapela. This problem is specifically associated with the measurement of the partial pressure of CO_2 in blood in the brain. Currently available electrodes for the measuring system have an inadequate time response. The time response of the electrode depends upon the diffusion of CO_2 through a teflon membrane and into a layer of aqueous bicarbonate. Carbonic acid is produced in the layer, lowering the pH. The inner glass electrode is pH-sensitive, providing a measure of the partial pressure of CO_2. Because of this dependence on diffusion and intermediate reaction, the time response is too slow to perform the measurements that are required.

2.2 Problem Summaries

The activities of the team with respect to specific biomedical problems are outlined in the following paragraphs.

DU-6 Correction for Latency in Vidicons

The stroboscopic lighting equipment installed as a result of biomedical applications team activities at Duke University is continuing to function well. Dr. Johnson finds, however, that it is now the sensitivity of the vidicon which is the limiting factor in the usefulness of the system. He is planning to replace the vidicon with either a plumbicon or/and oxicon both of which are at least an order of magnitude more sensitive at low light levels. The stroboscopic lighting is, however, essential no matter what type of tube is used. Without this lighting technique Dr. Johnson would not be able to monitor the movements of cardiac muscle quantitatively to any useful degree. Previous difficulties with the video tape recorder in this system when used in the single frame playback mode with non-interlaced scanning have not been overcome, but they are understood and the system is being used within its operating capabilities.

DU-7 Microforce Transducer

We recently received information from the Optron Corporation concerning an optical tracking system which will permit Dr. Johnson to measure the amount of contraction of cardiac muscle fibers very accurately. The Optron extensiometer was suggested by Dr. Nathan at JPL. This determination may be as valuable as actually measuring the force of contraction which was delineated in the Biomedical Problem Abstract. In March of this year, Mr. Clint Johnson at NASA Flight Research Center, Edwards, California, suggested that an extensiometer might be applicable to this particular problem. We have received no further information from Mr. Johnson following this suggestion, and we are not sure if there is any connection between NASA and the instrument manufactured by the Optron Corporation.

DU-11 Pressure Transducers for Intra-Cavity or Subcutaneous Implantation in the Body

The problem of measuring pressure at various points within the circulatory system as well as other physiological systems, such as in the urinary tract, is a severe one. Most of the determinations in the past have been made by inserting a catheter to the point at which it is desired to determine pressure. Blood flows out through the catheter and makes contact with an external pressure transducer. Pressure information is transmitted through this column of blood to the transducer which is physically too large for insertion into the body. A great deal of information is lost because of the propagation characteristics through this column of blood. Recently smaller pressure transducers have been fabricated which utilize semiconductor strain gauges mounted on a thin membrane. These devices have been made small enough for inserting into the body and have in fact been inserted or implanted directly in heart chambers. Such devices are presently available from Electro-Optics, Inc. These devices have resulted from NASA-supported research and development programs. Generally, these devices are felt to be relatively expensive by the medical profession, and additionally they involve passing electrical current into the body which is generally felt to be undesirable. There is always a chance that if currents are applied to heart tissue, the heart can go into fibrillation which is essentially an unsychronized and ineffective state of activity of the heart.

An entirely new approach to measuring pressure within the body has been developed by Dr. Max Anliker at Ames Research Center which appears to offer many advantages over previous types of transducers. This particular approach is an optical one and involves the passage of only optical energy into and out of the body. No information on this device has yet been released from Ames. Briefly, it operates by sending light down a bundle of optical fibers to a thin diaphragm placed at the end of a catheter which is inserted into the body. The reflection of light from the inner surface of this diaphragm is effected by distortion of the diaphragm caused by differential pressure existing on the two sides of the diaphragm. Other optical fibers sense the direction of reflected light from the inner surface of the diaphragm,and pressure information can be obtained from two output bundles of optical fibers.

At the present time Ames Research Center is fabricating a number of catheter tips approximately 2 mm in diameter with thin diaphragms attached for evaluation by Duke University. RTI will aid Duke in fabricating complete pressure-sensing catheter systems for their evaluation.

Additionally, we have obtained from Langley Research Center a new type of low attenuation plastic optical fibers for use in this system. These fibers were obtained from Mr. Charles C. Laney. In summary this new optical pressure transducer for use in physiological systems should have tremendous impact upon both biomedical research as well as procedures in operating rooms and clinical diagnostic work.

DU-25 A Signal Conditioning and Multiplexing System for Multiple Electrode EKG Patient Monitoring

We have obtained sample integrated circuit operational amplifiers from the Radio Corporation of America and Fairchild Semiconductor for evaluation by Duke University medical personnel in a signal conditioning and multiplexing system for multiple electrode EKG patient monitoring. The amplifiers which we have obtained are a new low-noise type that are still in the developmental stage. They are scheduled, however, to be commercially available by the end of the summer. Dr. Johnson at Duke has informed us that the electrical characteristics of these amplifiers are quite sufficient for amplifying the EKG signals. The use of the integrated circuit operational amplifier approach in this application will greatly reduce the system cost for multiple electrode EKG monitoring and processing.

We have continued to aid Drs. Spach and Boineau at Duke in designing a multichannel EKG system. We have obtained sample integrated circuits from RCA and Fairchild, and the amplifiers to be used in this system have been selected. We would prefer to use hybrid amplifiers which have been designed at Ames Research Center because they are more appropriate for amplifying physiological potentials. Unfortunately, these amplifiers are not commercially available, and there is no facility presently available for fabricating these circuits.

DU-26 Simulation of Coronary Infarctions in Experimental Animals

In discussions with Dr. Henry McIntosh at Duke University, the need for a reliable and predictable means of causing cardiac artery occlusion which in turn result in an infarction in experimental animals was brought to our attention. The devices would be used to study the effects of a variety of drugs and other treatment in treating coronary infarctions. The presently used device is a ring of material known as ameroid which swells as it absorbs body fluids. It was originally thought that this swelling would occlude the artery in a predictable manner. It has been found, however, that the time of occlusion of the artery following the ameroid placement on the artery varies from 12-60 hours. This fluctuation in time to occlusion is highly undesirable and represents an additional variable factor which complicates interpretation of results in this work. The device must be either modified, or a new approach to the problem must be taken. To be a useful experimental technique, it must be possible to cause an occlusion in 48 $\pm$ 6 hours. We are presently attempting to identify the source of variations in the ameroid constrictor so that an accurate problem abstract can be prepared.

DU-27 A System for Recording and Performing Simple Data Processing of Evoked Action Potentials in Smooth Muscle Tissue

We have been attempting to aid Dr. Nels Anderson at Duke in selecting recording and data processing equipment to be used in the investigation of smooth muscle tissue. The muscle action potentials are non-repetitive and generally will not require high speed recording equipment. Dr. Anderson's primary concern at the present time is to devise a low-cost configuration which will provide limited capabilities but will also have the capability for expansion in the future as further equipment allocations are available.

DU-28 Fluid Dynamics of Sucrose Gap Chambers

Sucrose gap chambers are used frequently in physiological research when it is necessary to electrically isolate small regions (on the order of .010 inches) of single cells or fibers of nerve or muscle tissue. This isolation is achieved in sucrose gaps by flowing alternate streams of sucrose (insulator) and Krebs solution (a conductor) over these cells.

Presently available sucrose gap chambers at Duke University as well as other medical institutions can be used with relatively large nerve cells, such as the giant squid axon but, because of fabrication difficulties, have not in the past been built small enough for cardiac muscle cells and smaller nerve cells on the order of 20-30 microns in diameter. This reduction in size of the sucrose gap chamber requires completely new approaches to fabrication which in turn require that the basic configuration of the chamber itself be changed. This change in chamber configuration means that the operation of smaller chambers cannot be predicted by simple extrapolation from existing designs. Thus, the design of a new smaller chamber required that new empirical or theoretical information on fluid dynamics be obtained.

A manual search at STRC uncovered six NASA contractor reports related to fluid dynamics in small passageways and chambers. These documents were reports on NASA-supported programs to develop fluid amplifiers and logic circuits. Information in these reports has allowed Dr. Johnson at Duke University to design a new chamber with reasonable certainty of successful operation for studying the characteristics of single cardiac muscle fibers.

DU-29 Methods of Fabricating Small Sucrose Gap Chambers

Sucrose gap chambers in the past have been made from lucite and were fabricated by drilling all holes and fluid passages using a milling machine. The process is generally expensive, and one is limited in just how small the chamber can be made. The applications team suggested to Dr. Johnson at Duke University that if the sucrose gap chamber could be laid out in a planar configuration, then it could be fabricated using autolithographic and etching techniques similar to those employed in obtaining oxide diffusion masks on silicon in the fabrication of silicon integrated circuits. Through STRC we learned that two different processes have been developed which may be appropriate. Bowles Engineering Incorporated has developed a technique for selectively etching channels into plastics for fabricating fluid amplifiers. This process, however, required the use of plastics which are somewhat soluble in water and therefore could not be used in fabricating sucrose gap chambers. Another technique developed by Corning does appear applicable. This particular process involves selectively exposing portions of a glass plate to ultraviolet radiation. These exposed regions, following development by heating, etch at a rate of from 25-30 times faster than the etching rate in the unexposed portion of the plate. Thus, it is possible to form intricate patterns or channels to any depth desired in glass. The chamber itself can thus be formed by etching appropriate patterns into the surfaces of two plates and then pressing these plates together to form the desired closed fluid system. Drawings and photographs of a completed sucrose gap chamber fabricated by this glass etching technique will be included in our next Quarterly Report.

UNCD-1 Preparation of Metallic Powders from Silver Alloys

During the quarter we received a response from the Lewis Research Center on this problem abstract. The suggestion offered would require a feasibility program and perhaps an extensive development program. Since the medical researcher was seeking an inexpensive innovation rather than an expensive extension of existing techniques, the suggestion was not appropriate to the researcher's funding and interest.

UNCD-6 A Sensor to Measure the Temperature of Individual Teeth in Such a Fashion as to Determine the Viability of the Tooth

We are currently evaluating various types of temperature-sensing devices which can possibly be applied to this problem. One of the significant difficulties on this particular problem concerns the methods by which various investigators have attempted to determine the thermal distribution of the oral cavity. These techniques are not uniform, and it appears as a result of preliminary study that new techniques of measurement may well be required rather than newer and more sensitive sensors.

UNCD-7 A Method of Obtaining X-Ray Films of the Entire Mouth on a Single Film with Depth of Focus on 1 mm or Less

The potential application of transverse axial laminography to this problem was discussed in the last monthly report of the previous year. The dental researcher is extremely interested in the technique and desires to see a set of X-rays taken with such a device on a structure with which he is familiar; namely, a human jaw bone. This would permit him to make meaningful assessments of the usefulness of the transverse axial X-ray laminography technique. Accordingly, Mr. James F. Blanche of Marshall Space Flight Center, who authored the article which prompted our interest in laminography, was telephoned in an attempt to arrange a series of X-ray pictures of the jaw bone using the transverse axial laminography technique. It was learned that, unfortunately, the original laminographic equipment has been dismantled, and a new, more advanced unit is being constructed. The new unit will not be in operation for 12-18 months, and Mr. Blanche knew of no other available equipment which we could use.

Mr. James Beal of the Marshall Space Flight Center, Huntsville, Alabama, has suggested that it might be possible to place a radioactive source in the mouth and then to position a film around the outside of the jaw bone and tooth structure in such a fashion that radiation from the source would pass through the teeth and jaw bone structure and expose the film. This would give on one film an X-ray shadowgraph of the entire mouth structure. He noted that the source should, of course, be shielded so that the emitted radiation would only occur outward through the teeth and jaw bone structure. This procedure would give the exposure, on one film, of the entire mouth. It would not, however, provide the small depth of field which is another aspect of the problem. No experimental work has been done to determine the applicability of this suggestion.

UNCD-10 Techniques of Applying Thermography to the Mouth

In connection with this problem, we have obtained a group of articles and a series of bibliographies on liquid crystals from the North Carolina Science and Technology Research Center. STRC has been in contact with Mr. James B. Beal who is in nondestructive testing at the Marshall Space Flight Center. Mr. Beal has widely used liquid crystals in the nondestructive testing program and has furnished us valuable information through STRC. In addition, we have contacted Mr. Beal at Marshall Space Flight Center and have discussed liquid crystals in general and also the possibilities of applying liquid crystals to a number of biomedical applications. Mt. Beal gave us the names of principal suppliers of liquid crystals and recommendations for the best types to use. In the course of talking with Mr. Beal, it was discovered that he would be willing to come to RTI and give a presentation on liquid crystals to members of the

Biomedical Applications Team and other interested personnel at RTI. We were most receptive to such a visit, and we wrote Mr. J. W. Wiggins, Technology Utilization Officer at Marshall Space Flight Center, requesting that Mr. Beal come to RTI the latter part of July or the first part of August and give a presentation on liquid crystals. As a result, Mr. James B. Beal of Marshall Space Flight Center came to the Research Triangle Institute in August and gave a presentation on nondestructive testing techniques, including the application of liquid crystals. Several possible techniques for employing liquid crystals in dental thermography were discussed. Further investigations are continuing, but the principal impediment is the lack of funds to purchase appropriate liquid crystal compounds and associated hardware to permit analytical evaluation of the feasibility of achieving the desired results with these techniques.

WF-5 A Method of Photographing Ultrasonic Energy Patterns and

WF-10 Theoretical Treatments of Holography which Discuss Aberrations and Distortions

We have contacted Mr. Al Richardson, Technology Utilization Officer at the Electronics Research Center, concerning his suggestion that Dr. Thurstone would possibly be interested in visiting ERC to discuss problems in ultrasonic holograms with scientists at that Center. Mr. Richardson suggested that Dr. Hartwig contact Mr. Lowell Rosen at ERC before arranging the trip. He also suggested that at least one representative from the RTI Biomedical Applications Team visit ERC in the near future to discuss a variety of medically-related problems with people at ERC, especially those in the Bioelectronics branch. We are attempting to arrange this visit through Mr. Richardson and Dr. Howard Yanoff.

WF-20 A Technique for Continuously Monitoring the Inside and Outside Diameters of Capillaries and Small Arteries in the Veins and

WF-21 A Method of Measuring Velocities of Individual Red Cells

Information on the Optron Corporation extensiometer has also been given to Dr. Thurstone at the Bowman-Gray School of Medicine, Wake Forest. This instrument seems to be directly applicable to the continuous monitoring of the inside and outside diameters of capillaries, as well as to the measurement of the velocity and tumbling of red cells in small arteries and veins. Dr. Nathan at the Jet Propulsion Laboratory suggested this approach to these two problems.

<u>UNC-5</u> Techniques for Facilitating the Insertion of Needles into Small Arteries and Veins

We have discussed with Mr. Foster, Technology Utilization Officer at Goddard Space Flight Center, the vibrating needle (suggested by Mr. Raymond G. Hartenste). We talked with Dr. Sugioka at UNC about this response. He pointed out that the problem of inserting the needle was really quite minor in comparison to that of actually locating the veins or arteries. Frequently, the veins or arteries cannot be seen because of their depth in the tissue. He actually had little interest in methods of insertion of hypodermic needles into veins and arteries as a mechanical operation. It may be advisable to rewrite the Problem Abstract in order to more clearly delineate Dr. Sugioka's interest. The suggestion that liquid crystals could be used to help locate hidden veins, which has come from Goddard as well as a number of other places, is being investigated at the present time. Liquid crystals may be particularly used for locating veins and arteries near the surface of the skin with dark skinned or obese people. Further activities concerning liquid crystals and plans for future activities are discussed under UNCD-10.

<u>RU-2</u> A Survey of Recently Developed Transducers for Monitoring Physiological Parameters

In April of 1967 a number of reports and surveys related to new developments in transducers were sent to Dr. Eisenberg at Rockefeller University. In a telephone conversation with Dr. Eisenberg, we recently learned that a number of techniques, including the use of a microminiature pH electrode, obtained from these reports has been of value at Rockefeller University. We have not received any specific information on these applications, but we expect further feedback in the near future.

2.3 Information Searches

During this quarter, two information searches were made: one on the effects of weightlessness on skeletal calcium, the other on blood coagulation and regulated topics. In addition, a number of abstracts have been received from information searches which were made previous to this quarter. The information search title and the total number of abstracts received for each title are listed below:

Information Search	Abstracts Received
Biotelemetry #679	11
Electromyography #680	23
Imaging Techniques Using Ultrasound #767	4
Biomedical Pressure Sensors #905	4
Computer Processing of Physiological Data #924	2
List of Technical Surveys Prepared #965	11
Effects of Weightlessness on Skeletal Calcium #980	1

3.0 Contribution Evaluations

CONTRIBUTION EVALUATION FORM

Organization: NASA - Lewis Research Center, Cleveland, Ohio

Contributor: Kirby W. Hiller

Biomedical Problem Abstract: WF3 "Prosthetic Urethral Valve"

Evaluation: This suggestion has been reviewed by members of the Biomedical Applications Team. It is an interesting approach and seems to be a feasible solution to the problem.

Plans for Use: The medical researcher who originated the problem is presently in the process of evaluating the proposed solution.

CONTRIBUTION EVALUATION FORM

Organization: NASA - Lewis Research Center, Cleveland, Ohio

Contributor: Andrew E. Potter

Biomedical Problem Abstract: UNCD-1 "Preparation of Metallic Powders from Silver Alloys"

Evaluation: The method proposed in the reply might be applied to this problem. However, as noted by the contributor, a rather expensive development program would be required to prove feasibility of the approach.

Plans for Use: Since the medical researcher who originated the problem was looking for a method less expensive than conventional methods of obtaining the powders, no further action is anticipated along this approach at the present time.

CONTRIBUTION EVALUATION FORM

Organization: North American Aviation, Inc.

Contributor: Mr. Sidney Keife, 10381 Eleanor Drive, Garden Grove, Calif.

Biomedical Problem Abstract: UNC-1 "Oxygen Measurements in Gas Mixtures"

Evaluation: Two suggestions were made:

(1) Suggested use of fuel cell as oxygen partial pressure sensor. Electrical energy generated by the cell can be amplified and used to light an indicator lamp which shows oxygen is present in the gas mixture.

(2) Ball check valve and flow meter arrangement to indicate reduced oxygen flow.

The researcher does not like the idea of fuel cell as O_2 sensor because of (1) space limitations (need bottle of H_2 and associated plumbing) and (2) hazards of H_2 in the operating room.

As far as the second suggestion is concerned, a ball check valve and flow meter is essentially the procedure now used and is unsatisfactory.

Plans for Use: Researcher does not feel these approaches to the problem are suitable for the operating room environment and has no plans for further action on these suggestions.

CONTRIBUTION EVALUATION FORM

Organization: North American Aviation, Inc., Space & Information Systems Division

Contributor: Mr. E. S. Quilter, 1617 Santa Maria Avenue, Glendale, Calif.

Biomedical Problem Abstract: UNC-1 "Oxygen Measurement in Gas Mixtures"

Evaluation: Suggested the use of a sensitive heat measuring device to determine the rate of oxidation of a sample of anesthetic gas. This rate of oxidation can indicate the concentration of oxygen in the gaseous mixture. Because of hazards in operating rooms, the researcher is generally unreceptive to oxidation devices. Also, space is extremely limited. There is no room for a piece of apparatus which occupies more than several cubic inches.

Plans for Use: None

MEDICAL PROBLEM REPLY REPORT

Center: Lewis Research Center

Contributor: R. G. Hortenste

Problem No. and Title: UNC-5 "Techniques for Facilitating the Insertion of Needles into Small Arteries and Veins.

Evaluation: It appears that the problem abstract has not adequately defined the problem. The suggestion of using an ultrasonically vibrated needle to facilitate insertion of needles into veins and arteries may well be a very excellent idea. We discover after talking again with the medical researcher this, however, was not his specific problem. The real problem seems to be that of actually finding the vein or artery, which may be concealed by the tissue, and guiding the needle to it. The problem of physical penetration is of secondary interest to the researcher.

Plans for Use: Although not applicable to the primary problem in this case, we feel the idea is workable and will continue to seek an opportunity to employ it.

4.0 Financial Status

A summary of contract expenditures for the period 15 June 1967 through 14 September 1967 is presented in Table I.

TABLE I. COST SUMMARY

Quarterly Costs:	
Direct Labor	$10,854.82
Overhead	9,769.34
Direct Costs	4,334.72
Commitments	860.00
Fee	1,494.52
Total Quarterly Costs	$27,213.40