DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON 25, D.C.

8 MAR 1964

MEMORANDUM FOR THE UNDER SECRETARY OF THE AIR FORCE

I am enclosing a memorandum on the purpose of the MOL program which I believe you have already seen. As you know from discussions between my staff, you, Dr. Flax and General Schriever, a list of possible MOL experiments, together with a brief statement of their military and/or scientific significance, must be submitted by the Air Force to the Secretary of Defense.

Since the Secretary of Defense wishes to approve these experiments before he releases the study funds for the MOL program, it is desirable that this approval precede the consideration of a Technical Development Plan. May I request that the Air Force, with your guidance, submit such a list by March 16.

Signed
Eugene G. Fubini

Harold Brown

Enclosure
a/s

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DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D.C. 20301

March 5, 1964

MEMORANDUM FOR DR. BROWN
DR. FUBINI

SUBJECT: Experiments for the MOL, and the Purpose of the MOL Program

I. Introduction

A vigorous and productive discussion has taken place in the last month or so which has analyzed the purposes of the MOL, and, in the process, has sharpened and better defined the rationale and guidance which is necessary to permit proceeding with the next phase of the MOL. While there are still some remnants of apparent differences in view, we have progressed to the point where substantive differences are ones of degree, at the most, and not any longer ones of basic concept or purpose. We believe that these common current views are adequate to provide authoritative guidance to the USAF to pursue the next phase of effort. During this phase of effort, observation experiments should receive careful and predominant attention. Several alternatives of experimental equipments and procedures should be pursued, possibly in combination. Prior ground simulation experiments should be thought through in detail; critical factors to be measured and observed in orbit should be identified, and the equipments and measurements examined for their definition and constraining of the MOL configuration. As a result of this phase of effort, we should be able to proceed with an authoritative plan to define the basic spacecraft configuration and overall program, and initiate an intensive program of ground or aircraft simulation and detailed formulation of the critical orbital experiments. The following sections II, III, and IV develop these considerations.

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II. General

A. We believe that, if we want to determine the capability of men in the performance of military missions in space promptly and efficiently, we must minimize the cost of the experimental program, and yet make it orderly, well defined, and comprehensive even if this leads to decisions which may postpone the initiation of work aimed at operational capabilities until the time when experimental success has been achieved. This is a fundamental, necessary principle on which this memorandum is based. The principle has two main aspects: the cost of arriving at key technical decisions is minimized, but the experimental program must be complete, and self-contained, so that a decision to undertake an operational program can be made with confidence.

We are not unmindful of the necessity of having data and pictures to present to a non-technical public to explain the result of the expenditures, or to obtain continuing support if such support appears warranted. The experimental program will demonstrate publicly, in an acceptable way, the achievement of key results and program milestones, demonstrate the accomplishment of important technical objectives, and provide authoritative answers to man's military space mission capability.

It is essential, in order to arrive at this minimum experimental program, that a number of general test planning precepts be followed:

a. A space experiment will not be planned unless it has been tried beforehand in a preliminary way, whenever technically practicable, on the ground or in an aircraft;

b. An experiment in space will not be conducted when the ground or aircraft tests have given the final answer regarding feasibility, and have determined, beyond any reasonable doubt, the necessary and sufficient conditions for success;

c. Experiments in space will be undertaken to determine sufficient conditions for success only after the necessary conditions have been determined on the ground;

d. Space experiments will be undertaken, even if such experiments by themselves do not justify the expenditure of a launch, when a vehicle is available and it has been determined that the launch expenditure is warranted by the primary experiment.

B. An example of the application of these precepts, which we consider essential, is the question of fully testing man's observational capabilities in the space environment. This question takes several phases:

a. In the case of optical systems, the ability of a man to train a camera in a desired direction with minimum extraneous movement, and the possible improvements over automatic control can and must be simulated first in a laboratory and/or aircraft, to properly define the boundaries of the space experiment, and to actively contribute to the design of the space experiment.

b. The simulation experiments will not fully duplicate the interaction of the man, the space environment, the target conditions, and the space vehicle environment. In the following section III. A. b. we propose that the man be supplied with optical devices which test, in the space environment, his ability to determine direction, track and perform smoothing and adjustment functions. The optical devices will be capable of achieving high resolution, but need have relatively small fields of view and simple recording cameras to demonstrate the contributions of the man (typically we need a tracking and high resolution telescope, with at least one degree of freedom, exposure control mechanisms, film reading, and ability to optionally perform instrumental adjustments).

c. If a. and b. are successful experiments, then one could provide a man with a high resolution camera, capable of a relatively wide field of view, and with complete pointing freedom. This would properly be considered in an operational program, and not in the MOL experimental program, which would determine whether operations should be undertaken. In any event, such a complete camera system need not, and should not, dominate the cost and timing of the MOL program.

C. Additional precepts can be applied to the space experiments to make them sufficient and complete. These are as follows:

a. Assuming that the result of an experiment regarding military capability is successful, all necessary information must have been obtained to permit design of a future operational system.

b. The design of the space vehicle must include the possibility of carrying on experiments which are not of necessarily unique military nature, but which appear to be of possible future national importance. For example, the design requirements for a centrifugal couch will be developed and it may be feasible to include such a device in one of the later MOL flights.

c. The design of rendezvous capabilities must be considered in light of possible military missions; and we must not exclude possible expansion to future space exploratory needs, even if the NASA would be tasked with the responsibility of this series of experiments.

d. Finally, the psychological impact of actually operating in space, and the ability of the human being to use his sensors, both biological and instrumental, in a new environment, must be considered in the design of the vehicle, so as to permit human action nonrelated to predesigned experiments.

III. Proposed Experiments

A. Experiments Regarding Observation from Space

a. The effects of man's motion on a space system and of the possibilities of maintaining a complete stable attitude, when this is necessary, despite man's motion, can be partially tested on the ground by means of suitable test stands. However, the presence of gravity will have an effect on structures, even if they are CG supported, and on the man's actions, which cannot be fully predicted. The experiment should consist of a programmed series of human motions, with the vehicle's net motion monitored by some external reference (ground or stellar reference) and vehicle inertial references. The programmed motions would include ones related to optical system slewing.

b. As discussed above in I. B. b., the ability of a human being to detect and track a ground target, in both angular rate and in rate of change of angular rate, to be used in pointing a narrow field of view high resolution camera (such as a telescope mounted camera), will be measured in ground simulators and simulated by aircraft flights whenever these can be accomplished in a meaningful fashion. We expect that, as it was stated, even if the equipment is designed or modified to make aircraft tests successful, space flights are still required because of the possible interactions between the environment and the human operations. The purpose is to obtain broad coverage with high resolution by exploring the human capability to select areas of interest and to point an optical system accurately at them. A low resolution zooming telescope for target selection, etc. would be used to preposition a high resolution telescope. A typical major experiment will consist of human pointing toward, acquisition, and tracking of a predesignated or roughly known ground or astronomical target, with the objective of determining the human ability to compensate for vehicle motion around its c. g. as well as the orbital motion (a prerequisite for high resolution photography). Saturation photography could be tried.

c. There are many questions which relate the general seeing ability of the astronaut and his capability to interpret ground and atmospheric phenomena from visual, orbital observations. The GEMINI program, with the military experiments to be included, should provide many answers. Further experiments can be done simply in the MOL program. These experiments could serve to define a number of possibilities such as the ability of the human, observing the earth in the presence of clouds and other background, to detect missile plumes, interpret weather phenomena and detect low and medium yield nuclear explosives. Experiments can determine the ability of the human eye to detect changes, to detect abnormal conditions existing in the atmosphere above a particular point on earth (such as in the case of a bombing raid, a forest fire, a typhoon, etc.) and the human ability to interpret the extent and severity of such conditions for the purpose of estimating the consequences of the event on earth. An experiment will typically test the human ability to recognize patterns or changes in patterns, correlate such information, and establish thresholds for quick judgment on alerting criteria, etc.

d. The ability of the human being to reach conclusions from events just described and to report these conclusions to earth. The experiment tests the usefulness of the human ability to compile, abstract and select key information from a wealth of irrelevant data, to act as an information compression device: this will be a by-product of a, b, c, d, and e.

e. Ability of human beings to satisfactorily process film (e.g., from optical, IR, or radar devices) already exposed, detect significant information on it, and report back to earth or select for TV transmission to earth. This experiment will test the concept of an on-orbit processing lab and photo interpretation, to establish delay times for recognition and accuracy of recognition, among other things. The experiment should utilize pre-exposed film to maximize the experiment worth even in the presence of optical system deficiencies, and to provide critical sensor outputs perhaps not realizable on the first flights.

f. The ability of the human to detect, observe and classify ships on the sea. The experiment will test the ability of the man to visually search a designated area, perhaps the sea about an island or harbor. Consideration will be given to low magnification optical devices to assist him and perhaps some type of IR scanning device as an attention getter. After detection, he will observe the ships with available optical devices and photograph it for later more careful analysis. The sequence of operations in the orbital environment is the critical factor to evaluate.

g. The ability of the human being to use suitable tools for the repair of devices, and construction of small items from existing parts. 'his experiment will test the ability of man to improve the longevity of complex equipment by repair or replacement (as a trade-off for the very numerous and costly additional requirements caused by his presence).

h. [redacted]

i. While IR or radar sensors need not be specifically developed for the MOL experiments, or used for some time, it may be prudent to examine MOL constraints in design if such a capability were to come along usefully. Power supplies, cooling equipment, and antenna mounting would be factors to consider, for example.

B. Experiments regarding Subsystems and Bio-Astronautics

a. To enhance man's ability to perform effectively in tasks of a military nature or implication, such as those outlined in A., it will be necessary to observe the limitations placed on man by the subsystems on board the space vehicle (e.g., stabilization), reconfigure such sybsystems to enhance man's performance, and test the improvement in his performance in the presence of these improved subsystems. Similarly, it is expected that, in order to maintain a human in a highly alert state, capable of precision monitoring and manipulation of instruments and tools, and able to routinely and at random times to make complex observations and reports, promptly communicated to the ground, a very considerable improvement in knowledge of the relations between human performance and the bio-physical environment in which the human finds himself will be needed. For example, fundamental questions of the effect of the vehicle internal environment on continued alertness, the duty cycle and "replacement rates" of the human operators, etc., to maintain observation effectiveness, need precise definitions.

b. In both of these instances, the feedback of human performance as monitored in the space vehicle and on the ground, into changes in subsystem or bio-astronautic parameters, and further testing of human performance, forms a cycle which must be continuous, uninterrupted, and specifically tailored to the performance enhancement of the human. To do this will require that numerous subsystem and bio-astronautic experiments be performed hand-in-hand with the mission performance experiments, and as dictated by these experiments. Those additional experiments must be done as part of the MOL effort, even though NASA will or may have some programs which would overlap these in part, because the precise mission performance subsystem parameter change relations cannot be expected to be duplicated in the NASA programs in the areas of major DOD concern. These additional experiments in the MOL may then assume an independent importance aside from the specific human performance enhancement in the observational experiments; but the fact that the experiments may be of more than MOL-related importance must not inhibit their inclusion in the MOL experiments because of possible relation to "national" needs which might be considered to be a NASA mission. In fact, we expect that the effort to enhance man's observational capabilities will have many basic application results to other areas.

C. Basic Measurements.

There are several examples of a class of measurements which evaluate man's performance of a complex task and at the same time obtain data of basic value. In such experiments biomedical monitoring and human performance data are key results of general applicability.

a. Spectral measurements to define missile plumes and determine cloud and other background characteristics have proved difficult to obtain for many reasons, some of which stem from the rarity of significant events, either background or target. The most damaging sources of background, such as high altitude thunderheads, occur relatively rarely making it difficult to accumulate statistics. If it proves feasible to provide a versatile set of spectrophotometric equipment, the man will be able to search for sources of strong returns and, having found them, will be able to make detailed measurements of their spatial, spectral and temporal characteristics. Measurements in both the U-V and IR region of the spectrum should be possible.

b. Scientific experiments should be considered carefully. Depending upon the nature of the optical equipment aboard for other purposes, it may be feasible to perform basic experiments of astronomical interest. Spectrometric experiments are possible. There may exist cases where the function of the man can be evaluated for military application while the man performs a scientific experiment.

IV. Proposed Ground Rules and Course of Action.

In view of the preceding considerations, which we believe form a sufficient basis to proceed with the MOL program, the USAF should draft a work statement for the MOL recognizing, and explicitly incorporating, that:

A. The MOL is an experimental facility, not an operational vehicle. It may ultimately evolve, however, into a vehicle capable of performing an operational mission; therefore, key factors to measure in the MOL experiments should be derived from a careful and thorough synthesis of missions of potential operational significance.

B. The experimental effort is to develop the capabilities and limitations of man's direct involvement in military missions. The first candidate for military missions is that of observation. A prime set of experiments is to test man's potential contribution to observation from space vehicles (III. A. Experiments).

C. To support a thorough testing of, and best performance in, man's utility for observational missions, another most important class of experiments will involve subsystem and bio-astronautic work tailored specifically to enhance man's observation role, but undoubtedly contributing to other national efforts in the process (III. B. Experiments).

D. The effort in B is to make quantitative the possibilities inherent in man's participation in the use of observation systems, to estimate the performance of systems which make best use of man's assistance, and to determine the form that such systems might best take. It appears possible to perform the primary experiments, and to obtain the primary data, without undertaking a major development of equipment and without imposing on the MOL design or schedule constraints which interfere with other experimental objectives. It is only after the primary data are available that the question can be answered, whether it is desirable to attempt to develop a system optimized for manned observation. The experimental program will be a means for reaching such a decision, not a result of such decision.

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