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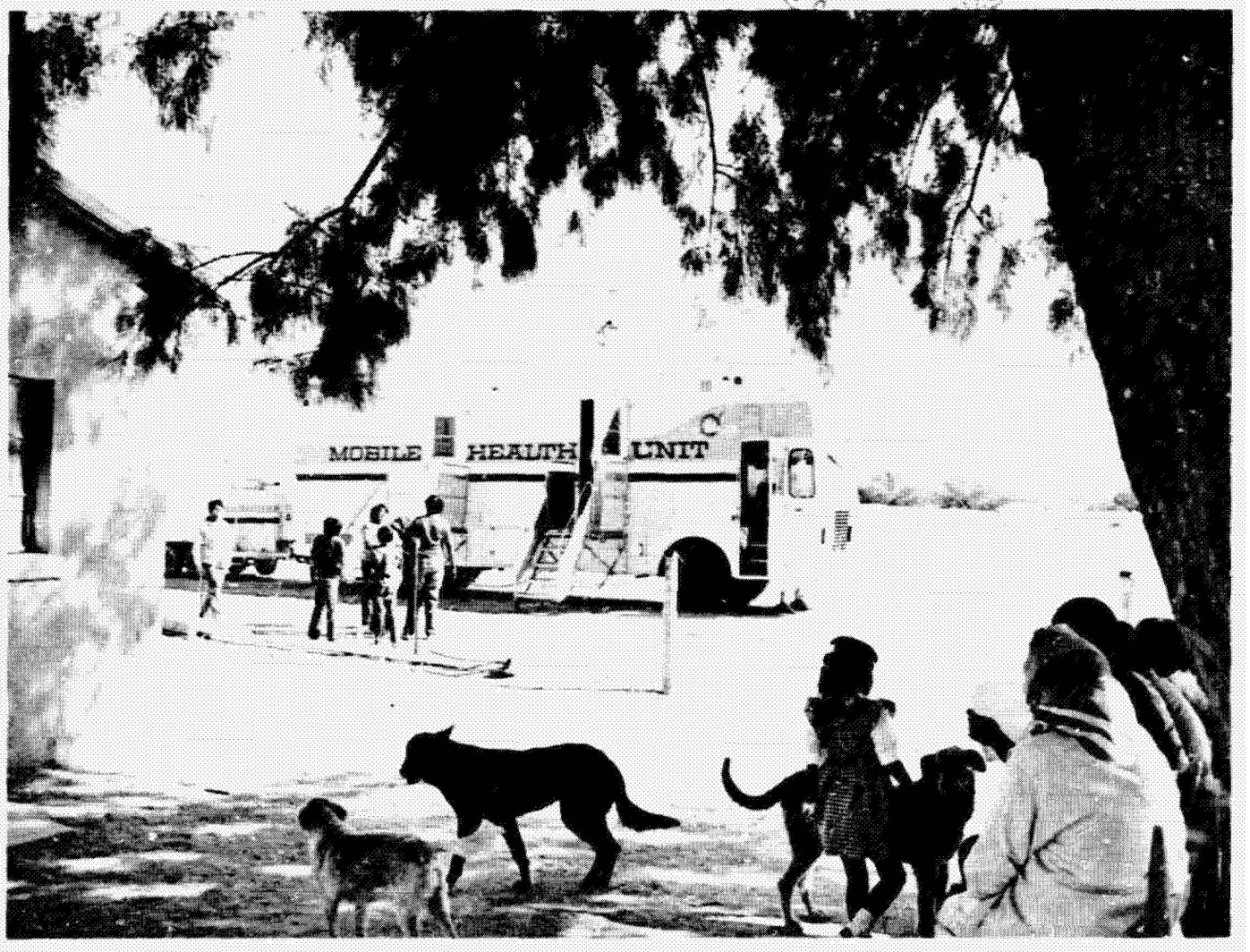
STARPAHC SYSTEMS REPORT

Volume 1 – EXECUTIVE SUMMARY



LOCKHEED MISSILES & SPACE COMPANY, INC.
A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION

FOREWORD

This STARPAHC Systems Report is submitted in compliance with Contract NAS 9-13170 15 December 1972. The report is a final summary of the four and one-half years contract period, and it emphasizes the two years of evaluation.

This document is published in two volumes. Volume 1 is the STARPAHC System Report – Executive Summary; Volume 2 is the STARPAHC System Report – Operational Performance.

This program, Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC), is conducted under the auspices of the NASA (Johnson Space Center), Norman Belasco, Project Officer working in conjunction with DHEW (IHS-ORD), Stuart Rabeau, M.D., Director, and the Papago Indian Nation, Cecil Williams, Chairman of the Tribal Council, and the Executive Health Staff of the Papago Tribe. The LMSC STARPAHC staff is directed by Frank Riley, Program Manager.

The STARPAHC system was evaluated over a 2-year operational period. Evaluation of the medical aspect is conducted by IHS under the direction of James W. Justice, M.D., and evaluation of the hardware aspect is conducted by LMSC under the direction of William C. Wyatt. At the completion of the 2-year period, these results are presented in this STARPAHC system report.

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Section 1
INTRODUCTION

A joint NASA and Department of Health, Education, and Welfare/Indian Health Services (NASA/DHEW/IHS) demonstration project titled Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) has been conducted to develop a solution for delivering quality health care to people in remote geographical areas. Maldistribution of physicians, the low percentage of general practitioners among new medical school graduates, and the dwindling ranks of existing generalists diminished by retirement and expiration (compounded with the time and travel demands imposed by population distribution and a variety of associated negative economic aspects), have resulted in a scarcity of physicians and in relative inaccessability of health care to populations in remote areas.

Because health care delivery onboard extended-mission spacecraft constitutes a "remote area" case, another goal of STARPAHC was to derive information valuable to NASA planners and designers from the implementation of a system that practically demonstrates health care delivery to remote areas on earth. This information is to be used for planning manned space missions of extended duration performed by sizable complements of crew and passengers. The availability of quality health care to those complements is vital to the success of their missions.

Forerunner to STARPAHC was the NASA Program, Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS). This program was initiated in 1964 and culminated with preliminary designs of flight-type hardware by 1970. Knowledge and technology from that program facilitated engineering development of STARPAHC. In 1971, the President's Domestic Council requested that NASA study one of the nation's most pressing health problems and recommend solutions. STARPAHC was conceived by NASA-JSC as one solution to the problem – delivery of health care to remote areas.

In STARPAHC, a combination of capabilities derived from space technology in communications, data processing, and systems engineering enables the physician in the hospital to direct trained allied health professionals located in remote fixed and mobile clinics. The resultant health services team effectively extends the physician's skills, knowledge, and capabilities many kilometers from his physical location to the point of patient encounter. This operational telemedicine system has been installed and has successfully completed a 2-year evaluation phase on the Papago Indian Reservation in Arizona.

Volume 1 of this report, Executive Summary, provides the history, background, and summary of the project implementation, operational results, and potential for expansion. Volume 2, Operational Performance, is the comprehensive technical report; it contains specific emphasis on operational data, cost information, and analysis for expansion to other sites.

The medical and engineering data contained in Vol. 2 provide more in-depth response to the following questions:

- Is the concept of telemedicine using physician's assistants feasible for providing quality health care delivery to remotely located populations?
- What is significant about interactions between the providers, providers and equipment, providers and equipment and patients?
- What is the degree of acceptability of telemedicine among patients and providers?
- Can commercially available equipment of different manufacturers be assembled and maintained as a reliable operational system?
- Can a computerized, patient-oriented, health data system reliably serve a rural health delivery network?
- Will system operation be competitively cost effective?
- Will system capabilities have inherent spinoff advantages presently nonexistent?
- What are the potential and the value of system expansion?
- What is the potential of the concept, system, and subsystems for use in areas other than this demonstration area?

This report presents specific data from the 2-year evaluation that indicate the degree to which objectives have been met. The DHEW/IHS decision to continue operations of the STARPAHC system after two years of field operations represents a value judgment about the success with which service has been provided and is indicative of the potential that telemedicine offers for delivering quality health care to the people of remote areas.

Section 2
HISTORY AND BACKGROUND

During the 1964 and subsequent time frame of early manned space flights, NASA embarked on a program, IMBLMS, to establish feasibility and develop designs and technology for onboard clinical care and for the conduct of onboard laboratory biomedical and biosciences experiments. By 1971, IMBLMS had brought technology and hardware designs through their early development stages, test and verication, and into preliminary designs of flight-type hardware. When addressing health care delivery onboard manned spacecraft, these studies indicated the importance of visual, audio, and data link-type communications between physicians at the Mission Control Center and the remotely located crewmember health professionals, or physician generalists, on the inflight spacecraft. They also indicated the value of a consultation capability between physicians at the Mission Control Center and specialists (who may be at a medical center-type location).

In July 1971, the President's Domestic Council asked NASA to make a concentrated study and recommend solutions to the delivery of health care to rural and inner city areas. The study report, dated September 20, 1971, contained a progressively phased program to provide quality health care delivery to remote populations. Joint implementation with agencies such as the Department of Health, Education, and Welfare (DHEW) was recommended. The key to concept implementation was the utilization of physician's-assistants-type trained health professionals at remotely located clinical facilities under the direction of physicians via audio and video communication links. The first increment of the proposed program was to assemble and operationally evaluate a "demonstration test bed" type system. The plan and corresponding funding to initiate the demonstration program element were approved by NASA management.

When the project was approved for implementation, important guidelines and constraints were established including:

- NASA funding and scheduling limitation for the total program
- Utilization of a system-manager-type contractor
- Use of commercially available off-the-shelf equipment wherever possible
- Inclusion of nonphysician trained providers to extend physician outreach
- Redundancy only when necessary for critical functions
- Tailor-made quality and reliability programs and minimized program documentation (with relation to those required by aerospace projects)
- Utilization to maximum extent of available software and data bases

The operational test site was selected by formal competitive process. On November 5, 1972, HEW published announcements soliciting applications of potential candidates for the test site. HEW evaluated candidate applications and in April 1973, with NASA concurrence, announced the selection of the Papago Indian Reservation in Arizona (Fig. 2-1).

In a competitive procurement, LMSC was selected as the NASA prime contractor for the project. The NASA-JSC contract with LMSC was initiated December 15, 1972, and included (1) a year for site selection, project definition, and design, (2) a year for system assembly and installation, and (3) two years of operational support and evaluation. In addition, a NASA/HEW Interagency Agreement was formalized, supplemented by a NASA-JSC and DHEW-IHS-ORD "Memorandum of Understanding" for guiding day-to-day activity. The Papago Tribal Council approved a resolution accepting the project, and the acronym "STARPAHC" was mutually developed (from Space Technology Applied to Rural Papago Advanced Health Care).

SITE SELECTION PROCESS

The site selection process was initiated when, in response to a DHEW public invitation issued on November 5, 1972, 16 U.S. communities applied for consideration as sites for the IMBLMS field test. Ten of the 16 applications submitted appeared to meet the site selection criteria. A more thorough analysis and screening was then conducted based on the following priority factors:

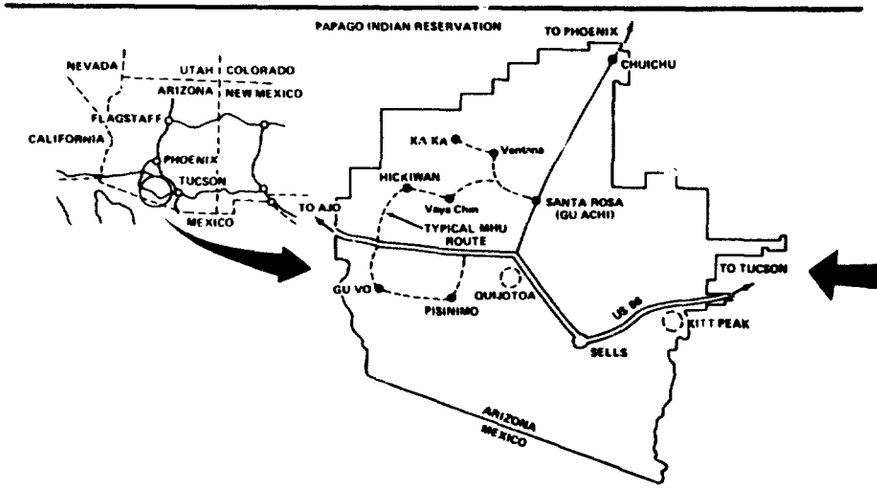
- State legislature or Tribal Council approval of IMBLMS paramedic activities
- Financial ability of site to operate system after 2-year demonstration
- Consumer and provider acceptance of system/service
- Potential for measurable health status improvement
- Availability of trained paramedic personnel

On the basis of this second screening, all but three of the applications were eliminated. The three selected were:

- Las Cruces, New Mexico
- Papago Reservation, Arizona
- Williamsport, Pennsylvania

All three areas were requested to submit additional demographic and other data, and were subsequently visited by a team of representatives of NASA, DHEW, and Lockheed. The results and findings of these activities were presented to the Site Selection Board, who in turn provided their report to the Administrator, HSMHA/DHEW.

After review and concurrence by the NASA Administrator's Office, DHEW, the Acting Administrator, Assistant Surgeon General David J. Sencer, M.D., officially announced selection of the Papago Indian Reservation on April 6, 1973.



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
HEALTH SERVICES AND MENTAL HEALTH ADMINISTRATION
ROCKVILLE, MARYLAND 20852

OFFICE OF THE ADMINISTRATOR

March 28, 1973

Dr. George M. Low
Deputy Administrator
National Aeronautics and Space Administration
Washington, D. C. 20546

Dear Dr. Low:

This is to officially inform the National Aeronautics and Space Administration that the IMBLMS Site Selection Advisory Board has designated, and I have approved, the Papago Indian Reservation as the test site for the IMBLMS Project. I have also informed the Office of the Secretary of DHEW of this selection.

It is my understanding that NASA will advise the appropriate members of Congress of the designated site. HSMHA will prepare, and clear with NASA, a news release to be submitted to the news media as soon after Congressional notification as possible. At the same time I will notify the applicant from the designated area and the other two unsuccessful applicants of the Board's selection.

Sincerely yours,

David J. Sencer, M. D.
Assistant Surgeon General
Acting Administrator

Fig. 2-1 Site Selection Process

Section 3

PROJECT IMPLEMENTATION

The STARPAHC scope of work included all activities, equipment, and facilities necessary for managing a complex project and accomplishing the three basic parts of this project:

- Part 1 – Definition and Design
- Part 2 – System Assembly, Test, Installation, Checkout, and Training
- Part 3 – Operation and Evaluation of the System at a Remote Site

The performance period (Fig. 3-1) for this work extended from December 15, 1972 through April 30, 1977. May 1 through October 30, 1977 was required to compile, analyze, and extrapolate data, and to complete the System Report on two years of operational performance of the project. The total contract award was approximately $3.88M. Figure 3-2 indicates the funding distribution for the three basic parts of the project. The program was completed well within the cost guidelines established prior to program initiation.

The project development plan recognized the key issues facing the project and developed approaches to deal effectively with them. These approaches in managing and system engineering a complex project required a diversity of skills including medicine, computer sciences, engineering, manufacturing, test, field operation, and system evaluation. The approaches entailed the following:

- This complex project required a team with broad systems engineering management/health care delivery capability augmented by support from communications, the computer, and the vehicle manufacturer.
- A thorough systems engineering and system integration job must be done, commencing with definition through program implementation.
- A cost-effective approach to meeting NASA objectives involved procuring proven commercial hardware and supplies and utilizing existing facilities, services, and personnel.

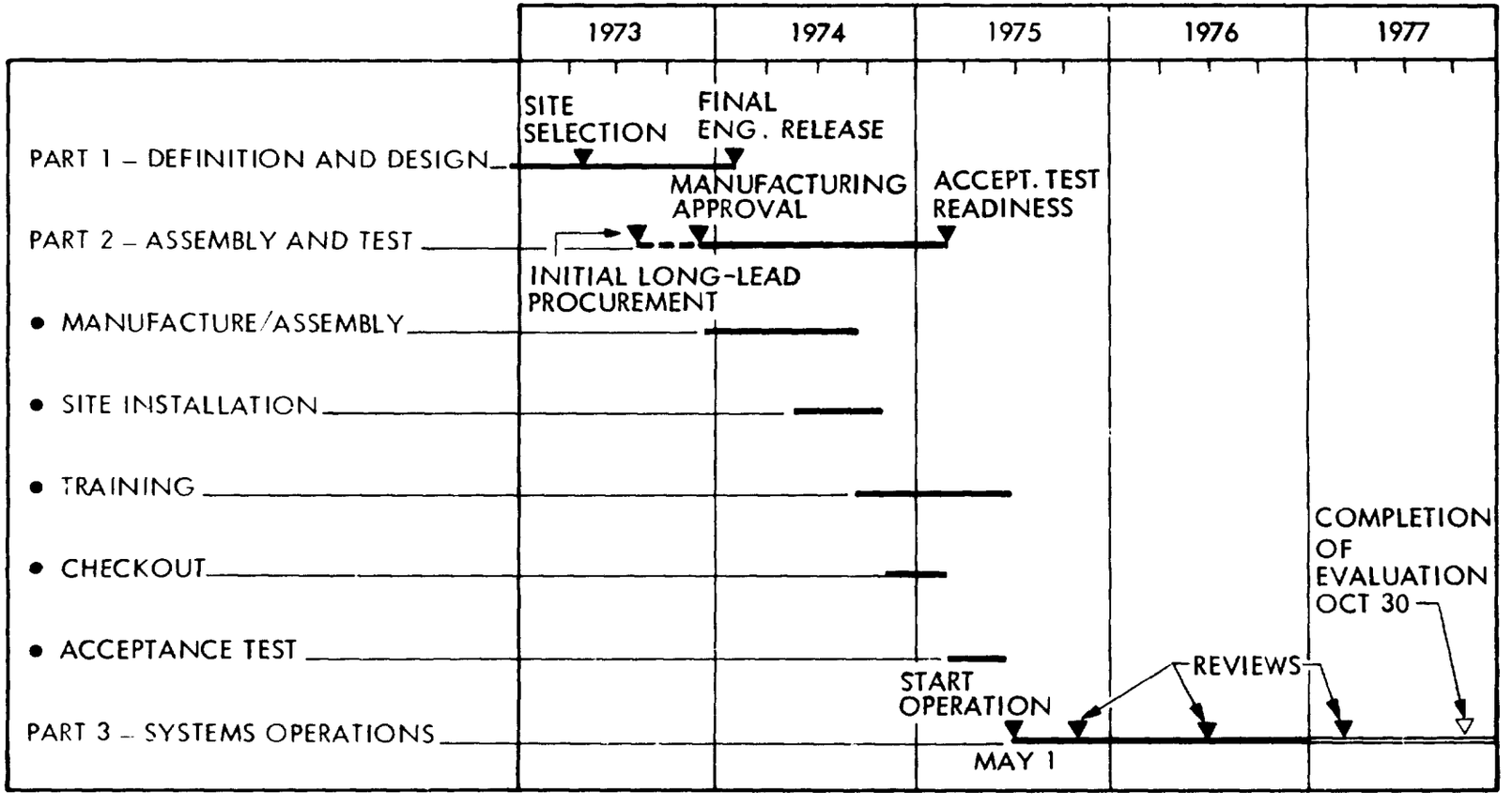


Fig. 3-1 Overall Schedule

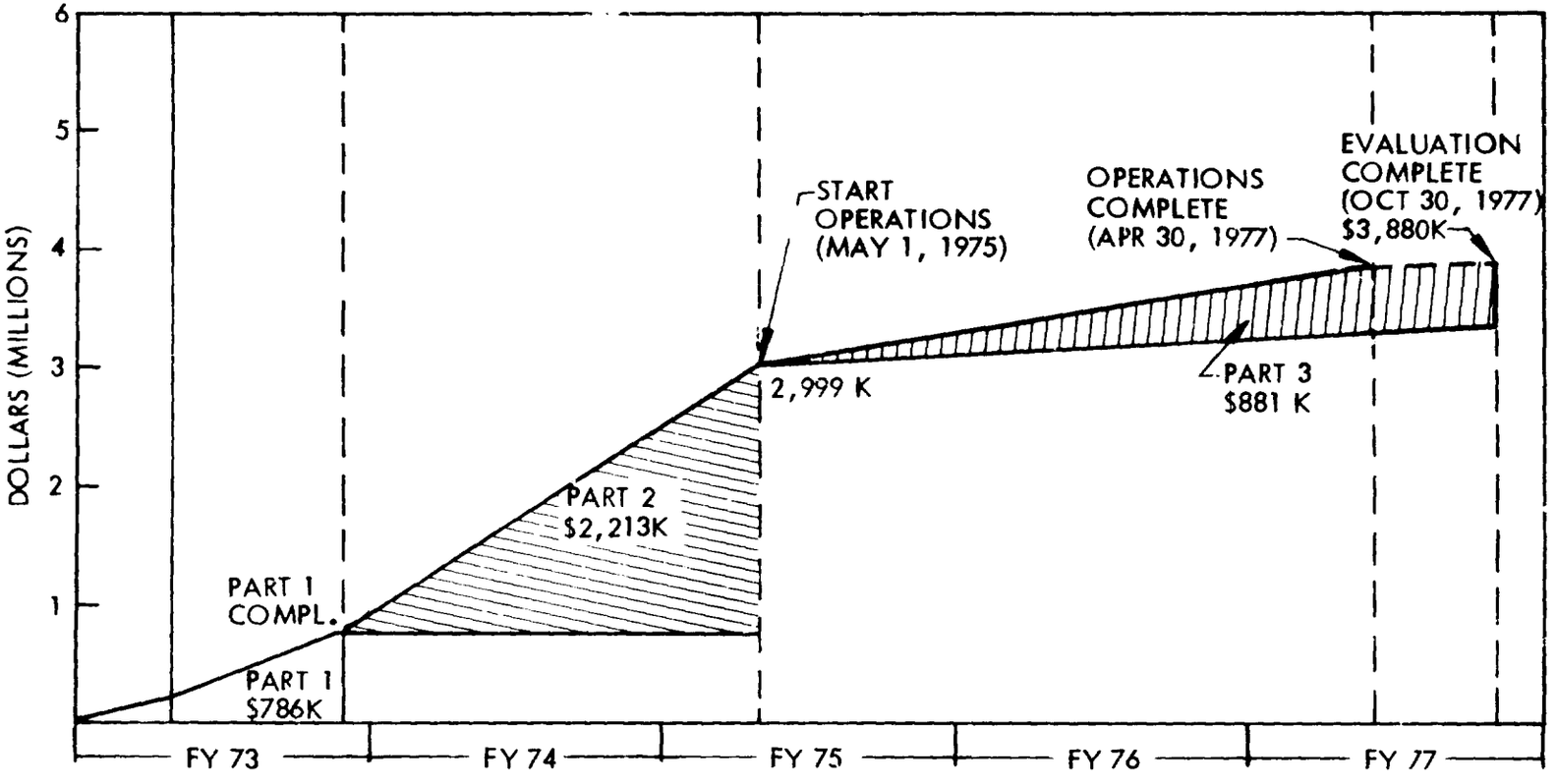


Fig. 3-2 STARPAHC Program Cumulative Costs (Including Fee)

To meet contract requirements, it was recognized that a wide variety of highly specialized skills would be required. These included medicine, computer sciences, engineering, manufacturing, testing, field operations, systems engineering and evaluation, and budget control. These skills were used in the following activities.

- A team was developed with emphasis on systems engineering – in its broad aspects – and health care delivery capability. These disciplines were augmented by support from communications, a computer, and vehicle manufacturing specialists.
- Systems engineering and systems integration were primary steps; they commenced with task definition and continued through program implementation.
- NASA objectives were achieved with cost-effectiveness by 1) designing systems to use proven off-the-shelf hardware rather than requiring expensive-to-manufacture custom equipment and 2) making maximum use of facilities, personnel, and computer-based health information facilities already existing in the remote station area.
- System safety, reliability, maintainability, and quality assurance were drawn from aerospace experience.
- A cost-effective plan was prepared for the transfer and continuation of the project after the initial steps were completed.
- A simulation plan was prepared for acquiring and applying information and data gained through the assessment of the system to the design of a future space health care system.

Systems engineering and program control techniques common to aerospace programs were modified and employed as both management and working tools. Specifically, time-phased interface logic flow diagrams were used throughout the program to schedule the startup and completion of tasks. These techniques were very useful for gaining maximum efficiency from limited resources and stringent schedules.

3.1 ORGANIZATION

The STARPAHC project was conducted under the auspices of NASA (Johnson Space Center) working in conjunction with DHEW (IHS-ORD) and the Papago Indian Tribe.

LMSC, the NASA systems contractor, supported the development, operation, and evaluation of the system. Figure 3-3 shows the three organizational functions and indicates the participants, their responsibilities, and interrelationships.

3.2 SYSTEM DESCRIPTION

The STARPAHC approach combines the utilization of space technology and the use of trained, remotely located, allied health professionals. A system was installed on the 11,137-km^2 (4,300-mi^2) Papago Indian Reservation in Arizona (Fig. 3-4). The goals of the program were to determine the effectiveness and exportability* of this technique for improving the delivery of health care to remote populations and to gain information that will be valuable for the development of health care systems for future manned spacecraft.

STARPAHC serves approximately 10,000 permanent residents of 75 villages on the Papago Reservation, and 2000 to 4000 persons who live outside the boundaries of the reservation but return to the reservation for health care. The system is staffed by IHS medical personnel, who throughout the 2-year period received technical support from technicians of the onsite contractor, Lockheed Missiles & Space Company, (LMSC). IHS personnel were trained to assume technician duties following the 2-year evaluation period. Operations are being continued by the IHS once the 2-year test and evaluation period is completed.

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*"The potential for transferring in whole or in part, the STARPAHC concept, data, and information. Purposes may be to utilize for analyses or decision judgments in planning, engineering, and implementing telemedicine systems to meet the needs of specific operational sites."

participants

- Papago Indian Tribe and Its Executive Health Staff
- DHEW Health Services Administration (HSA)
- Indian Health Service Center for Research and Development (IHS ORD) (DHEW)
- NASA Hdqtrs Office of Space Science (OSS)
- Lyndon B. Johnson Space Center Sciences and Life Sciences Directorate, Bioengineering Systems Division (JSC) (SLSD) (BSD)
- Lockheed Missiles & Space Company, Inc. (LMSC) (Contractor to NASA-JSC)

responsibilities

NASA/JSC PROGRAM OFFICE — PROGRAM MANAGEMENT

- Program Team Guidance and Coordination
- Program Planning and Budgeting
- Technical Management, Direction, and Control
- Interagency and Contractor Coordination
- Program Data and Documentation Control
- Government-Furnished Equipment (GFE)

DHEW/IHS OFFICE OF R&D — PROGRAM MANAGEMENT TEAM MEMBER

- Management and Coordination of Medical Aspects
- GFE, Facilities, Personnel, and Services
- Health Information System Data Base
- Medical Operations Management and Evaluation
- Interface With Executive Health Staff Project Team

PAPAGO TRIBAL COUNCIL — EXECUTIVE HEALTH STAFF PROJECT TEAM

- Appropriate Legislation
- Community Cooperation for MHU Operation
- Community Acceptance Evaluation
- Video Health Education

LMSC PROGRAM OFFICE — PRIME CONTRACTOR

- System Definition and Detail Design Responsibility
- Subcontractor and Vendor Selection
- System Assembly, Testing, Installation and Checkout
- Field System Operations, Maintenance, and System Evaluation

organization

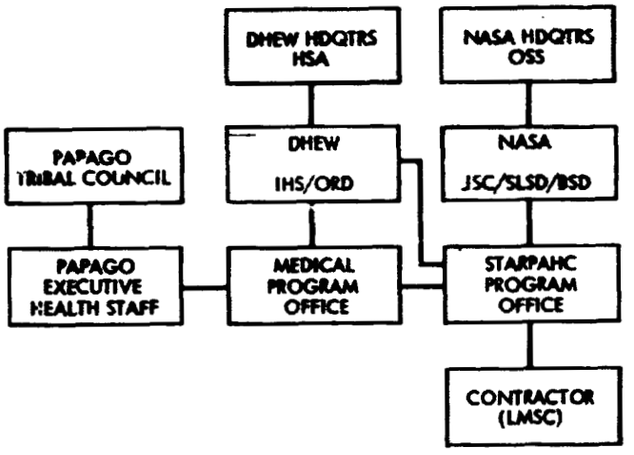

Fig. 3-3 Program Organization

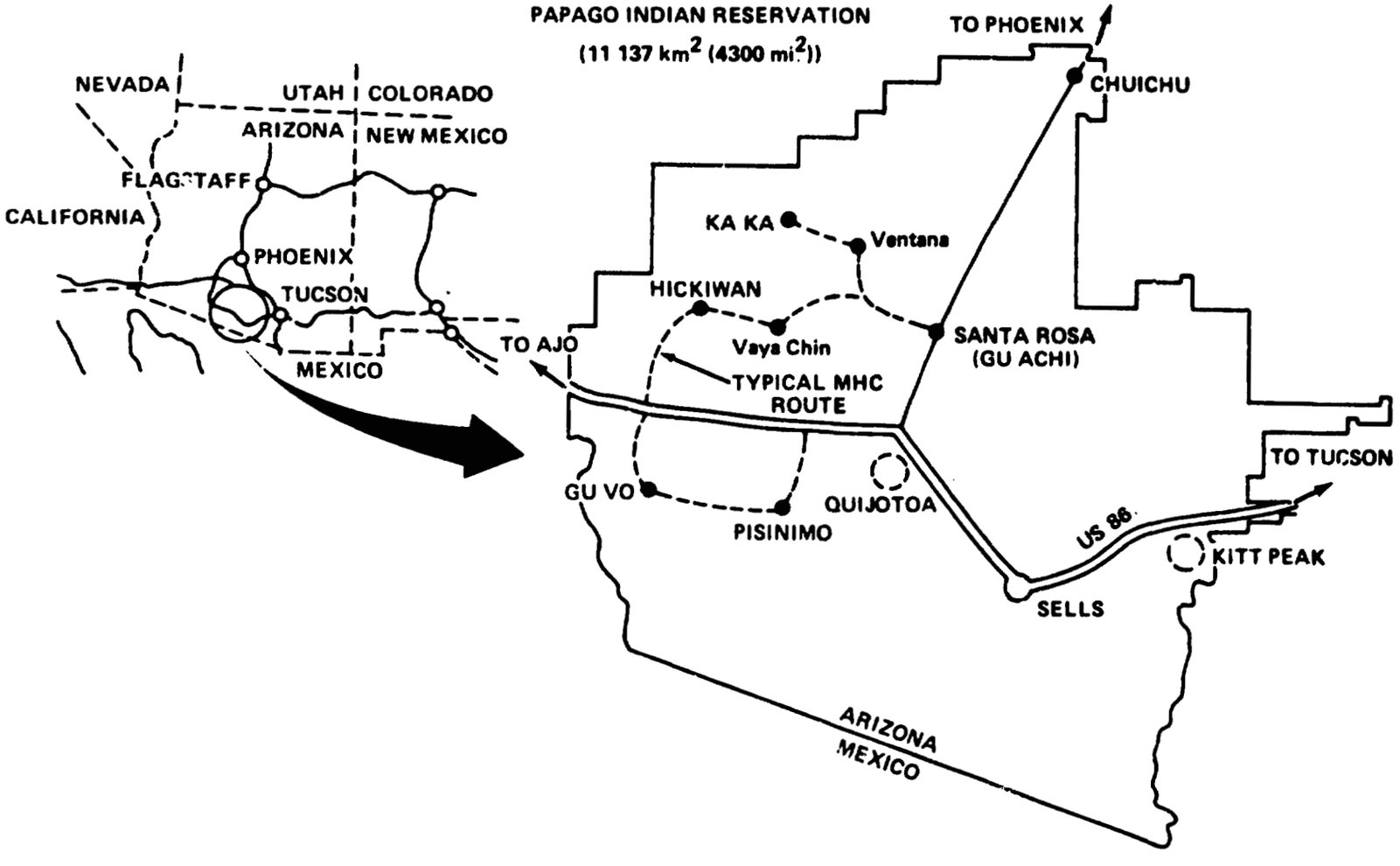

Fig. 3-4 STARPAHC Test Site

The STARPAHC system (Fig. 3-5) includes a control center located in the Sells Hospital, a fixed clinic at Santa Rosa, Ariz., a mobile health unit (MHU), and a referral center in the Indian Health Hospital in Phoenix, Ariz. (for access to specialists by television (TV), data, and voice links with the control center). The Albuquerque, N.M., computer center provides STARPAHC access to the IHS health information data base. Television, voice, and data transmissions are routed between system elements through a strategically located relay station. A portable electronic vital signs monitor (Telecare unit) is used for house calls and emergency treatment.

The physicians' console in the control center at Sells Hospital is the focal point of the system. This control center, as shown in Fig. 3-6, provides physicians with the displays and controls required to perform their comprehensive functions. These controls and displays were selected to give physicians command flexibility and a maximum amount of information with a minimum of technical functions. Most important to the physicians' visual examination of the patient are the capabilities to remotely control the TV cameras at the MHU and the fixed clinic from his console, to display pertinent patient medical data, to control privacy in voice and TV communications, and to read x rays or microscopic slides by TV.

The MHU (Fig 3-7) is a fully equipped clinical van that visits settlements and villages on a preselected route and schedule. Staffed by physicians' assistants called community health medics (CHMs), a practical nurse, and a driver, the MHU gives the physician a flexible outreach capability through its color TV, its black-and-white TV, voice communication, and computerized data information links with physicians at Sells Hospital.

The fixed clinic (Fig. 3-8) staffed by CHMs and laboratory technicians, offers the medical services afforded by the MHU as well as a more extensive treatment capability.

This combination of capabilities, interconnected throuth the relay station (Fig. 3-9) enables patients at the remote clinics to be diagnosed by the physician at the hospital and to be immediately treated by the CHMs in the clinic under the physician's direction. The patient visits are accomplished in minimum time, and the patient travel time is also minimized.

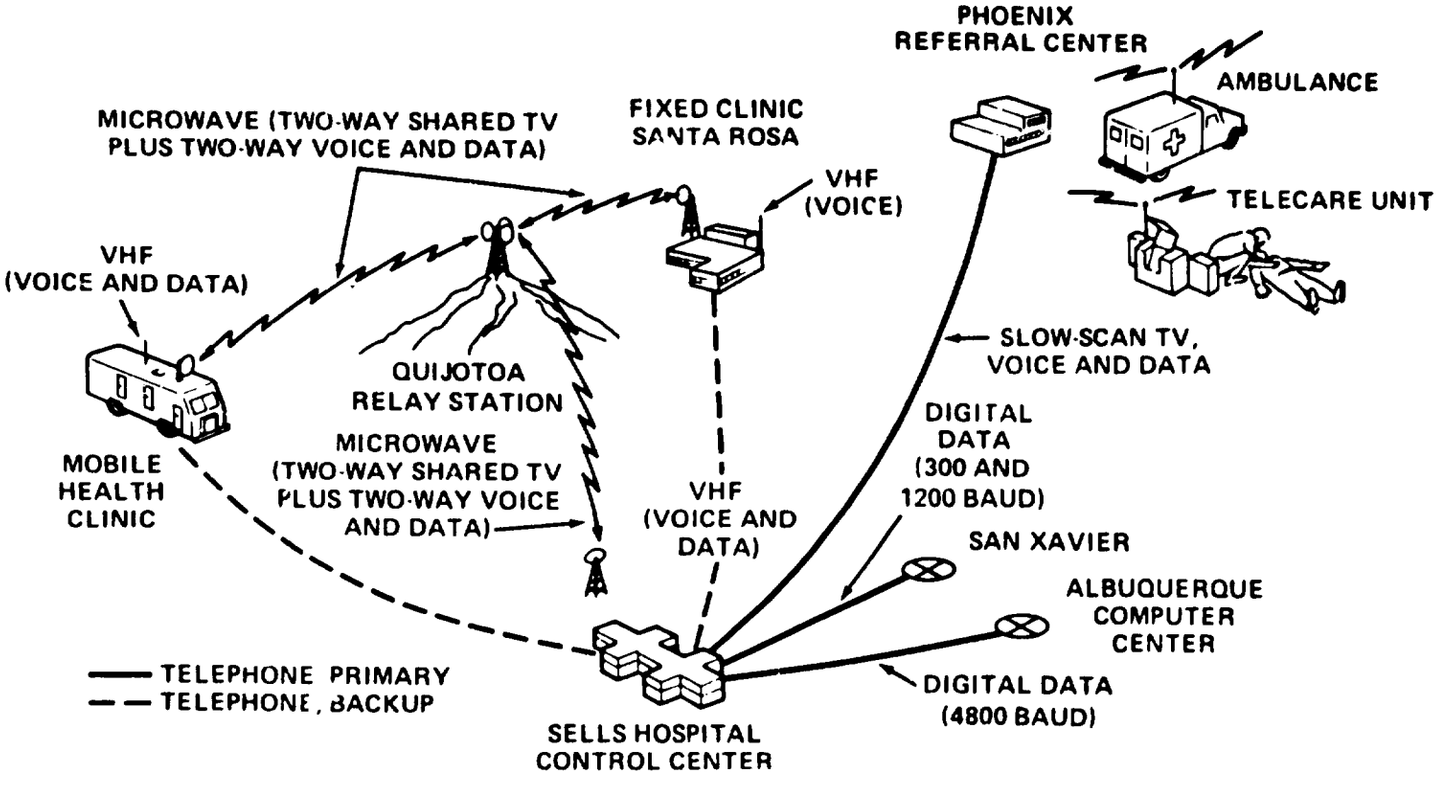

Fig. 3-5 STARPAHC System Concept

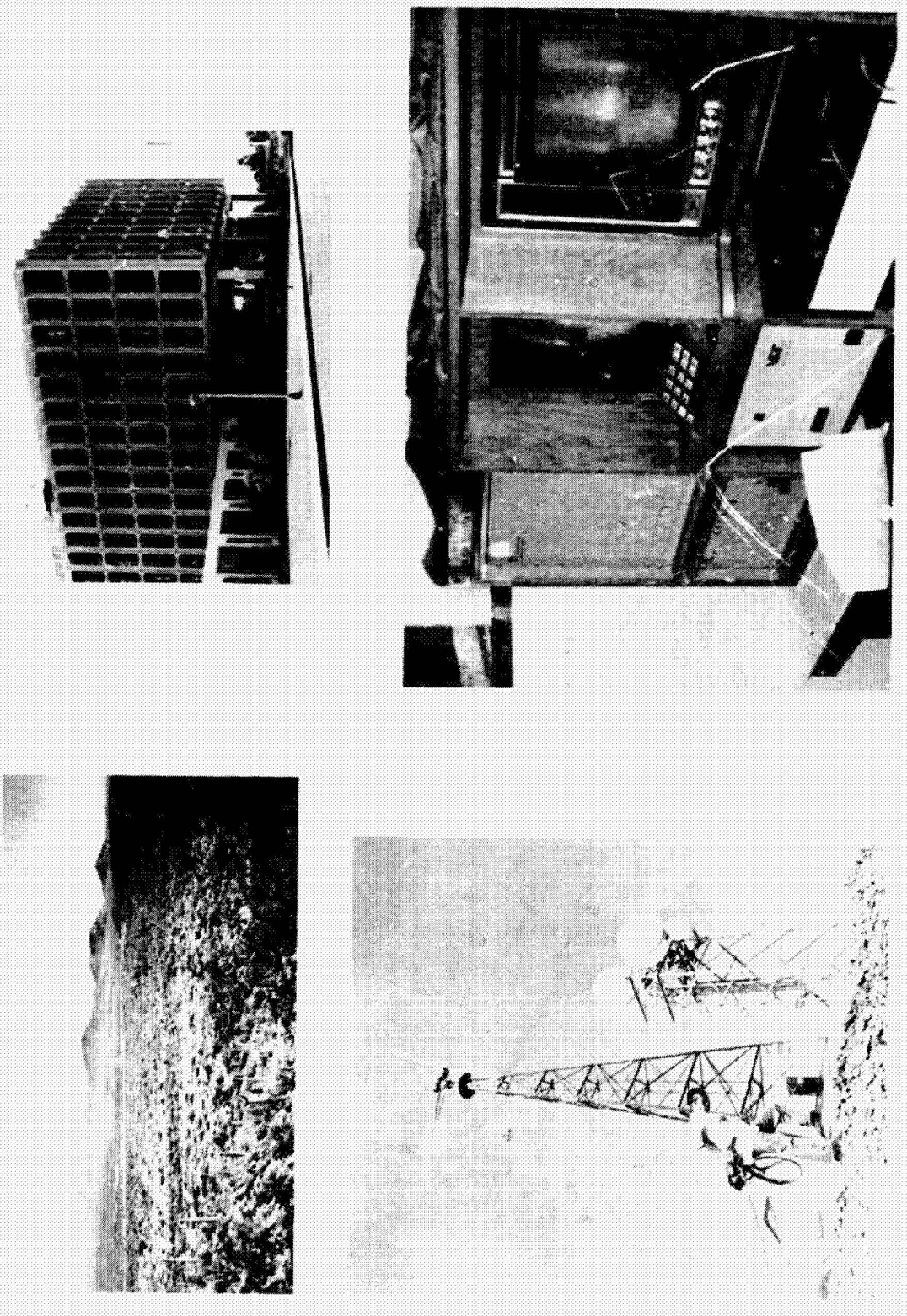

Fig. 3-9 Quijotoa Relay Station and Phoenix Indian Medical Center

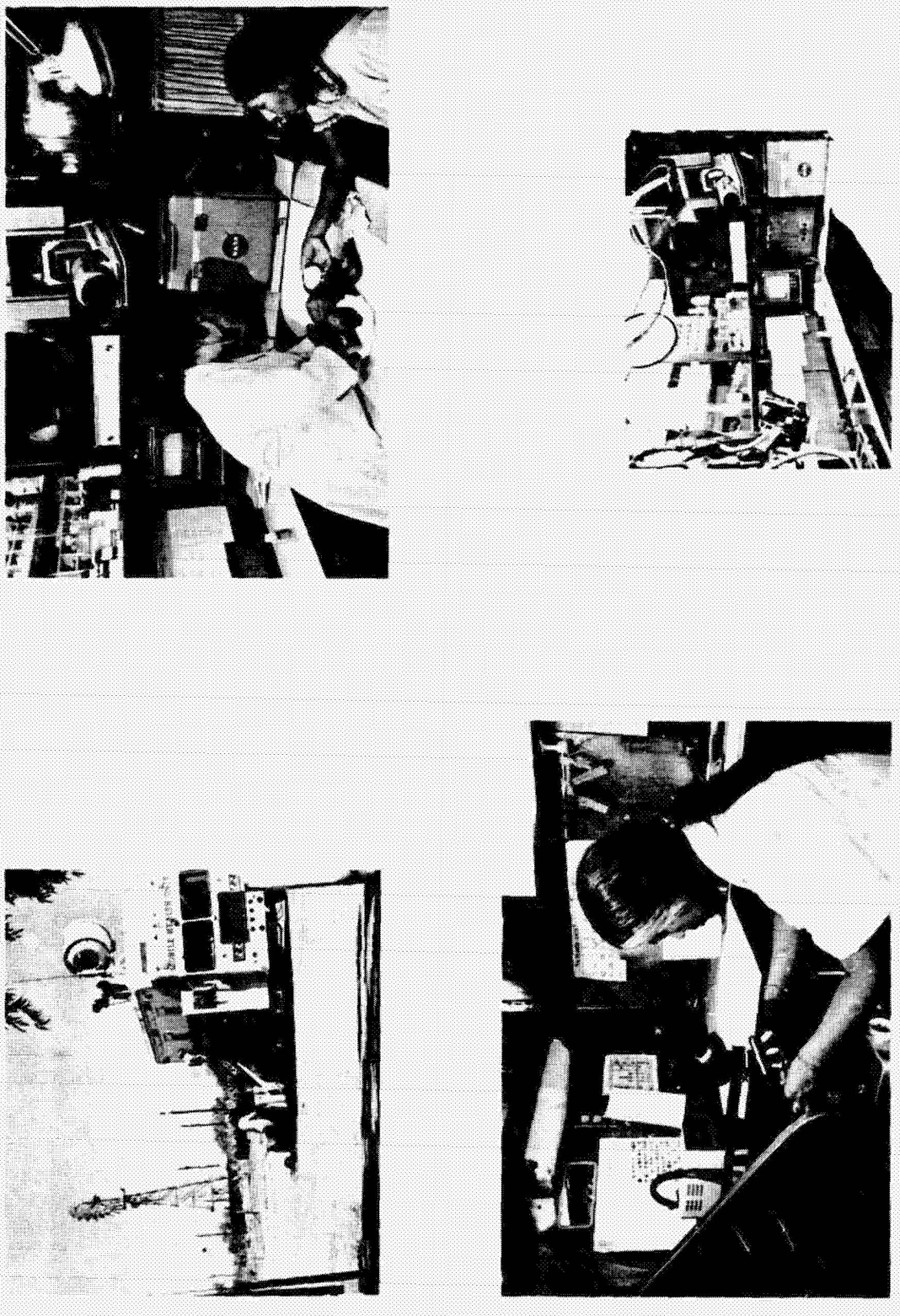

Fig. 3-7 The Mobile Health Unit

Fig. 3-6 Support Control Center at Sells Hospital

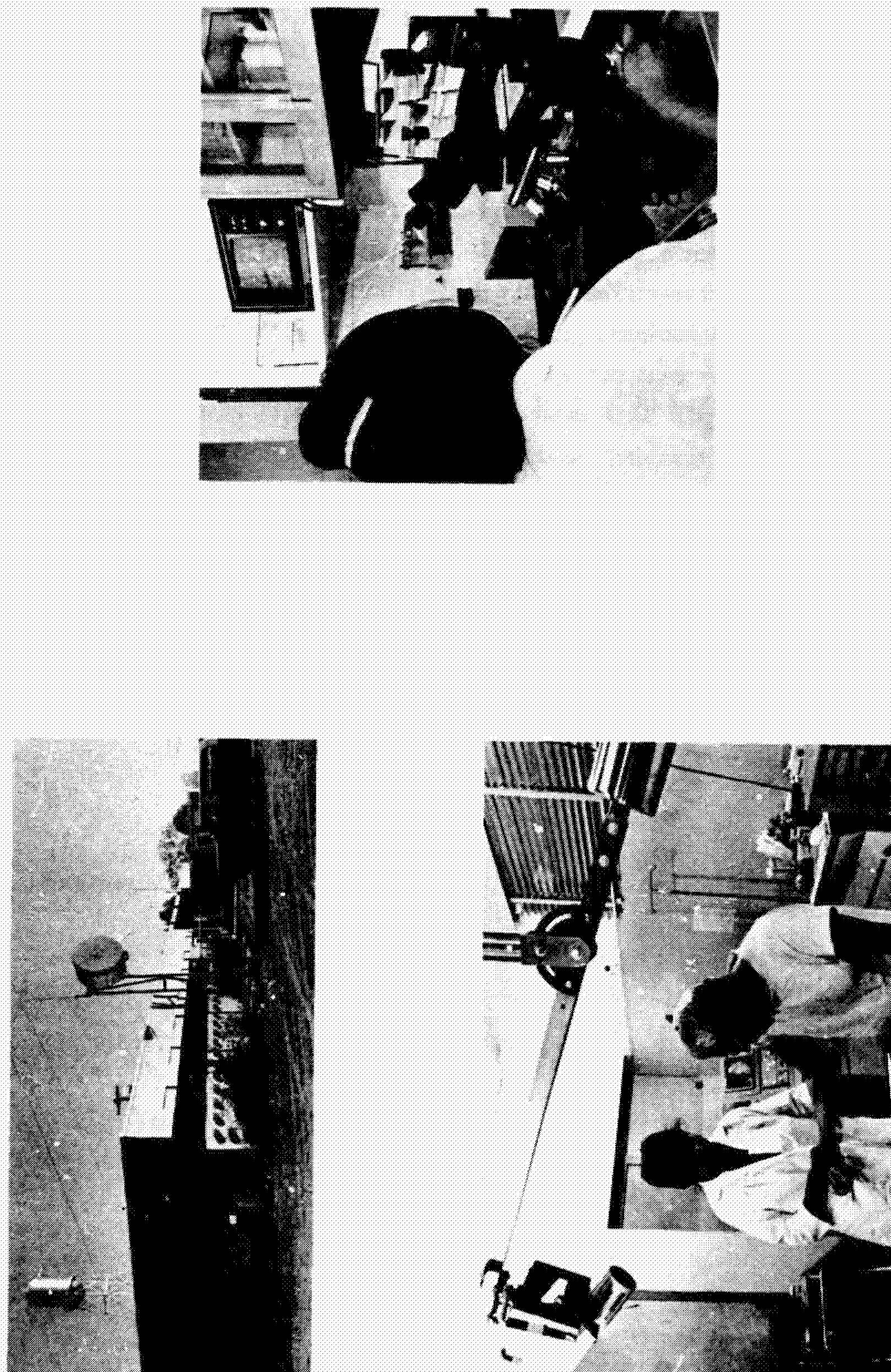

Fig. 3-8 Fixed Clinic at Santa Rosa, Ariz.

Another outstanding innovation in STARPAHC is the slow-scan video system. By use of "dial-up" telephone lines, high-quality single-frame color and black-and-white video can be transmitted to the Phoenix Referral Center (Fig. 3-9) for study of the subject matter by medical specialists. In routine use, x rays, microscopic slides, and views of patients are transmitted on real-time TV from the mobile and fixed clinics to the control center at Sells Hospital (or originated at Sells), where the video signal being received is transmitted via the dial-up slow-scan video link to Phoenix for additional study and consultation. The video images received at Phoenix are displayed on monitors and/or recorded on a disk and video tape recorder for later playback and study, if required. This capability is proving to be an extremely valuable tool for consultation (and teaching), and one that gives the patient in the most remote area direct, timely access to some of the finest physicians and specialists.

Section 4

OPERATIONAL RESULTS

The major goal of the STARPAHC project was to evaluate the value and potential of telemedicine, using physician's assistants for providing quality health care delivery to people in a remote area. Generally, the program goals were to:

- Establish the feasibility of the STARPAHC concept in the delivery of health care.
- Gain information for developing health care systems for future manned spacecraft.
- Determine the constraints and capabilities involved in the interaction between physicians and nonphysician health care personnel.
- Determine effectiveness and exportability* of the STARPAHC technique.
- Define the additional developments that are needed and/or are most valuable to improving telemedicine and its exportable potential.

4.1 OUTSTANDING CHARACTERISTICS

The following outstanding characteristics may distinguish the STARPAHC project from the many others called telemedicine projects:

- STARPAHC is the only project where consumers, health providers, and engineers jointly developed the initial design requirements and cooperated in every step of the project, including operations.
- Today, STARPAHC may be the only project to operate in a large remote area for two years, serving a population of about 10,000 people.

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*Exportability is defined as "The potential for transferring in whole or in part, the STARPAHC concept, data, and information. Purposes may be to utilize for analyses or decision judgments in planning, engineering, and implementing telemedicine systems to meet the needs of specific operational sites."

- To date, the most extensive hardware, medical, and cost evaluation data for any telemedicine project have been collected during the two years of operation of STARPAHC.
- STARPAHC is the only system to continually upgrade capabilities with developing technological innovations.
- STARPAHC is one of the few telemedicine projects where significant cultural and language diversities were included in both the planning and operation phases.
- STARPAHC is one of the few projects directly associated with NASA and other space contractors whose engineers and physicians have had greater experience in the design and manufacturing of equipment to support remote health care.
- STARPAHC is the only project to operate within a rural comprehensive care setting, with as many and diverse types of health providers, e.g., MDs, DDSs, Pharmacists, Laboratory Technicians, Physical Therapists, Community Health Medics (CHMs), and Tribal Health Workers.

4.2 BASELINE COMPARISON

Baseline data on prior-to-STARPAHC operation was collected for the prior five years and was compared against the first year of STARPAHC (May 1, 1975 through April 30, 1976) and the second year (May 1, 1976 through April 30, 1977). Results of this comparison for the nine districts comprising the Papago reservation's main body were:

- There was increased utilization of all health care facilities after STARPAHC was initiated.
- There were increases in (1) the number of patient visits, (2) the ratio of patients to patient ambulatory care visits by district of residence, and (3) the percent of total population using services.
- Increases in the three factors itemized above were significantly greater for patients residing in the three most western districts whose closest and most frequently used health care facility was the Mobile Health Unit (MHU).

After STARPAHC was initiated, the health care facility received greater use; this indicated that the general health care objectives of the Papago Executive Health Staff and the Indian Health Services were being achieved.

Along with the increased utilization of health care facilities was the increased utilization of personnel other than physicians to provide direct health care. The number of visits to physician's assistants and LPNs, as well as the number of patient contacts by tribal health workers, were significantly increased.

A principle objective of the STARPAHC project was to improve or match the quality of care provided prior to STARPAHC. Results showed that:

- CHMs, working independently, achieved quality of care comparable to physician-staffed sites.
- The quality of care provided at the MHU is equal to or better than other health care facilities, whether staffed by physicians or CHMs.
- All health care facilities evaluated (Sells Hospital, San Xavier Health Center, Santa Rosa Health Center, and the MHU) demonstrated a quality of care equal to or better than that provided prior to STARPAHC.

4.3 MEDICAL TELECOMMUNICATION UTILIZATION

The utilization of telecommunication for patient consultations averaged 9.2 percent of the total patient visits. The MHU 2-year average was significantly greater than the average for the Santa Rosa Clinic (18.6 percent compared with 3.2 percent). This difference is partly attributed to the predominant use of telephone consultations at the Santa Rosa Clinic, which were not monitored, as contrasted to the MHU telecommunications, which were monitored. Routine school examinations and influenza immunizations at the Santa Rosa Clinic accounted for a large number of patient visits and this type of visit does not generate a need for remote consultation. This also helps to account for the difference in the percent of the total patient visits between the two health care facilities.

Of the 3,648 patient visits to the MHU during a 1-year period, teleconsultations were needed for 439 health problems – about 12 percent of all problems. Video teleconsultations, between the MHUs, CHM, and the Sells physician, were used for approximately 3.5 percent of all visits.

Accidents and injuries constituted the highest percentage of problems requiring telecommunications (38 percent out of the total of 79 accident diagnoses); skin disease was the next highest (27.9 percent out of the total of 179 skin diagnoses); and metabolic, nutritional and blood disorders required 21.4 percent out of the total of 206 disorders. Respiratory diseases resulted in the largest total number of diagnoses (771 or 21 percent of total diagnoses); however, they only required 55 telecommunications (7.1 percent of the total telecommunications).

Physician direction has been effective in diagnosing and/or treating patients by telemedicine in cases of fractures, lacerations, minor surgery, throat lesions, skin ulcers, snake bites, respiratory infections, and gastroenterities. Physician and CHM users have reported that the communication capability has been either critical or important and useful in a large percentage of the teleconsultations (86.3 percent).

4.4 VALUE OF VOICE AND VIDEO TELECONSULTATIONS

The quality of medical telecommunications as rated by the health providers (physicians and CHMs) during the 12-month evaluation period indicated that 85 percent of the total telecommunications were acceptable.

Video teleconsultations were used most often for help in diagnosis, treatment, or therapy. Voice telecommunications were used most often to gain information from the lab, records, and appointments.

During a 12-month period, there were 170 TV teleconsultations which resulted in 1) elimination of 49 physician or dental referrals, thereby eliminating the necessity for the patient to make round trips of from 76 to 150 miles and 2) 43 referrals which indicated the need for the physician - CHM interaction.

Physicians rated 78.3 percent of all TV teleconsultations and 72.5 percent of all voice teleconsultations as either critical or important and useful for proper care. On the other hand, CHMs indicated that they believed 93.1 percent of all TV teleconsultations and 97.0 percent of all voice teleconsultations were either critical or important and useful for proper care. CHMs believed that the video addition was important for their supervision and for reassurance by remote physicians. Video teleconsultations have resulted in immediate care being provided and in many hundreds of miles of patient travel saved.

4.5 RESEARCH EVALUATION OF SLOW SCAN TV

The evaluation of Slow Scan Television for remote medical consultations was conducted for three areas: radiology, skin tones/orbital pictures,* and microscopy. The general purpose of the radiology evaluation was to transmit randomly selected test films from the primary care hospital at Sells to an expert diagnostic radiologist at the Phoenix Indian Medical Referral Center and then to compare his readings (upon special reporting forms) with the originals. The general purpose of the skin tones/orbit picture evaluation was to determine how adequate transmitted color images are for diagnosis. The purpose of transmitting microscopic slide data was to test the usefulness, feasibility, and the overall capabilities of televised microscopy for interpreting smears of peripheral blood and bacterial specimens.

Radiology. A medical x-ray evaluation experiment was conducted during which selected test x-ray images were transmitted from Sells Hospital to the Phoenix Indian Medical Center to be read there by a radiologist. Excellent agreement (100 percent reliability) on the interpretation of the negative or positive pathology was obtained by the radiologist and the original interpretations; however, the radiologist had difficulty with lesions identification and location on the positive images. The explanation for the missed diagnosis was indeterminate. The radiologist stated, "Lesions were seen on the monitor, but were not appreciated when the film images were mixed in with normals during the transmission sequence." The need for training of the radiologist to interact with the video presentation is a valuable result of the evaluation. Another is the improvement of resolution.

*The term "orbital pictures" as used in this report refers to pictures of the eye and eye area.

Patient Examination. Specific experiments were carried out to determine the effectiveness of the color TV system to transmit adequate skin tones and orbital structure over the slow-scan TV from Sells to Phoenix.

The limitations of the camera capabilities and lighting resulted in inadequate color differentiation within the skin tone range of hue for diagnosis of dermatological lesions. Similar difficulties were encountered in ophthalmologic problems, where it was found that elevated light levels needed to produce adequate coverage caused the eyes to tear. The existing system requires considerable improvement by providing higher quality cameras and peripheral supporting equipment.

Videomicroscopy. Experiments were carried out to evaluate the quality of transmitted microscopic slide images over slow scan TV. It was found that out of the transmission of 110 slides of blood smears, 98 were judged to be of acceptable quality (89 percent). Out of 56 slides of mixed flora transmitted, 50 were judged to be of acceptable quality (89 percent).

The accuracy of reading 98 slides of blood smear was graded as 89 percent correct out of the total transmissions. The accuracy of reading 50 slides of mixed flora was graded as 58 percent correct out of the total transmissions.

Conclusions reached were that blood smears and large specimens could be transmitted over slow scan TV with acceptable accuracy. The mixed flora slide transmissions revealed that when the size of the cells was very small, the morphology and gram stain category of the cells were difficult to determine.

4.6 EQUIPMENT PERFORMANCE

The STARPAHC system equipment performed exceptionally well after the early months of shakedown were over. Significantly, the use of reasonably priced (commercial) off-the-shelf equipment has been a firm program rule. Historical reliability performance data on this equipment are sparse, contrary to popular belief, and quality control is

largely indeterminable. These factors contributed in large measure to early equipment failures, to the necessity of a "burn-in" period to establish performance, and to the importance of thorough system engineering and selective integrated system testing. Results to date strongly indicate that off-the-shelf equipment can be synthesized into a reasonably dependable and maintainable well performing telemedicine system.

An average of 273 patient visits per month were made to the MHU while Santa Rosa averaged 427 per month. 57.6 percent of all telecommunications were used for medical purposes. Teleconsultation between the physician and the CHM accounted for 25.7 percent of the total. An average of 308 telecommunications per month were held. The quality of transmissions, as measured by the system operators, was rated excellent/good 90.5 percent out of the total telecommunications.

The performance of 24 telecommunications equipment subassemblies was monitored during the two years of operation. Of the 7,390 uses, 120 were classified as having some equipment failure. The resulting performance acceptability ratio (PAR) was 98.4 percent for the entire two years. Telecommunications equipment for each 6-month period was used from 1,520 to 2,022 times, with corresponding reductions in failure rates from 43 to 19 from start to finish.

The MHU, on a schedule of four village stops per week, lost only 13 days of service in the two years and traveled 43,346 kilometers (26,940 miles). Twelve of the days were scheduled for major maintenance of the MHU. On only one of those days were alternate clinic arrangements not provided to the village scheduled for service. Trouble reports on the MHU vehicle and equipment diminished progressively, indicating the value of early remedial actions, preventive maintenance, and proper care.

4.7 USAGE OF TCE

TV microscopy had a low usage because of 1) a lack of training, knowledge, willingness, and familiarity with the microscope and slide image transmission, 2) priority given to high-density patient-load accommodation in preference to equipment set-up time, and 3) the limited need for that type of data.

Instruments used for examining inner orifices (ears, mouth, etc.), e.g., endoscope, had a low usage because their complex design was time-consuming to set up, oral pathology could be more easily achieved through attaching a close-up lens to a standard color camera, and excessive dust caused damage to fiberoptics. Other examining instruments that had low usage were the ECG and Heart Sound monitor. This low usage was attributed to the low evidence of heart disease in the Papago Indians, the lack of cardiologists at the Sells Hospital, and the opportunity for relatively easy referral to a hospital with a cardiologist.

Communication modes most often used were the dedicated voice channels of the narrowband system (hotline and hands-free audio channel). The wideband audio channel, which was a back-up to the prime narrowband audio channel, was seldom used because of the reliability of the prime audio mode.

The telemetry used for remotely controlling the TV cameras in the MHU and the Santa Rosa Clinic were used frequently by the physician and/or support personnel assisting the provider.

In summary, use of the TCE varied from high for the most direct means of communication (audio) to low for specialized instrumentation. Fifty percent, twelve out of the list of 24 TCE identified for STARPAHC, had high usage and accounted for 97.6 percent of the total use.

4.8 PROVIDERS' AND PATIENTS' ACCEPTANCE

A series of interviews was completed by a behavioral scientist from outside the Office of Research and Development. In general, most providers in contact with STARPAHC were interviewed.

Twenty-one physicians and five CHMs were interviewed. Six physicians stated that training in many cases was not enough and that retraining is needed if the equipment is not used constantly. More training was requested by one CHM. The majority of

physicians had not used computer or TV before STARPAHC; however, they had worked with physician's assistants.

It was reported, as anticipated, in 1.5 interviews out of 65 interviews (23 percent) that a teleconsultation – although acceptable – was not a substitute for a face-to-face encounter.

Major negative effects of telemedicine mentioned were time lost by physician when the CHM had to set up equipment for consultation or had to modify the set up, the physician leaving the patients in the hospital exam room while having to go to the special teleconsultation room, and time lost from equipment malfunctions.

The majority of physicians said the teleconsultation has resulted in change of treatment plans, and one physician reported that STARPAHC had given him more confidence in the CHM's ability to deal with patients and consequently gives the CHM more credibility and authority. Other changes in treatment reported were that more precise descriptions were required than in face-to-face encounters, and the CHM relies more on the physician and can show the area of the problem to the physician on TV.

Both the physician and the CHM felt that STARPAHC was useful in helping to learn about difficult cases as they came up. The potential value for education of physicians, CHMs, and the community was also mentioned.

Out of the twelve practicing physicians at Sells, five physicians said they had no consultation where voice communication alone couldn't have solved the problem. The other seven physicians at Sells said TV was important in making a diagnosis.

Only one physician was apprehensive about using TV and other STARPAHC equipment. The remaining eleven said they were either neutral or enthusiastic. The majority of interviews indicated that the providers thought that STARPAHC would be successful, attributed to the fact that the improved access afforded many Papago patients medical care. All providers see value in technology that provides better access of care to the patient and encourages more appropriate and equitable use of medical services.

The majority of Papago patients interviewed said 1) they liked the service provided (93.3 percent), 2) they liked the attitude of the mobile staff (100 percent), 3) questions had been clearly answered (75 percent), 4) waiting periods were about the same as at Sells Hospital (61.3 percent), 5) the MHU had not been late (74.1 percent), and 6) they prefer to visit the health service at the MHU site rather than go to either the Sells OPD or the Santa Rosa health center.

There was a requirement to transmit the physician's image from Sells Hospital to the MHU or to the Santa Rosa Clinic and then display it on a TV monitor. When asked the question of whether it was important to see the Sells physician on the monitor, 71.5 percent of the patients who were queried responded yes.

4.9 OPERATING COSTS

Cost considerations as evaluating factors must be viewed in the context of the principle goal of the program and that, as previously stated, is to provide quality health care to people in remote areas, both in the U.S. and internationally. Offering physicians excessive monetary rewards has not been a workable or permanent solution (although in isolated cases, it may have been an acceptable temporary measure). Therefore, when cost is being used as a decision and/or evaluation factor, it must be considered relative to the value and need for a solution to the problem of remote-area health care delivery. In this context, the STARPAHC effort was essentially for research and development and not "production."

To provide objective, accurate cost data, STARPAHC conducted a continuous, thorough cost analysis, considering both the recurring and nonrecurring costs for the system and each of its major elements and functions. Existing data reveal that the "cost per outpatient visit" figures are most meaningful and do equate favorably with costs for outpatient visits in comparable facilities without telemedicine capability. A comprehensive cost summary is contained in Vol. 2, which indicates that the total average annual recurring cost for all maintenance and operations resulted in a cost of $49.69 per outpatient visit (OPV).

To further understand the significance of cost per outpatient visit, one must consider other hypothetical applications of STARPAHC: the MHU and Santa Rosa Clinic could be operated either on a longer schedule (such as a 2-shift basis), or the patient density could increase significantly. In the former application, there would be additional costs associated with the salaries of the operating personnel; in the latter application, there would not be any cost increase. In both applications, one could expect a significant reduction in the cost per outpatient. In view of these potential operational changes, one must carefully assess the environment in which the system operates and recognize that cost per outpatient can be directly proportional to the number of outpatient visits, which can vary widely depending upon the application of the system. IHS projected costs of operating STARPAHC after the transfer from NASA resulted in certain economies effecting a reduction of OPV cost to $47.22 per OPV.

4.10 SOFTWARE PROGRAMS

The Health Information System, a computer-based source of patient histories, was invaluable in assisting the providers with up-to-date medical records. The STARPAHC computer performed the functions of 1) a data concentrator/port of entry for requests for this data and 2) the initial memory bank for STARPAHC medical data until confirmation of delayed entry into the HIS.

The Medics application software consisted of programs designed to interact with a user at his terminal. They supplied the user with 1) reports of medications due for inpatients, 2) a schedule for any clinic in the system, and 3) guidelines of care for diagnosing and managing some health conditions. These programs, except for scheduling, showed low usage because there was a low number of patient medications for a small hospital and communication between physicians and CHMs resolved most problems associated with diagnosis.

4.11 EXPORTABILITY

The STARPAHC concept, data, and information will be of benefit and significance to future planners of other telemedicine projects. The concept of interactive telecommunication between professional health care personnel operating from fixed and/or mobile

health facilities and physicians based at central hospitals has proven to be practical, and the quality of care has matched or has improved upon that provided by the conventional physician/patient relationship. Modification of the concept by placing less qualified (dependent) CHMs in the field monitored by more qualified (independent) CHMs has also proven feasible. Expanding the concept to include larger hospitals with medical specialization has been successfully demonstrated with research evaluation of Slow-Scan TV transmission for radiology, patient examination, and microscopy.

In Section 4 of Vol. 2, a cross-index between the report data and its location in the volume is provided to be of value in telemedicine planning. Information is provided regarding the various options that are available in terms of telecommunication equipment, computers, facilities personnel-services/skills, and logistics.

Telecommunications equipment (TCE) as defined for STARPAHC consists of the communication transceivers and their associated peripheral sensor instruments, such as the narrowband transceivers and an ECG recorder.

The selection of specific TCE is dependent on the system requirements. If voice/data transmission is the requirement, then there is a broad selection of RF equipment in the narrowband and VHF range. If video transmission is required, two options are available, wideband and Slow-Scan TV. If audio is also required with the video, program audio channels (hi-fi) can be provided with the wideband transceivers. The voice requirement is easily supplemented with Slow Scan by simply adding an additional telephone line. Twenty-four TCE items have been identified, and their performance is discussed in this report.

In future planning four basic communication modes can be recommended: 1) telephone link, 2) VHF, 3) narrow-band microwave, and 4) wideband microwave. The telephone link option provides the lowest cost option. Voice, data, and Slow-Scan TV can be transmitted using this option. ECG or any other data adaptable to the voice range can be transmitted over standard telephone lines. The VHF option permits a low-cost RF link that provides all the telephone link option capability plus the capability to transmit or receive while in transit.

The narrowband option permits multiple-voice grade channels, all the capabilities provided by the telephone or VHF, private dedicated (hotline) voice channels, and separate maintenance lines.

The wideband microwave option offers 1- or 2-way television images, 1- or 2-way voice, and all capabilities provided by the narrowband microwave option. There are advantages to combining some of the communication options. For example, VHF can be added at a low cost to provide a backup.

The decision-making processes for exportable models of the STARPAHC concept must be initiated by taking a systematic approach to defining a telemedicine system to meet the requirements of a specific locale. The starting point in the process is establishing criteria and guidelines for the concept. The criteria and guidelines that have evolved from STARPAHC are offered below as a model:

- The expertise of physicians (and other health professionals) is extended great distances by physician monitoring of the remotely located CHM. Visible and audi' ' communication should be provided.
- Easily accessible points of entry into the health care establishment should be provided by appropriate combinations of fixed and mobile facilities.
- Scr.'ening and routing patients by a central control are required.*
- Unique technology and management skills tailored to the environment and patient need should be applied.
- The maximum use of existing medical establishments and capabilities should be applied.
- Restraints imposed by unique soc.al, economic, and health characteristics of the locality under consideration must be recognized.
- System design must be amenable to orderly, expeditious extension. The basic design should be applicable to all future-area situations.

The end products of the decision-making process are 1) criteria and guidelines, 2) a selected configuration, and 3) basic system requirements. These products now permit the orderly initiation of a system engineering effort to give further definition to the

*Triage is a local function.

concept, and establish end item specifications and the preliminary design. Further sequential action requires the detailed design, fabrication/assembly, test, and operation. Cost estimates can be generated early and refined as the program progresses.

Export decision influencing rationale and test candidate concepts can be compared against these factors: 1) accessibility – improve access of rural patients to health care through use of interactive telemedicine, 2) quality – provide quality of care equal to or better than that previously available, 3) acceptability – ensure acceptability as perceived by the involved providers and patients, 4) cost (to the patient) – equal or below that of conventional health care, 5) funding – capital costs to be competitive with alternative forms of health delivery, 6) hardware – reliability and maintainability, 7) growth potential – ability to perform research and testing, 8) population shifts – response of the system to population changing location, and 9) service demands change – response of system to an increase/decrease in utilization.

Another means of approaching exportability analysis for STARPAHC specific alternatives is contained in reports and studies conducted for IHS (Vol. 1, Project STARPAHC Export Decision Model Preliminary Report, August 1977). A summary of this report is provided in Vol. 2, STARPAHC Performance Evaluation, Section 4. The following is a brief description of the results of the analysis.

Table 4-1, Mathematical Model, presents in summary form the computed decision values based on analysis of five program objectives and five alternatives. Subtotals are shown for total program values, cost/funding decision values, and the performance index.

The Mathematical Model presents the total program values and the values of each objective for review and comparison. The cost/funding decision values, the performance index, and the total decision values may then be compared with total program values. The decision process highlights the program values or benefits against costs and performance indicators.

Table 4-1

STARPAHC – PRELIMINARY EXPORT REPORT MATHEMATICAL MODEL

		Alternative 1 One Mobile & One Fixed Clinic Wide & Narrowband Microwave System VHF or UHF Radio		Alternative 2 One Mobile Clinic Wide & Narrowband Microwave System VHF or UHF Radio		Alternative 3 One Fixed Site Clinic Wide & Narrowband Microwave System VHF or UHF Radio		Alternative 4 One Mobile & One Fixed Clinic Narrowband Microwave Multiplex System VHF or UHF Radio		Alternative 5 One Mobile Clinic No Microwave VHF or UHF Radio and/or Phone	
	Weight	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value
Program Objectives											
1. Accessibility	20	1,608	32,150	1,680	33,600	1,326	26,525	1,648	32,950	1,750	35,000
2. Quality	20	1,675	33,500	1,688	33,750	1,663	33,250	1,600	32,000	1,388	27,750
3. Acceptability	20	1,713	34,250	1,763	35,250	1,688	33,750	1,550	31,000	1,456	29,125
4. Hardware & Systems	20	1,438	28,750	1,388	27,750	1,500	30,000	1,650	33,000	1,738	34,750
5. Adaptability	20	1,819	36,375	1,838	36,750	1,738	35,750	1,688	33,750	1,350	27,000
Total Program Values			165,025		167,100		159,275		162,700		153,625
Cost/Funding Decision Values			11,496		17,608		17,294		15,128		45,184
Performance Index			33,600		7,020		26,580		35,004		9,459
Total Decision Values			210,121		191,728		203,149		212,832		208,268

4.12 SIGNIFICANCE OF FINDINGS

The major goal of the STARPAHC project, "to provide quality health care to people in a remote area," has been achieved. The general goals of the project and the assessment of our performance in meeting these goals are addressed below.

Feasibility of the STARPAHC Concept. The STARPAHC concept is indeed an effective, realistic way to administer quality health care to people isolated in remote areas. There have been overall increases in the utilization of all health care facilities and appreciable increases in the utilization of both the mobile and fixed clinics. The quality of care administered by CHMs at these facilities has been rated as "better than or as good as" that administered in facilities staffed by physicians and other health professionals.

Interaction Between Physicians and Nonphysicians. Physician direction has been effective in diagnosing and/or treating patients by telemedicine in a wide variety of case types. Physician and CHM users have reported that the telecommunication capability has been either critical or important and useful in 86.3 percent of the teleconsultations for providing proper treatment and diagnoses. A major value of the telediagnostic capability is reassurance to the initiator that the proposed treatment plan is satisfactory (whether the initiator is a CHM or a physician).

Exportability of the STARPAHC Concept. The STARPAHC approach to providing access to quality health care at remote locations may be a model for other health care delivery systems. If, in fact, the problem of remote health care is of the magnitude and importance indicated by the news media and statistical data – and it is – those charged with the responsibility of providing care to remote areas (local community, state, national, and international) should seriously consider implementing programs that use the knowledge and data gained through STARPAHC.

The feasibility determination of the STARPAHC concept for remote-area health care delivery is indicative of future growth potential. As a first step, one-of-a-kind demonstration system, its possibilities for exportability, growth, and expansion appear to be very good.

Any combination of the major system elements can be used singly or in multiples to accommodate the specific needs of each area. The present and near-future communication satellite capabilities enable any degree of partial or total service networks to be synthesized and to go beyond regional medical centers to national medical centers and, perhaps, to international medical centers. Section 4 in Vol. 2 explores the potential of the STARPAHC system and its elements for application to other localities.

Medical/Engineering Evaluation of the Value and Potential of Telemedicine. Video teleconsultations were used most often for help in diagnosis or therapy while voice communications were used most often to gain information from the lab, records, or appointments. TV teleconsultations resulted in elimination of unnecessary referrals or decisions to include needed referrals. These decisions resulted in immediate diagnosis and treatment and in a savings of many hundreds of miles of patient travel. Physicians indicated that 78.3 percent of all teleconsultations where TV was used were either critical or important and useful for proper care. Seventy-two and five-tenths percent of all voice teleconsultations were judged similarly.

It has proven feasible to design, construct, test, operate, and maintain a reliable telemedicine system in a remote environment. The performance and qualify of the system were rated high. Maintenance was within the capability of the crew. Computers were valuable in storing and providing current patient histories to the field health care personnel. Computers were also useful for storing evaluation data and providing statistical analysis.

In summary, the STARPAHC project has demonstrated that telemedicine with the use of physician's assistants is one answer to the problem of providing quality health care to people in isolated areas and, indeed, may be the only practical way of providing health care in a world of ever-increasing population in dire need of such care.

Section 5

CONCLUSIONS

The major goal of the STARPAHC project was achieved – "to evaluate the value and potential of telemedicine using CHMs for providing quality health care to people in a remote area." Additional goals met were (1) establishing the feasibility of the STARPAHC concept in the delivery of health care, (2) gaining information for developing health care systems for future manned spacecraft, (3) determining the constraints and capabilities involved in the interaction between physicians and nonphysician health care personnel, (4) determining the effectiveness and exportability of the STARPAHC technique, and (5) defining the additional developments that are needed and/or most valuable to improving telemedicine and its exportability potential.

It has proven feasible to design, construct, test, operate, and maintain a reliable telemedicine system in a remote environment. The performance and quality of the system were rated high. Maintenance was within the capability of the site crew.

5.1 MEDICAL CONCLUSIONS

The STARPAHC concept is indeed an effective, realistic way to administer quality health care to people isolated in remote areas. There have been overall increases in the utilization of all health care facilities and appreciable increases in the utilization of both the mobile and fixed clinics. The quality of care administered by CHMs at these facilities has been rated as "better than or as good as" that administered in facilities staffed by physicians and other health professionals.

Physician direction has been effective in diagnosing and/or treating patients by telemedicine in a wide variety of case types. Physician and CHM users have reported that the TCE capability has been either critical or important and useful in 86.3 percent

of the teleconsultations for providing proper treatment and diagnoses. A major value of the telediagnostic capability is the reassurance to the initiator that the proposed treatment plan is satisfactory (whether the initiator is a CHM or a physician).

Utilization of the combined fixed and mobile facilities resulted in an increase in 1) the number of patients, 2) the number of individual patients treated, and 3) the percentage of total population. A significant part of the increase resulted from deploying the mobile facility to a remote part of the reservation that was under-utilizing health services prior to STARPAHC.

The five most valuable capabilities of STARPAHC, in the opinion of the providers, were 1) computerized health records, 2) audio teleconsultations, 3) the mobile health unit, 4) Color TV, and 5) B&W TV. Slow Scan television was not rated in the above context.

Providers have negative as well as positive attitudes; they have problems accepting equipment malfunctions and making time for consultations plus overcoming old biases and parochial attitudes toward innovative practices. It is important that providers be sufficiently trained and that they be made to feel part of the system through early involvement and organizational responsibility. All providers recognize the significance of providing the Papago people with better access to good care.

Research evaluation of Slow-Scan TV for the diagnosis of x-ray images, patient examinations, and microscopic slide images concluded that quality visual data presented to the specialist were effective. More experimental work is needed in this area to refine equipment and procedures and enhance the total capability.

The patients report considerable satisfaction with the services provided. The Mobile Health Unit is the most important aspect because it provides health service to the western districts which prior to STARPAHC received less than the other districts. The acquiring of immediate care plus time saved for a patient in an outlying village receiving remote health care compared to the delays associated with his visit to the central hospital is one of the significant side benefits. Another benefit is his imminent return to productivity.

The cost per outpatient visit (OPV) for STARPAHC patients is $49.69. This compares favorably with other telemedicine project costs and is reasonable for providing health care to remote areas.

Projected costs during the on-going IHS operation resulted in certain economics that are reflected in costs per OPV of $47.22. Further reduction in cost per OPV can be effected if the number of patient visits increases and/or fixed and mobile clinics are operated on a longer schedule.

5.2 ENGINEERING CONCLUSIONS

Commercial off-the-shelf equipment can indeed be synthesized into a reasonably dependable, reliable, and maintainable system. (For example, out of 7,390 telecommunications during the May 1975 to May 1977 time period, there were 120 failures, resulting in a 98.38 percent performance acceptability ratio.) High maintainability with minimum down-time requires skilled maintenance technicians, adequate spares, and a redundant audio-communication mode.

Operation in a rural desert environment requires attention to several unique situations. Power in rural areas is not stable enough for equipment operation. All equipment that can be should be powered from D.C. power supplies. Where it is necessary to provide A.C. – e.g., for a computer operation – an uninterruptable power system (stable AC power) should be specified. Sensitive equipment installed in mobile units should be shock-mounted. Protection from dust should be provided, particularly for optical equipment. Grounding and lightning protection must be installed. Grounding is particularly difficult in rocky ground. Eight-foot copper rods (5/8-in.-diameter) must be buried and, in many cases, must be wet down to create an effective ground. Temperature and humidity controls on sensitive electronics are vital to their reliable performance. Temperature compensating devices such as transmission coolers, oversize capacity radiators, etc., should be considered when designing rolling stock.

High or low equipment utilization was found dependent on the capability of the provider, the medical need of the measurement, and the provider's assessment of its value.

Some equipment was beyond the capability of the provider regardless of training while others were not needed because of low incidence problems. Computers were found valuable in storing and providing current patient histories to the field health care personnel. Software application programs designed to give special aid to the CHM or the hospital nurses and pharmacists were not used frequently because of the low need resulting from the ease of communicating with the physician. These programs would probably be very useful in a larger (350 bed) hospital and telemedicine network.

5.3 SUMMARY

The STARPAHC concept verified the feasibility (telemedicine plus physician assistant -- under the direction of a physician) of delivering quality health care to people in remote areas. The two years of operational evaluation have provided considerable medical and engineering data which will be valuable to the designers and planners of future health care systems on earth and in space.

The anticipated plus the known benefits demonstrated by STARPAHC will, in time, prove the foresight of those who were willing to initiate this innovative and unique health care approach. STARPAHC provides a direly needed solution to the major problem of delivering quality health care to people in remote geographical areas.