AIAA AND AEROSPACE MEDICAL ASSOCIATION
MANNED SPACE LABORATORY CONFERENCE
STATLER-HILTON HOTEL, LOS ANGELES, CALIFORNIA MAY 2, 1963

63131

AN EVALUATION OF SPACE RESEARCH REQUIREMENTS

by
ROBERT F. TRAPP
Office of Advanced Research and Technology
National Aeronautics and Space Administration
Washington, D.C.

63131

RETURN TO C-250 TECHNICAL LIBRARY
Copy No.

First publication rights reserved by AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, 500 Fifth Ave., New York 36, N.
Abstracts may be published without permission if credit is given to the author and to AIAA.

MANNED SPACE LABORATORY CONFERENCE

KEYNOTE PRESENTATION

AN EVALUATION OF SPACE RESEARCH REQUIREMENTS

by Robert F. Trapp*

63131

We are here today to discuss the technical aspects of a new class of space systems. New in the sense of aerospace developments, yet one of the earliest manned space systems to be conceived and discussed.

In the strictest sense, we are here to discuss manned space laboratories; facilities whose prime utilization falls in the areas of both basic and applied research. One important basis for this research is that man will continually search for greater knowledge and attempt difficult missions to gain that knowledge. Exploration of outer space is the "new frontier" in that search for knowledge.

A part of the analysis of manned space laboratories and their application is the determination of laboratory functions. The functions are, however, largely attempts to provide solutions to scientific or engineering problems which are in turn oriented toward an application of the particular knowledge. Thus, it appears that by anticipating the space missions of the future, one can work backward through mission phases and functions to anticipated problem areas. The delineation of such problem areas points out the key features in a research program oriented toward the chosen missions. Problems requiring a space laboratory for investigation can be so selected.

As a sample of the application of this rather straightforward logic let us consider four possible future space missions: lunar base, operational space station, planetary flyby, and planetary landing. General specifications must first be assumed for the chosen missions. By assuming scheduling for the missions, required scheduling for the research programs leading to the flights can be generated.

<u>Lunar Base</u> - This mission involves the establishment of housing and experimental facilities on the lunar surface or subsurface following initial explorations using Apollo. Such a base may house 12-24 men, their

* Chief, Man-Systems Integration Division
Biotechnology and Human Research
Office of Advanced Research and Technology
National Aeronautics and Space Administration
Washington, D. C.

exploration and experimental equipment, and supply their communications, shelter and life support requirements. The crew members would probably be subject to six months duty at the base. The base would be expandable in size. Additional boost stages may be required beyond the Saturn V - Apollo program in order to provide support. The base might be established by 1970.

Operational Space Station - This mission involves the establishment of an orbital base of several years duration. Base resupply would be required. The size, limited by booster availability, would probably match the 200,000 pound orbital capability of Saturn V. The base will be manned with a crew of 12-24 men to be rotated on a six month schedule. The station may or may not be rotated to provide an artificial gravity. The station functions will be for operational earth and space observation and communication in addition to experimentation on and in the space environment. The orbit altitude should be above the drag regime but below the radiation belts. Such a base could be operational in or about 1970.

Planetary Flyby - This mission involves manned flights to Mars, Venus, or both flown on hyperbolic grazing trajectories chosen to orient the flight path for return to earth. This mode is chosen to achieve short transit times with minimal energy expenditure. The flight would provide direct visual observations of the planet from close proximity. Mission duration would be a minimum of one year. The crew size would be small, possibly three to five. Such a mission may be feasible based upon Saturn V boost and rendezvous although the C-5N would be preferable in performance. This mission might be feasible for 1971-73.

Planetary Landing - This mission incorporates the early manned exploration of Mars or Venus. It is possible that such might be accomplished by 1975. Much of the required spacecraft hardware required would be new development. Nuclear stages will most certainly be required. This mission would be, at a minimum, of one year duration but would be limited to less than two years. Individual portions of the spacecraft system may be designed for limited reuse. The mission may well require the steps of earth orbital rendezvous, establishment of orbit about the target planet, aerodynamic entry at the target planet, extended stay time for the exploratory party (on the order of 30 days), boost to orbit rendezvous, and return to earth where aerodynamic entry would be used. A crew of three to five persons is expected on this mission.

Having set the scope of missions under consideration it is then necessary to examine them in more detail by mission phase to identify the potential problem areas. Analysis of individual missions can be based on mission phase and specific tasks to be considered. To assure general coverage of tasks, a division of pre-mission, mission, and post-mission can be used. A typical set of pre-mission tasks (Figure 1) can be found to range from environmental and static testing facilities requirements, launch and recovery site and range selection, ground equipment design and checkout, and launch and flight crew selection and training, on to the actual launch itself. The mission phase involves trajectory analysis and adherence, safety and hazards, rendezvous requirements, flight duration, flight environment, unusual task assignment, functional analyses, communication, measurement and control of critical flight and habitability variables, trip time, crew size, shielding requirements and many other considerations through and including the recovery operations. The post-mission analysis will include consideration of transportation requirements, crew debriefing, vehicle refurbishment, data reduction and analysis, and other tasks leading to the successful accomplishment of the mission.

Following through this functional analysis of the various missions and considering key technological areas, forseeable problems and required developments are more readily ascertained. Individually or collectively the above mission analyses indicate the requirement for a wide range of research and development tasks. However, these task analyses based upon specific missions only partly suffice in determining required research for mission accomplishment. We are currently using an additional technique within our office in NASA. This technique is a matrix approach to evaluating knowledge existing and required in various research, technology, and task areas. Figure 2 outlines the major aspects of this evaluation technique. First the mission must be specified and broken into its various systems and subsystems.

As you can clearly see this approach first breaks down the mission into seven or eight sub-levels. depending upon possible consideration of an atomic level below the indicated chemical level. The chart also breaks out separately the man, machine, and vehicle as part of the overall system. Notice that within each of these boxes there are subportions labeled E, C, F, and M. These stand for environment, configuration, function, and material which are essential elements of each and every box on the chart. Each box on the chart is a matrix of the technology at the particular level of detail.

In order to illustrate this chart by an example, I will choose from the previous mission analysis the fact that each man will be, unless other provisions are made, in a zero or greatly reduced acceleration state for long periods of time. I have chosen a particular box in the matrix of man vs. environment; under or within this box is another matrix which is man's body system vs. the particular types of environment. This is shown on Figure 3. Within each of the boxes on this chart information can be listed which gives the state of knowledge of interactions at that level. For further breakdown into detail, each specific body system such as the cardiovascular system may be investigated as a function of the various aspects of acceleration as shown in this slide (Figure 4). In this manner a logical technique is used to call out areas of important technical interaction to be checked against the specific definition of the mission for relevancy.

At this point it becomes fairly clear what the roles of the two techniques are and how they interrelate. The first method is a detailed mission description which covers all aspects of the mission accomplishment. The second technique is a general research information evaluation which when correlated with mission requirements can yield a summary of existing knowledge and required research.

This meeting today concerns itself with an item which may be derived as a necessity by the above logical analyses. They are used to generate a list of problems and a research program for their solution. It is in the establishment of facilities and techniques for accomplishing the research that the manned space laboratory falls out. It is a required facility in which many space research and development tasks must be performed. It is partly because the manned space laboratory is a facility and not a system for mission utilization that its justification process has been slow in evolving.

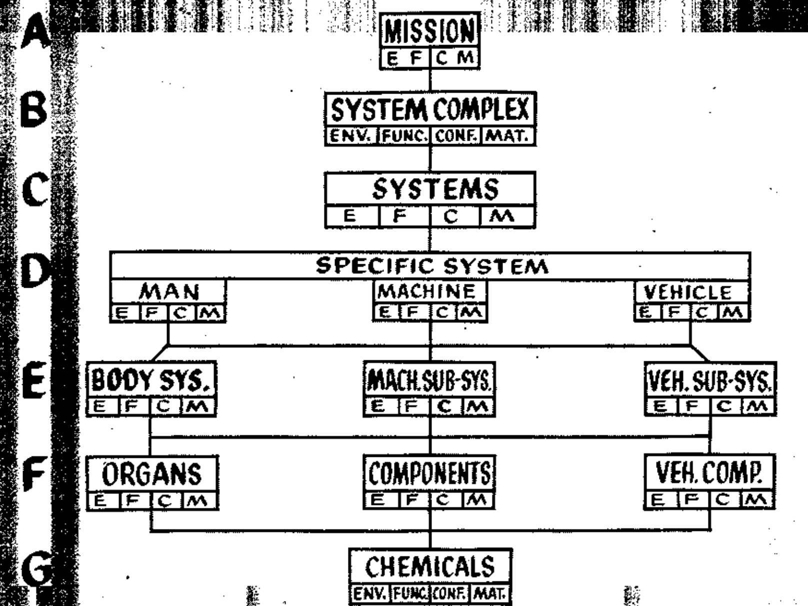
A definite requirement exists for a manned space laboratory. The only prime justification for the laboratory is for the performance of research on the pysiological, psychological and performance aspects of long duration weightless manned flight and attendant problems such as enduring reentry following prolonged weightlessness. Key among the secondary reasons for the manned laboratory are experimentation in the weightless environment in which man is an integral part or in which he adds measurably to the value of the experiment. Of the other research efforts which require flight accomplishment, many can be more efficiently done without the manned system. This does not diminish however the fact that the manned space laboratory is a required step toward future manned space accomplishments.

In summary it can be noted that a vigorous completion of a mission analysis essentially breaks out all requirements in the development and operation of the particular mission. As such, I have only included a few key aspects to provide guidance as to use of the evaluation technique. A similar completion of the matrix analysis is even broader in that it would show the current status of all technology. In applying these techniques to the manned space laboratory or that is to the previous missions and similar missions which yield requirements for the laboratory, one finds a simplifying feature which, once again, through logic, might have been anticipated. The manned space laboratory is required almost exclusively as a research facility which can provide experimentation in zero or reduced levels of acceleration.

It should also be noted that if those of us in the research end of the technological spectrum are to accomplish our jobs properly, we shall perform the research and necessary prototype development to make available the basic technological information required in the performance of a particular new project by the time of project approval. Thus one can readily investigate the schedules of possible flight dates for the missions discussed earlier and deduce a requirement for immediate activation of the manned space laboratory as an experimental facility. If we even consider accomplishment of major missions with 1970 dates, then projects must be activated by the 1966-1967 period. To produce research and development information from a space laboratory by that time is a formidable, but not impossible, task to which we must address ourselves. This conference will be a contributing factor to that accomplishment.

MISSION: EARLY MANNED ORBITAL SPACE LABORATORY

MISSION CONSIDERATIONS			
PRE MISSION	LAUNCH SITE LOCATION LOGISTICS LAUNCH SITE OPERATIONS REQ. PERSONNEL REQ.	SELECTION AND TRAINING SAFETY ASSEMBLY CHECKOUT RELIABILITY GROUND CREW ENVIRONMENTAL REQ.	
MISSION	SAFETY REQ. LAUNCH ABORT RENDEZVOUS RESUPPLY RESCUE	LAB CREW SIZE & ROTATION TIME STABILIZATION AUX POWER ENVIRONMENT LIFE SUPPORT	PROTECTIVE SYSTEMS CREW PERFORMANCE CREW FUNCTIONS < EXP. OPS. CONTROLS & DISPLAYS COMMUNICATIONS REENTRY
POST MISSION	RECOVERY TRANSPORTATION MEDICAL EXAM.	CREW DEBRIEFING DATA EVALUATION	



E=ENVIRONMENT F=FUNCTION C=CONFIGURATION M=MATERIAL

E

HUMAN RESEARCH

BODY SYSTEMS / ENVIRONMENT	ACCELERATION	ATMOSPHERE	RADIATION	THERMAL
INTEGRATED (TOTAL)				
CARDIO-VASCULAR				
DIGESTIVE				
EXCRETORY				
GLANDULAR				
INTEGUMENT (SKIN)				
MUSCULO-SKELETAL				
NERVOUS				
RESPIRATORY				
SENSORY				

F

HUMAN RESEARCH

CARDIOVASCULAR SYSTEM / ACCELERATION	ZERO G	SUB G	LINEAR G +	LINEAR G −	VIBRATION	NOISE
HEART						
CORONARY ART.						
PERIPHERAL ART.						
VENOUS SYSTEM						