Organization, Selection, and Training of Crews for Extended Spaceflight: Findings from Analogs and Implications

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Ample research evidence from space analogs points to the crucial role that teamwork plays in the performance of small groups in isolation and confinement. This paper surveys findings about the impacts of group behavior and social interaction on crew morale, coordination, and productivity. Implications for the organization, selection, and training of crews for extended spaceflight are discussed.

Introduction

A NEW kind of space mission is rapidly emerging. What distinguishes it from earlier missions is the fact that larger groups of people will be staying in space together for longer periods of time. So far, the Shuttle has carried crews of seven, but only for a week. On the Soviet Mir, missions have lasted up to 366 days, but with crews of only two or three and occasional visitors. Starting with Space Station Freedom, crews will number at least four and be in space together for up to 90 days. As the Station matures and lunar/Mars expeditions are added, the numbers will grow to 8, 12, and more people who will be in space together for as much as 36 months.

The composition of the crews will be more heterogeneous, including a greater number of nonastronauts from science and industry. Because of the time lags and distance involved, they will be more autonomous and have greater onboard responsibility for mission goals and their own safety. At the same time, more of the work will be automated, forcing the crew to serve as the system's monitor; this is a job that is difficult to sustain over long periods. The combination of larger crews, more time in space, increased heterogeneity, more responsibility, and greater automation will create unprecedented problems.

Increasingly, space crews will have to be looked on as *groups,* i.e., units that have all of the psychosocial features characterizing other groups. They will have to work together as a team and get along with each other despite isolation from society, prolonged and enforced close confinement, limited provisions, and stresses imposed by the hazards of unearthly environments.

According to one model, a group's performance depends on three factors: its task and environment, the individual capabilities and skills of its members, and the features of the group itself.[1] These factors combine to define the way a group interacts to make decisions, to perform its work, and to cope.

In current space planning the first factor, task and environment, is addressed through habitat design, work design, and scheduling, with the emphasis on habitability and biomedical issues. The second factor, the individual crew member, is addressed through crew selection and training procedures, which currently emphasize crew member health and technical skills. That leaves the third factor, the group; about this, so far, nobody has shown much concern. On the Shuttle and earlier programs there have been some group-related problems, but the crews were able to work around them because the missions were so short.

For decades scientists have pondered the effects of long-duration spaceflight on behavior.[2-6] Because no actual behavioral research has been conducted in space by the United States, scientists have relied on studies and reports from space "analogs" for clues about what to expect. Space analogs are situations that have various similarities to the physical environment or task structure of space vehicles. Among the types of analog situations studied are system simulators (Shuttle trainers and mockups), isolated and confined operational environments (nuclear submaries and polar stations), situations requiring close technical teamwork (aircraft cockpits and simulators), dangerous expeditions (mountain climbing and polar explorations), and earlier manned missions (Apollo, Skylab, Salyut, Mir). Although some of these situations (aircraft cockpits) are particularly good for investigating aspects of group performance under stressful circumstances, and other (Antarctic bases and submarines) for studying behavior in long-term confinement or isolation, none alone is the ideal model for extended spaceflight. This is one potential role for a Space Station: a real-life test bed for studying behavior and designing crew selection and training systems for lunar and Mars expeditions. Before then, of course, a great deal needs to be learned to properly organize, select, and train the crews who will live on the Space Station.

Despite the limitations, research from analogs provides convincing evidence about the kinds of behavioral issues to affect crew performance and social well-being on extended spaceflights. This paper focuses on three areas of this research: crew organizational structure, selection, and training.

Organizational Structure

Organizational structure includes such factors as the crew members' relationships with one another, crew task design, and crew support. The focus here is on three organizational factors in particular: crew role structure and status, crew leadership, and the norms regulating crew behavior.

Role Structure and Status

Role structure and status are associated with group members' responsibilities and the influence they have on

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group relationships. Usually, each person's position within a group has expected behaviors constituting that person's role. Because group members tend to evaluate each role as to its importance or value to the group, roles and status are interrelated. Status can be thought of as the rough equivalent of social worth, and in any group the people with higher rank or more experience are granted higher status. In an aircrew, the role of commander has the most status, the first officer the next most, and so on.

Since people of higher status are afforded more power, they dominate conversations, and others are more accepting of what they say. Higher-status people talk to each other, whereas lower-status people remain on the periphery. Lower-status members find it easier to remain silent, and even when encouraged to speak, they tend to avoid candidness. In some circumstances, the consequences can be disastrous. For example, although copilots in aircraft ostensibly provide backup, they are often too subtle in speaking up about errors they may observe in the commander's performance. Numerous aircraft accidents have been caused by these status-induced communication problems.[7] In flight simulation studies where captains feigned subtle incapacitation, 25% of the flights ended in crashes because the copilot did not assume control.[8] On the Apollo-Soyuz mission, a near-fatal accident occurred during Apollo re-entry because all three astronauts failed to set some critical switches. Two of the astronauts were long-time veterans and one a rookie, and it is possible that status differences contributed to a communication breakdown.[2] In most cockpits the crew behave according to whatever they think pleases the commander, and most are not bold enough to contradict his decisions.

Studies from polar and submarine groups show similar effects of roles and status on performance. At some Antarctic stations, rigid roles and status differences have led to the formation of subgroups of military vs civilian and support vs research personnel. People in lower-status roles (those viewed as "less important") band together. Between groups, rivalries, disputes, and conflicts grow, and groups sometimes are reluctant to help each other out, even in emergencies.

In contrast, seldom do these kinds of problems arise when there is a low status discrepancy between roles. Called status leveling, this practice has been found important to preserving crew morale in both Antarctica and on nuclear submarines.[9,10] Status differences are minimized, and jobs of recognized low status are shared by everyone. The concept is not new: When Amundsen chose to have a medically trained layman instead of a physician for his expedition to the Pole in 1914, he was partly trying to minimize status disparity between members; instead of scientists, he selected lay people trained to do scientific work.

On shuttle missions there is a clear status hierarchy, with pilots being at the top and nonastronaut payload specialists on the bottom. One observer has suggested that payload specialists are forever regarded by the rest of the crew as "rookies," even after they have flown (although apparently this has not resulted in any significant performance problems).[11]

Status leveling may be desirable, but it should not lead to the elimination of specific role assignments. To the contrary, evidence from Antarctica indicates that assigning roles and having one specialist in each occupational category is probably a crucial factor to maintaining crew morale. Each individual must feel that he has indispensable skills on which everyone else depends for a unique contribution to the mission.[10] Similar findings from submarines indicate a connection between crewmembers having a clear concept of their roles and the effectiveness and morale of the overall crew.[12,13] Although specific role assignments are of primary importance, it is also important for cooperation and group cohesion to have some role sharing between members; by sharing, members mutually appreciate the problems in doing tasks. Also, limited role sharing ensures redundancy of skills necessary to safeguard the mission.

Leadership and Performance

Decades of research on leadership leave no doubt as to its importance to morale and productivity; some studies in analog environments have even singled it out as *the* most influential variable on group behavior. In observing 18 Arctic stations, Sells concluded that the primary factor differentiating high- from low-performing groups was the leader's ability to set the work pace and establish a social atmosphere.[14] During the subpolar transit of the nuclear submarine Nautilus, Kinsey concluded that the single most important factor to crew morale was the quality of leadership.[15]

A lot of investigation has focused on the styles used by leaders, ranging from authoritarian military command to participative decision-making and delegation. Authoritarian leadership is more effective when quick decisions are required, but a participative style usually results in greater satisfaction and morale. It is difficult to say which predominant style would work best on long-duration missions, but there is evidence about the dangers of maintaining a rigid authoritarian style in hazardous circumstances. Studies from multicrew aircraft indicate that several fatal crashes may have occurred because authoritarian commanders inhibited subordinates from taking corrective action, even though their subordinates were in a position to do so.[7] In polar regions, groups have suffered disastrous consequences by rigidly following commands instead of using common sense.[16]

In hazardous situations, orders often call for interpretation and require judgment, and a leader's style must be adaptable. The leadership style that seems to stand out as most effective in polar and submarine environments is delegation of responsibility and advice-seeking. At Antarctic bases, the leaders held in highest esteem solicit the advice of their subordinates,[17] and even on nuclear submarines commanders routinely delegate responsibility, so it is not unusual to have junior officers in charge and senior officers "taking orders."[9] Studies of airline crews reveal similar findings.[18]

Additionally, research from analogs indicates that the best leaders give personal praise to members and reward them whenever opportunities arise.[14,18,19] Such leaders show that they care about the psychosocial and physical well-being of their groups,[10,14] and they maintain frequent personal contact with members.[9,10] This serves more than a social purpose, as Huntford illustrates in contrasting the leadership styles of Scott and Amundsen in the race to the Pole[16]:

> . . . perhaps Scott's saddest flaw was his isolation [from his men]. He seemed to be incapable of sensing the psychological undercurrents which rule human behavior, the understanding and exploitation of which is the heart of leadership. (p. 158) [In contrast, Amundsen] was an acute psychologist, observing his men all the time, searching out their foibles. After two months in the close confinement of a ship, he was beginning to know their strengths and weaknesses; who could be depended on, who not. (p. 281)

Among groups in isolation, the most effective leaders are more than just people-oriented, they also maintain a "tight ship."[14] Effective leaders tend to be strong on adherence to conduct, cleanliness, and dress codes. At polar bases, they emphasize getting the job done, heavy work schedules, and full use of recreational facilities. Keeping people occupied seems to promote cohesiveness and morale. Even on Shackleton's incredible expedition when his group was stranded for 18 months inside the Antarctic Circle, morale fluctuated with the group's ability to keep busy.[20] Among expeditionary Army units in Greenland, those with greater workloads maintain a superior group attitude.[21]

One problem in drawing parallels between analogs and space missions is the different makeup of the groups involved. Antarctic teams have a part military, part civilian structure; crews at early-warning stations and on submarines are military; and crews on commercial aircraft have a quasimilitary structure. In extended spaceflight, crews will be a mixture of military pilots and civilian scientists and engineers. But all members will be highly skilled professionals, and research indicates that the best way to lead professionals is to entrust them with discretion for planning, implementing, and controlling their own work. This suggests a sort of "administrative" role for space commanders, making them responsible for, say, the integrity of the mission and vehicle, but not for the technical tasks of the crew. This role is not unlike that of modern project managers,[22] most of whom "lead" through developing the trust and respect of their project team members.[23]

Of course, seldom do project managers have to work in isolated, high-stress places like space, nor do they have to make snap judgments during life-threatening situations. Studies of wartime episodes indicate that in those kinds of situations, it is better to have a calm, but very firm and decisive leader.[24]

What the research seems to boil down to is that in isolated, hazardous environments, leaders must be able to adapt their style to the situation at hand: Under normal operations they delegate authority and seek advice; in crises, they take command and give orders. This is somewhat supported by the broader research on leadership, one example of which is the model developed by Hersey and Blanchard.[25] This model uses a follower's "maturity" (defined as his ability and willingness to do a particular task) as the independent variable for determining the most effective leadership style to use with that person. In the context of a space crew, the model says that in routine situations (when the crew is "mature" at what it does), a delegating, nurturing style is best, but in emergency situations (when the crew may be scared or disorganized, that is, "immature") an authoritarian style is more effective.

Group Norms and Performance

Group norms are the rules of acceptable behavior the group establishes for itself. Norms develop during social interaction and remain largely stable over time, even as membership changes. Norms reduce ambiguity about what is the right thing to do and help group members predict and anticipate each other's actions. At the same time, they encourage conformity and reduce variety in members' behavior. The greater the solidarity or cohesiveness of the group, the greater the influence that norms have on regulating group behavior.

In discussing the influence of norms, it is interesting to review the findings about small combat units. Although military units might seem like poor analogs for space crews, combat units that are isolated and exposed to risks over a long period may be considered in situations roughly analogous to spacefarers on hazardous, long-duration missions.

The norm that is the single major motivator in combat units is to not let your comrades down. In one study it was shown that the *performance* of a soldier in combat depends not so much on his training, readiness, or leader, but on the social support he is able to *provide* to others in the unit.[26] Most soldiers develop a "buddy" relationship with someone who will listen to his problems and can be relied on to help out in danger. The buddy system not only provides therapy to the individual, but it helps minimize the overall group's exposure to risk through such norms as "never put a buddy on the spot," or "never volunteer unless your buddy approves (then your buddy will volunteer also)."[27] Norms also prescribe against boasting and intentional displays of courage. Such behavior is considered a show of putting one's self first and others second, violating the norm of mutual concern for the group. Tagged as heros and unable to keep their own buddies, boastful members become social isolates and seek to transfer out.

Studies of U.S. combat units in World War II and Korea, as well as recent Israeli units, provide evidence about the strong influence of group norms in prescribing the bounds of group performance. For example, the norms of the unit are much more important to carrying out a mission than any directive from the higher-level command.[26-28] A unit will fail in its mission if it does not internally support the goal involved, regardless of orders or support coming from the higher command. Conversely, a unit will continue on its mission for as long as strong leadership and support continue *within* the group, even if the higher-level command erodes. Generally, the longer a unit is isolated and the more risks to which it is exposed, the more its members identify with the values and norms of the group and less with those prescribed by the higher command.[27]

Studies of analogs reveal another norm common among groups in isolation: the tendency to close off boundaries to "outsiders." Visitors to Salyut have commented on feeling ignored by cosmonauts, and travelers to Antarctic stations have been refused shelter by long-term inhabitants. This has been called the "us versus them" phenomenon. The more a group is isolated, the greater its resistance to outsiders, even to the organization of which it is a part. During isolation, mistrust of outsiders grows and reduces outsider's ability to influence the group. This norm has probably contributed somewhat to situations such as the astronaut "strike" on Skylab IV.[29]

These findings have social implications for extended spaceflight. First, they indicate that selecting crew members who are overly aggressive and self-oriented may cause instability in the crew, and suggest the importance of composing crews of people who care deeply about one another and can readily demonstrate that. They also reveal the potential danger of relying too heavily on Earth-based command and support mechanisms. It seems that the longer the crew is away, the more it will rely on itself for motivation and social support.

Given the strong influence of norms in small groups, the norms that crews take into space must be those that promote effective functioning and survival—not simply norms adapted from NASA, the military, or academia. Norms about being competitive, self-oriented, and acquiescent to authority may work in large institutions, but in small, isolated groups they can be counterproductive and downright dangerous. Crews need to train together long enough to establish strong shared values that provide not only the drive to accomplish mission goals, but mechanisms for emotional and psychological support.

Organizational structure is but one factor affecting group performance; another is the "process" that group members utilize as they work together. Group process is influenced by group structure and by the attitudes and behavior of the members of the group. In the following we consider features of group process and ways to optimize it through crew selection and training mechanisms.

Crew Selection and Training

To optimize crew performance it would seem that astronauts should be selected solely on the basis of their technical qualifications. However, because the operation of a vehicle requires coordination between crew members, and because tasks sometimes interfere with each other, technical skills alone are insufficient to ensure effective crew performance. In the past, NASA relied primarily on technical qualifications, and the reason why this was successful was because crew populations were mostly homogeneous and missions short. Also, space crews received unprecedented amounts of mission training together during which time any potential interactional difficulties could be resolved *before* a mission began. On future extended missions there will probably be more social tensions because crew populations will be more heterogeneous. Strain can be predicted on the basis of the incompatible scientific aims of crew members as well as greater numbers of nonprofessional astronauts onboard.

There is much research evidence concerning the appropriate selection and training of individuals for *solo* assignments, but the research for *team* assignments is rudimentary. For long duration space operations, crew selection and training should produce a desired level of "synergy." Crew members must not only work well together, they must be compatible and, preferably, like each other. Despite high technical qualifications, a crew's performance will slip if there is interpersonal strife. In other words, selection and training must go beyond the technical skills emphasis of the past.

Selection Guidelines

Guidelines for assignments must be developed that balance technical qualifications with environmental adaptability and social compatibility. But before guidelines can be generated, research is needed to understand how semiautonomous, task-oriented groups develop over time, and what personality characteristics promote compatibility *and* productivity. It would be worthwhile to conduct further research on crew selection criteria and group performance for a variety of space analogs such as Antarctica and submarines, for so far not much has been forthcoming. Fortunately, several such studies have been completed in aviation, and it is on these that we shall focus.

In the past, selection criteria for astronauts have been somewhat deficient, partly because they have not been oriented toward *team* performance. To the contrary, they have tended to focus solely on characteristics that may be inversely related to team performance, especially in isolated and confined environments. These characteristics define a profile commonly referred to in aviation as "the right stuff."

Most people are familiar with the stereotypic image of a pilot as being a fearless, technically qualified, and slightly egotistical individual whose job calls for frequent defiance of death. Such a characterization was probably true at one time—in the formative years of aviation when equipment reliability was minimal and a pilot's savvy and skill were the only reliable resources—so that the properties of the so-called right stuff were essential prerequisites for the job.[30] Over time, these same properties became not only key elements of a pilot culture passed from generation to generation, but they were institutionalized in regulations governing pilot *and astronaut* selection criteria. They still exist in aviation today even though most flying is routine and remains the safest mode of commercial transportation.

In many ways, reliance on the right-stuff profile for crew selection is paradoxical. Since this profile places so much value on features such as self-sufficiency and bravery, the result is to select individuals who tend to keep to themselves, communicate less than average and are not very good at sharing responsibility—not exactly the best characteristics when trying to assemble a well-functioning team. In other words, characteristics associated with the "right stuff" may be the "wrong stuff" for effective *team* functioning, and therein lies the paradox.

NASA has been able to attract the best and brightest, not only from aviation, but also from academia and industry. As a result, many individuals in the astronaut program are people who have spent their formative professional years either flying alone or doing research (research is often a solo effort) and who may be dispositionally less suited to working in groups.

Redefining the Right Stuff

Robert Helmreich and his colleagues have studied personality styles associated with the functioning of effective aircrews. Their research shows a consistent, strong relationship between the personalities of individual crew members and overall crew performance.[31] One finding of this research is a strong relationship between the personality dimension of "task orientation" and total crew performance. Task orientation means that a person is rather "driven" to do the job; in the extreme, it leads to a singular focus on a task. An additional, but perhaps more interesting, finding is the relationship between "interpersonal orientation" and total crew performance. Interpersonal orientation is a person's awareness of his relationships with others and his effect on others; it also includes elements of caring about others and skills that tend to improve relationships. The research shows that those crews that perform the best have members characterized by *both* high task orientation *and* effective interpersonal orientation. In contrast, crews that perform poorly have members typified by *negative* interpersonal orientation (e.g., competitiveness and verbal aggressiveness). Put in terms stated earlier, the right stuff profile alone, distinguished by high competitiveness and low interpersonal skills, is not the most effective for group operations. These findings are consistent with studies in other settings, and there is every reason to believe that the same pattern will hold in extended spaceflight.

Another issue with selection implications concerns the increasing level of automation within the astronaut's job. Traditionally, the profession has attracted individuals who derive great satisfaction from being able to do a demanding job well. With automation assuming a larger share of control in space systems, more of the astronaut's job will include the less demanding function of systems' monitor. Monitoring something is never as satisfying as doing it yourself, and studies show that human beings are, in general, ill-suited for this function.[32] On extended spaceflight, mistakes due to complacency and boredom might become a serious problem.

Crew Coordination

It would seem that training which facilitates working together would be an essential element in any operation that requires teamwork; again, one of the few environments in which this has been studied is aviation. In the 1970s a team of NASA researchers first noticed a perplexing pattern in the reports of air transport incidents and accidents, namely, that many of them had nothing to do with "stick and rudder" skills but seemed more related to interpersonal skill problems such as poor group decision making, ineffective communication, and inadequate leadership. Fatal accidents such as the crash of the L-1011 in the Everglades, in which the entire crew was so preoccupied that no one was flying the airplane, and the crash of the B-737 in the Potomac, in which the copilot tried unsuccessfully to convey his feelings of distress before takeoff, are examples. Most significant was the finding that 60 to 80% of the accidents were at least partially caused by crew "coordination" problems and that aircrew training did little to address these problems.[33]

The causes of crew coordination problems have been studied during full-mission flight simulations at NASA-Ames.[34,35] Crews fail to coordinate their tasks for a variety of reasons, including some mentioned earlier such as ineffective interpersonal styles, subordinates not speaking up, commanders being too directive, failure to delegate responsibility, and so on. One of the more interesting findings is that well-coordinated crews seem to communicate to each other in similar ways, whereas poorly coordinated crews are erratic and show little comparability. In short, there are many ways to mess things up, but only a few ways for people to work together well.[35]

The common theme underlying these studies is that good or bad performance almost always depends on the *group*, not the individual. The most relevant findings are from aircrews, but similar conclusions follow from studies of other groups such as sports teams.[36] It is simply not true that a collection of technically competent, stable, healthy individuals will guarantee effective team performance. Groups that need to coordinate their actions must *know* how to work together. However, crew training is frequently aimed exclusively at developing and maintaining individual technical competence.

The aviation community now appears to be accepting crew coordination as an important aspect of training, and programs are underway or planned at major air carriers, the Military Airlift Command, and international organizations.[37] NASA has taken note, and recently a Space Shuttle crew attended a training course presented by United Airlines. It is likely that crew coordination training will be just as pertinent to missions such as Space Station and lunar/Mars expeditions as it is to air transport operations. The stresses associated with isolation and confinement will serve to magnify the difficulties of maintaining effective team performance.

Elements of Crew Coordination and Training

Following are some conclusions about the necessary elements for effective crew coordination training. Although acquired as a result of aviation experience, we believe that they are equally applicable to the training of space crews. The three necessary phases are 1) awareness, 2) practice combined with feedback, and 3) constant reinforcement.

The first phase, awareness, consists of classroom discussions of the role of interpersonal and group factors in crew performance. This phase provides a common terminology and conceptual framework by which crew members can begin to think about coordination and communication problems, and how such problems contribute to unfortunate incidents and accidents. Awareness promotes credibility and helps change attitudes, even though it alone is not enough.

The next phase is practice and feedback. Interpersonal role-playing exercises and personality questionnaires that provide feedback to individuals about their own interpersonal styles are examples. However, although these techniques are valuable, they provide only short-term insight. People usually leave such programs feeling that they have learned useful lessons, but the insights gained fade fairly rapidly. It is easy to discount what an instructor or personality test says about you because the information is subjective and somewhat nebulous.

One of the best ways to augment these techniques is to have crews participate in realistic training exercises in hi-fidelity simulators or mockups. In aviation, these exercises are included as a component of line oriented flight training (LOFT),[38] in which crews participate in rigorous full-mission exercises on flight simulators. The flight scenarios are designed to include difficult situations (hardware failures, weather-induced problems, etc.) in which successful performance requires the coordinated efforts of the entire crew. Each exercise is videotaped, and afterward the crew reviews the tape for feedback and critique. Taped feedback is particularly effective because it does not lie, and it is impossible to deny that you have an ineffective interpersonal style when you see it for yourself. The psychological literature is full of empirical proof that taped feedback is an effective stimulant toward attitude change. The capability currently exists for providing similar learning experiences to astronauts through video-taped mission scenarios performed on Shuttle simulators and Station mockups at the Johnson Space Center.

The last and most important phase of training is reinforcement. No matter how good the classroom curriculum, drills, simulator exercises, and feedback, one exposure is not enough. Attitudes and norms that contribute to ineffective crew behavior are developed over a lifetime, and they will not be changed after a two- or three-day training program. As Helmreich says, training is a bit like religious conversion, "it must be continually reinforced and omnipresent. For the convert, life in a world of sin and temptation without constant reinforcement leads to backsliding."[34] One experience, even with powerful simulators, will not produce enduring change. Crew coordination training must be embedded in the total training program and become an element of the organization culture.

Crew coordination training is only effective when it includes the entire crew; for space, this means commanders, pilots, mission and payload specialists—everyone together. Many training programs have separated training for different crew positions (although NASA has traditionally been diligent about training crews together), and although this is more efficient for certain types of training (technical skills and systems knowledge), it is the antithesis of crew coordination training.

Most of the research on coordination training has been done in aircraft cockpits, although it is obvious that these are not very good analogs for long-duration space vehicles. Also, because this kind of training has been somewhat narrowly restricted to "coordination" issues, as a model for extended spaceflight, it is incomplete and only partially valid. Although the training of space crews should include coordination issues, it must also address the numerous other issues of long-duration flight. Such training would also have to cover, for example, intercultural and interpersonal awareness, methods of providing emotional support and handling conflict, and ways for dealing with psychosocial problems that could affect crew morale and performance.[39]

Conclusions

As more ambitious endeavors take mankind into the further reaches of space, group factors such as organizational design, selection, and training will take on greater significance. Despite the importance of these factors to group performance and morale, the amount of overall effort devoted to the systematic research of crew behavior in space analogs has been somewhat disappointing.

In preparation for extended spaceflight, several research needs are apparent. They include the following:

1) Identifying the elements of group structure—roles, status, leadership, norms, and others—crucial to the performance and social well-being of isolated groups, and extrapolating findings to the design, selection, and training of space crews.

2) Identifying the impact of risk and isolation on hierarchical structures; the longer a group is away from "home," the less relevant are the rules of the formal command, and the more relevant are the emerging norms and goals of the group.

3) Developing selection criteria that factor into account the importance of interpersonal orientation and teamwork.

4) Developing training procedures in team building, problem solving, coordination, and social support to provide the norms and interpersonal skills necessary for maintaining emotional health and high performance in long-term isolation and confinement.

Although much can be done in analog environments and high-fidelity simulators, the Space Shuttle STS and Extended Duration Orbiter programs offer immediate opportunities to begin this research.

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