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The Human Spirit in Space

B J. Bluth
Professor of Sociaology

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B.J. Bluth, Ph.D.
Professor of Sociology
California State University, Northridge

ABSTRACT

The space ships which have come from the human imagination have been extraordinarily successful. Does mankind have the spirit to reside in those ships, and newly planned space stations for long periods of time?

Evidence about the performance of people in isolated and confined environments for long periods of time raises issues that need examination. The Soviet experience in the Salyut 6 shows signs of interpersonal and individual strain. Studies of the Arctic, Antarctic, submarines, oceanographic research vessels, simulations, and many other cases indicate similar episodes that effect human performance, and consequently impinge on mission safety and success.

INTRODUCTION

In his diary written during his first six month flight aboard the Salyut 6 Space Station, Valery Ryumin comments that the experience is much like that of two college roomates. There are difficulties with the living and working complex, but there is also the human problem. "Here we are totally alone. Each uttered word assumes added importance. One must bear in mind - constantly - the other's good and bad sides, anticipate his thinking, the ramifications of a wrong utterance blown out of proportion".1

In these environments where there is little privacy, isolation from the rest of the world and its affairs, and confinement to restrictive quarters serving a small, unchanging group of people, there seem to be numerous instances of disruptive interpersonal problems which impact the mission safety and effectiveness. There is also an indication that such problems may have variable elements which can be adjusted to provide a more conducive interpersonal network. Knowing what problems might be expected, and what techniques might work is the next step in doing actual work in long term space operations.

PRECEDENTS

Considerable research has been done looking at small groups in confined, isolated, and stressful environments, including the Antarctic, submarines, oceanographic research vessels, undersea research labs, Alaskan oil pipe construction sites, oil tankers, and especially designed simulations. None of these situations exactly replicates permanent human operation of a space facility. The complex factors which vary from these analogs include crew size, the degree and type of isolation and confinement, the composition and organization of the crew, the work to be done, the historical context, and especially the unique characteristic of space -- weightlessness and all its related influences. What is important about these studies is that some of the predictions have been verified in the Soviet experiences aboard the Salyut 6 Space Station. This suggests a careful look at these studies will provide some ideas about what dilemmas might arise in long term missions.

The Arctic and the Antarctic

Antarctic stations, where the confinement due to wintering-over varies between six months and a year,

vary in size, with large stations numbering over 100, and smaller research bases having crews of 14 to 40. Crews are composed of Naval personnel who are responsible for the maintenance of the station and civilian research scientists.

So far, one murder has been reported[2], stabbings, and many reports of stress. The Naval contingent of crews stationed at various Antarctic stations showed an increase of 40% in symptoms of anxiety, depression, insomnia, and hostility.[3] Though the percentage increases were not as high for the civilian scientists, they showed the same symptoms. Both groups were most threatened by emotional instability and social incompatibility. A consistent emphasis on personality-oriented behavior developed as opposed to the expected task-oriented behavior.[4]

What is important about these incidents is that they are not easily predictable. "Neither emotional stability, social compatibility, nor overall performance could be accurately predicted by clinical evaluations, personality scales, opinion survey items, or personal history."[4]

Oceanographic Research Vessels

In oceanographic research ships coming from Woods Hole, Scripps Institute, and elsewhere, problems between the ship's crew and the scientists also occur. On one occasion, a crew tossed overboard a large part of the specimens gathered on the two year voyage of the British Antarctic R/V Bransfield because of a dispute about the use of a freezer to store soft drinks.[5]

Cultural differentiation between the various segments of the crews: merchant marine, ex-Navy, technicians, and scientists, is an important factor in explaining some hostilities that exist. Not all situations result in sabotage to the scientific goals of the voyage, but conflicts arise over port time, seating, and use of various sections of the ship. Usually the two groups interact as little as possible, and not at all socially. Such differences in values, interests, and background also show up in strain over music, leisure activities, and group membership.[5]

Scientists on these voyages also find it hard to do any creative thinking. Lab technicians forget or miss steps in their work. Scientists at deep sea drilling projects have also been known to recommend unsound projects, forgetting the simple principles of their disciplines.[6]

Submarines

During an 83-day cruise of the Trition, where 79 days of the 83 day mission were spent submerged in a circumnavigation of the world. The research results showed a "definite increase in feelings described as irritable, annoyed, disinterested, feel like giving up, bored stiff, uncomfortable, and frustrated".[7]

The general conclusion from the submarine studies seems to be that there is a negative decrement in overall alertness and reaction time. During World War II severe neurotic and psychotic behavior was observed during "silent running" when the ship was in danger or under attack.[8,9]

Undersea Laboratories

In the 30 day Ben Franklyn cruise carried out to determine psychological and physiological reactions to long duration and confinement, a crew of six men were towed in a submersible vessel down the East coast. The desire to participate was the main factor in crew selection, and compatibility was not used to determine crew membership. As the mission increased, the crew showed a general trend toward personal withdrawal and an increased need for privacy. Tension increased gradually, and all members of the crew experienced difficulty sleeping at different times during the mission. A major conflict arose between members of the crew and the surface staff resulting in failures and misunderstandings in communication, and bursts of anger and frustration. Indications about these interpersonal difficulties did not show up in early testing nor in the training time on the Langley Research Complex Coordinator. Crew proficiency was adversley affected in this case.[10,11]

Space Simulations

NASA engaged in a full scale simulation of a Spacelab flight in 1977, having Principal Investigators go through all the prepatory sequences for a life-sciences mission during the preceeding year. The mission culminated in a 7 day simulated flight carried out at Johnson Space Center from May 17th to May 23 of 1977.

The crew of the simulation (known as the SMD III) was composed of an astronaut Mission Specialist and two Payload Specialists, leaving out the astronaut pilot and co-pilot. Problems in the SMD III began during the preparation and training phases. Difficulties developed over the scope of decision-making authority regarding experiments and over lines of communication.[12] Interpersonal tension was reported to be high throughout the 7 day simulation. Overall, the problems resulted in disruption to some of the mission objectives.[13]

Dr. Joe Brady and his associate Dr. Henry Eumrian have been conducting simulations of confined microsocieties in an especially designed, programed environment for many years. These studies have shown that the way work and interpersonal contacts are organized have an important impact on the quality and amount of work done as well as crew morale and motivation. New members introduced into a group can be rejected, or can have a negative impact on total group work performance through being denied access to work facilities or because of individual reactions to the new members. Similar results in the quality and amount of work done and group interaction are found when the standards for work are altered, even slightly, with increases in testosterone and decreases in work output or outright refusal to work at all.[14]

THE SOVIET EXPERIENCE

The Salyut 6 Space Station has been on orbit since early 1977, and has been the scene of four of the longest space missions to date: 96 days, 139 days, 175 days, and 185 days (the longest American mission was 84 days flowm by a crew of three in the Skylab in 1974). Prime crews are composed of two cosmonauts who have visitations by two other cosmonauts at different times during the missions. The interior volume of the Salyut 6 Station is approximately 91 cubic meters (compared to 351 cubic meters in the Skylab or 71 cubic meters in the Space Shuttle), or what you might have in a large motor home.

Prior to each mission, extensive tests and plans are undertaken by the Group for Psychological Support to ensure the compatibility of the crew members and provide training for the flight. During each mission this Group constantly monitors the crews over television and by voice analysis to detect signs of stress, and is responsible for developing measures to deal with any symptoms that do develop.[15,16]

In spite of all these activities, General Georgi Beregovoi, Chief of Crew Training, reports that on all four of the long duration missions, the crews have developed signs of interpersonal hostility.[17] Though he is quick to say that they do not get involved in fist fights (if that is possible in weightlessness), and the Soviets have concluded that incompatible people can work together in space on flights limited to a few weeks. However, on flights of a month it becomes a factor, and on longer flights compatability is essential.[18] The crews also demonstrate incidents of hostility with the ground control staff which have resulted in misunderstanding and errors in communication. They have held back on confidential messages and deliberately hidden information and reactions, showing considerable agitation at what they deem "constant nitpicking from the Earth".[19] There is also a rumor that on the last 185 day mission cosmonauts Ryumin and Popov turned off all radio communication with the ground for two days.

The crews show mood swings, increases in tension, and difficulty sleeping. According to Cosmonaut Kovalenok, "In space you want to "load yourself with work so the time will go faster. Otherwise, you feel that the time slows down," and then you feel the lonliness, or you start thinking of aches, pains, sinus congestion, or your general physical condition.[20]

Since interpersonal relationships are so intense, the Soviets have done away with the concept of commander and an "absolute emphasis of a hierarchical structure in a crew consisting of 2-3 people".[21]

Multi-national crews are sent up to visit the long duration crews in order to break the boredom. However they can also bring a degree of hostility, misunderstanding, and confusion based on language and value differences. Czech Cosmonaut Remek commented that with the high stress tension of feelings, unique cultural "mental features disrupt the harmony among crew members" and foreign accents "deform Russian expressions" leading to misunderstanding. Learning the language of the flight crew so there is

no need to translate is also an imperative for times of danger when there is so little time to translate from one language to another.22

The Soviets note that "from the standpoint of group psychological training, one should note that one can hardly rely upon selection in each case of an ideal crew".21 Satisfying the whole range of socio/psychological requirements is met by a program that combines selection in conjunction with an intensive program of psychological training.

In spite of all their programs, however, the Soviets still think that they have not reached a "scientifically founded and effective program of psychological training of the crew".19

STRESS AS A FACTOR OF SPACE FLIGHT

The precedent research and the Soviet experiences in the Salyut 6 Space Station indicate that social and psychological factors become more salient the longer the duration of a mission. Two or three weeks seem to pose some problems, but small groups in isolated environments for longer periods show higher degrees of performance degradation traceable to human factors and the possible effects of weightlessness. If effectiveness and mission safety are to remain important goals, these variables need careful attention.

SYMPTOMS

SYMPTOMS OF ISOLATED AND CONFINED ENVIRONMENTS

- o Irritability
- o Anxiety
- o Depression
- o Tension
- o Sleep Disorders
- o Hostility
- o Lowered Efficiency
- o Mood fluctuation
- o Social Withdrawal
- o Vacillating Motivation
- o Fatigue

SYMPTOMS OF GENERALIZED STRESS

- o Irritability
- o Anxiety
- o Depression
- o Tension
- o Sleep Disorders
- o Anger
- o Lowered Efficiency
- o Excessive Emotion
- o Defensiveness
- o Lack of Concentration
- o Tiredness

Isolation and confinement in a hostile, dangerous environment are important factors in the generation of stress, but they should not be thought of as the only factors. Research in industrial social psychology, crowding, loneliness, organizational design, group dynamics, role relationships, small groups, social disorganization, etc. all show many of the same symptoms found in the precedent studies and the Soviet Salyut experiences. This research also indicates that reduction of some of these sources of stress is possible through the introduction of various training techniques and organizational systems.23

These symptoms of Generalized Stress have been traced to many different factors over a wide range of studies. Some are, conflicting definitions of a situation; mismatched work, organization, and leadership systems; scheduling; expectations; group size; reduced roles; boredom; reduced sensory input; architectural arrangements; group composition; training; sexually mixed groups; communication systems; physiological factors, etc. Some of the causes of these symptoms can be eliminated or mitigated, some must simply be recogonized and accepted.

Solutions to some of these problems are possible through pre-flight socio/psychological training, attention to group organizational systems and dynamics, and the relationship of human individual and group requirements to the design of space-based working and living environments. Since groups can develop as a important buffer to stress, elimination of as many areas of tension as is possible can go a long way in bringing about mission effectiveness, safety, and the creative, satisfying interaction of the people involved.

CONCLUSION

Up until now American space science and engineering has worked with the aim of optimizing all systems for safety and success. The results have been a remarkable achievement. As the windows of expectations expand to longer and longer missions, however, there is ample evidence that the human spirit may buckle under some of the conditions posed by space habitation. The same attitude toward optimization of space craft systems for safety and success also applies to the human

factor in the loop. Humans are not infinitely adaptable. The boundaries of tolerance of the conditions of space flight seem to be found after a three month stay, extending as the time continues. When the same approach that is given to the inclusion of a piece of hardware is applied to the human factor, this boundary may be significantly extended. A good engineer is not going to place a system into a spacecraft until as much as possible is understood about the tolerances of that hardware, its relationship to various environmental circumstances, and its capabilities. A similar approach to the human factor gives the crewmember the advantage of much more knowledge to deal with the unexpected, and more alternatives to cope with anticipated trials. Workable techniques are available, and can be adjusted to the special circumstances of space. Not to do so would leave the most facile element in the loop, the human being, subject to needless ignorance, randomly developed social systems, and unnecessary hazards. The conclusion reached by the National Academy of Sciences in 1972 is even more true today: "If man is to participate in long duration space flight, his requirements -- physical, pyschological, behavioral, and interpersonal -- must be given far more attention than has heretofore been the case in the design of the spacecraft and the mission."24

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