PRELIMINARY REPORT ON

SOCIAL PSYCHOLOGICAL FACTORS IN

LONG DURATION SPACE FLIGHTS:

Review and Directions for Future Research

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I. INTRODUCTION

Apart from communications between ground control personnel and the astronaut, social variables were of little or no consequence in the earliest manned space flights. But as solitary missions gave way to group missions, flight time increased from minutes to weeks, and technological advances provided personnel some liberation from monitoring instruments and operating controls, social variables gained prominence within the space capsule environment. Each of these trends which promotes social life in space is expected to continue. Orbital flights involving three persons for a period of half a year or so (16) and interplanetary missions which will occupy five to eight persons for the better part of two years (101) are possible within the foreseeable future. Huge orbital laboratories and settlements involving thousands of people have received serious discussion (82, 83, 88, 89, 104) and there appears to be a growing reluctance to dismiss, out of hand, those visionaries who foresee

large-scale outward migrations. Accompanying increases in crew size, mission length and leisure time will be increased needs to understand the emotional, behavioral, and social dimensions of life in space.

The purpose of this chapter is to examine how peoples' relationships with one another may affect the psychological functioning and welfare of the individual astronaut and the performance and morale of the crew. The primary focus is on crews that are "small" in the sense that each crew member has the opportunity to interact with each and every other crew member on a face-to-face basis (22). Large crews, of 20-30 members or more, require additional analyses which are to be provided in a subsequent chapter.

Moving into space was and is a staggering task involving tremendous research and engineering accomplishments. Necessarily and understandably, attention was first focused on the immense technological problems associated with launching and recovering a space vehicle capable of sustaining life under incredibly harsh conditions. The chief psychological interests centered around the effects of weightlessness on performance, and upon man-machine engineering (46). By the mid 1960's, however, interests had expanded to include social psychological variables. Over the following decade, a number of theoretical papers and reviews appeared, the most salient including those by Haythorn, Hollander, Latane, Helmreich and Radloff (63), Kanas and Fedderson (70), Kubis (75), Rawls, McGaffey, Trego and Sells (95), Sells (100), and Sells and Gunderson (101). These reviews firmly established that social psychological variables will be important determinants of human performance and well being in space. Participants on long duration space missions will be temporarily or

perhaps permanently extracted from the ongoing relationships that are important to them. They will then be thrust into a microsociety which cannot be expected to compensate for lost terrestial relationships. Within the microsociety there may be a whole new array of social deprivations and hardships.

People are, under normal circumstances, embedded in a complex social matrix. Most people are, at any point in time, members of a family group, a dozen or so informal friendship groups, one or more large scale organizations, and that even larger organization, society. Space mission participants are withdrawn from this social matrix. Such withdrawal drastically limits the social world.

First, over time, as a result of sampling many different people and engaging in accommodative behaviors, people build relationships with specific other individuals. The reassurance, affection, and respect which prompts and maintains friendship and love will be forfeited for the duration of the mission.

Second, over time, each person is likely to interact with many different individuals. Membership in a small space crew will severely limit the opportunity to obtain variety in social relationships.

Third, as social comparison (38) and social self theorists (84) have noted, other people are important in the self-evaluation process. Acquaintances, friends and lovers provide the individual with reference points which he or she can use to gauge his or her own potentials, or views. Withdrawal from pre-existing relationships removes known comparison points, and limits the range of comparison points that are available. Prolonged withdrawal from one's usual relationships with

significant others (that is, people of emotional consequence such as parents, spouses and long term friends) may make it difficult to maintain a sense of identity.

Fourth, in the course of daily life, people are likely to enact a variety of different roles (supervisor, husband, father) with people who enact interlocking or reciprocal roles (supervisee, wife, son). In addition to providing stimulation, such diversity allows the person to exercise different skills and talents, and may be important for a complete sense of identity. According to D. R. Miller (84), the different roles that people routinely fill develop different facets of their personalities or "subidentities," and role variety is hence useful for a balanced personality. Astronauts will undergo a reduction in their range of role activities and may risk personality impoverishment.

The ultimate damage likely from withdrawal from the social matrix will depend on several factors. One is mission duration: it is generally conceded that on a short term basis, almost all social deprivations are tolerable (16). Another factor is crew composition. If crew members are carefully selected, skilled in interpersonal relations, and formed into a cohesive group prior to departure, membership in the space capsule microsociety may provide partial compensation for withdrawal from the Earth-based macrosociety. But only in the case of extremely large missions (which might involve entire families or communities) can we hope for dependable sources for the satisfaction of routine interpersonal needs.

At the same time that astronauts must cope with the effects of withdrawing from the macrosociety, they will be confronted by additional

problems stemming from inclusion within the microsociety. These are the problems associated with living on very limited resources under conditions of isolation and confinement. In the foreseeable future, only some orbital missions will allow alleviation in the form of resupply and personnel rotation.

First, prolonged isolation and confinement appears to magnify the effects of attitudinal dissimilarities, need incompatibilities, annoying traits, irritating mannerisms, and other sources of personal dissatisfaction and interpersonal friction. As we shall see, most, but not all investigators have found, over time, subtle and not so subtle signs of mounting tensions. Such tensions are often suppressed for the sake of the mission, and tales of group collapse are nonexistent or rare. Yet a certain amount of personal aggravation would seem to be an unavoidable cost of participating on a long duration mission, and there is always some risk that such aggravation could seriously impair the well being of the individual or the functioning of the group.

Second, the processes through which people get to know one another generally occur gradually and against a backdrop of other developing and continuing relationships (6). For some time to come, space missions will involve unusually intensive contact with a very few people. Acquaintance processes are thus likely to be forced, rapid, and relatively unbalanced by alternative relationships.

Third, certain kinds of social responses incur costs, but are performed anyway because they ultimately have a beneficial effect within the group. Under many conditions, for example, an open display of antagonism incurs the cost of momentary unpleasantness which is

justified by reducing tensions and perhaps altering the conditions that gave rise to them. The conditions of space flight would seem to alter the potential costs of some of these behaviors in such a way that they become too expensive for use. Under conditions of isolation and confinement, for example, antagonisms may be suppressed because of a fear that their expression could touch off a "powder keg" of emotions and spark a conflict which rapidly gets out of hand. Thus, certain behaviors which would otherwise remain viable social options may not be available in space.

There are many other important behavioral options which may be unavailable or only partially available while living in space. First, with the possible exception of certain orbital missions, early withdrawal or resignation are not possibilities once a mission actually begins. Second, life within a group is often partially regulated through interaction with people outside of that group. For example, under everyday conditions, a dispute among co-workers might be resolved by appeals to a higher authority, or feelings generated at work placed into perspective during a session with a spouse, or friend. If available at all during an extended space flight, such external social resources will be available only in highly limited ways (for example, through telecommunication).

At present, very little social psychological data is available from space itself, and the missions which might prove the most informative lie in the future. Social scientists, behavioral scientists, mental health professionals and other people who are interested in the social psychological aspects of space flight have thus turned to environments which seem to

capture some of the elements of life in space, such as isolation, confinement, and stress. Most of the data reported in the present paper thus come from polar camps, underwater habitats, and space capsule simulators of varying degrees of verisimilitude. In 1966, Sells (100) compared a number of such settings with settings then expected in space. Variables included (1) objectives and goals, (2) philosophy and value systems, (3) personnel composition, (4) organization, (5) technology, (6) the physical environment, and (7) temporal characteristics. Similarity scores were computed, and the environments ranked (Table 1). It should be noted, however, that at the time these comparisons were made there was a assumption of a military or paramilitary model, an assumption which may be far less common today.

Systems	Similarity Rank	Similarity Score
Submarines	1	79
Exploration parties	2	68
Naval ships	3	61
Bomber crews	4	60
Remote duty stations	5	59
POW situations	6	39
Professional athletic teams	7	37
Mental hospital wards	8	23
Prison society	9	20
Industrial work groups	10	16
Shipwrecks and disasters	11	11

Table 1

A comparison of eleven systems on similarity to the extended duration space ship. From Sells, 1966, ref. 100, page 1132.

Social behavior reflects a complex interplay of many situational and dispositional (personality) forces. Because many variables affect peoples' social behavior, it is difficult to focus on one variable or class of variables without alluding to others. Nonetheless, it is necessary to start somewhere, so this chapter will begin with a consideration of crew composition. It shall then turn to possible structural arrangements which define the crew members' relationships relative to one another and place limits on discretionary behavior. We shall then turn to crew dynamics; that is, the functioning of the crew as a whole. Finally we shall review limitations in some of the available evidence, and consider some promising directions for future research.

II. CREW COMPOSITION

The size of the crew and the characteristics of the individual crew members are expected to have profound effects on performance and morale. In this section we shall consider how variations in crew size, crew background, and social compatibility factors are likely to affect individual satisfaction and group success.

A. Size

Most U.S. missions completed thusfar have involved primarily 2 person groups (dyads) or 3 person groups (triads), but, as noted, a crew of six members or so is seen as appropriate for a planetary fly-by, and it is considered technologically feasible to establish relatively large orbital or lunar bases involving 10-20 people. Most of the experimental literature involving "groups" uses dyads or triads; subject availability and other practical considerations have discouraged laboratory studies of groups larger than four. However, naturalistic studies in underwater and polar environments, a few fall-out shelters, and mathematical models of small group behavior provide some bases for forecasting some of the effects of size variation within the small group range.

1. Size and Performance

Steiner (110, 111) and others (74) have reviewed the effects of group size on problem solving and other measures of performance. Increasing group size has three general effects which in turn influence performance. These are pooling effects, motivational effects, and organizational effects.

Pooling effects refer to the aggregation of knowledge, abilities,

and skills within a group. Adding additional members to the group increases the number and range of cognitive and manual resources that are available thereby boosting the group's potential. Pooling effects are not unlimited, however, because there is an increasing likelihood that some abilities and skills will become overrepresented within the pool. Although larger groups have more potential than smaller groups, motivational and organizational effects may make it difficult for this potential to be realized.

Motivational effects refer to the impact of group membership on individual involvement and motivation to pursue group goals. This is a complex array of effects which is, in balance, likely to hurt performance (74). First, the larger the group, the less responsible each member may feel for the group's actions, with the result that ego involvement is low (28, 74, 117). Second, the larger the group, the less visible individual performance, with the result that good performance may go unrecognized and poor performance unpunished (74, 120). Third, the larger the group, the more thinly distributed social recognition and other rewards that may follow from good performance (74, 93). Fourth, the larger the group, the less likely the individual member can deepen commitment by making meaningful inputs into the decision making processes (74). Finally, large groups may encourage conditions such as anonymity which in turn gives rise to horsing-around and even destructive behavior (31, 32, 33, 39).

Organizational effects refer to pre-performance activities which become increasingly burdensome as the group increases in size. The larger the group, the more time and effort required for it to "get its act

together" so that it can effectively perform. Like motivational effects, organizational effects are seen as basically adverse.

As the size of a space crew increases, one might expect decellerating benefits due to pooling, but accellerating losses due to motivational and organizational decline (110). The overall rates of change should be such that performance first improves and then deteriorates with increasing size. Maximal perforamnce should come thus from intermediate sized crews. However, this should not discourage large missions, because steps can be taken to promote the beneficial effects of pooling and retard motivational and organizational loss.

First, further research should make it increasingly possible for crew members to be chosen, in part, on the basis of complementary skills and interests (63). A careful analysis of mission requirements and of the people who might satisfy them could result in a fairly large crew which is not characterized by a pool which is overstocked with certain abilities and skills.

Second, procedures might be found to combat the motivational losses associated with relatively large groups. Strong norms of personal responsibility might be established to help offset diffusion of responsibility. Behavior can be carefully monitored to ensure that individual performance is appropriately recognized. Individual incentives and systems rewards can be set at such a level that continuing with the group is a highly attractive alternative. Selecting people whose personal values are already congruent with group goals may lessen the need for participative decision making procedures. The frequent use of names and the encouragement of harmless idiosyncratic behaviors may help prevent anonymity.

Finally, through careful selection and training, organization may be imposed prior to the mission's departure. Unanticipated problems may arise in flight which require an immediate response and for which the crew, as a whole, is ill prepared. In this case, individuals or specially trained subgroups may be in the best position to take effective action. All of these remedies proposed for group ills, however, are to some extent based on conjecture, and require careful research.

2. Size and Social Stability

On the basis of work by Bales, Borgotta and others (10, 11, 12, 13, 14), Kanas and Fedderson (70) concluded that within the parameters of small groups, increased size should lead to greater social stability. Dyads experience tensions because of an inability to form a majority. Triads are unstable, because of shifting coalitions which involve two persons pitted against the third. Kanas and Fedderson recommend as large a small group as possible, but add that an odd-numbered crew would have the advantage of being able to break a tie in democratic decision-making situations.

3. Size and Satisfaction

Increasing crew size increases the number of possible dyadic relationships within the Crew according to formula $(n^2 - n) / 2$ where n is the number of people in the crew (101). Thus, while a three person crew could generate only 3 dyadic relationships, a six person crew could generate 15 dyadic relationships, and a 12 person crew, 66 dyadic relationships. Increasing crew size, through increasing the number of possible relationships, increases (1) options for social stimulation, (2) options for developing friendships and (3) options for exercising

varied role behaviors.

The evidence is a bit sketchy, and complicated by the problem that relatively large groups may be stationed in a relatively comfortable main base while relatively small groups are located in primitive quarters which offer few of the main base's amenities. However, S. Smith's (105) review suggests fewer emotional and interpersonal problems in relatively large isolated and confined groups. In one study, Doll and Gunderson (34) found that antarctic parties varying in size from 8-10 reported less in the way of compatibility and accomplishment than parties ranging in size from 20-30. In another study, these same authors (35) found that military personnel stationed at small bases were more hostile than their counterparts at more heavily populated bases. Although cross-study comparisons are difficult, it is interesting to note that the Georgia Fallout Shelter Studies (55, 56, 57), which imposed very Spartan conditions on unselected but unusually large groups, had very low defection rates. S. Smith and Haythorn found triads more harmonious than dyads in a simulation study (106).

B. Individual Characteristics and Crew Compatibility

A prominent theme in the literature is the problem of selecting, as crew members, individuals who are compatible with one another (3, 4, 5, 6, 58, 59, 60, 61, 62, 63, 75, 101, 106) as well as with the environmental systems (101). Crew members may be considered compatible to the extent that each member shows qualities and emits behaviors that the other crew members consider desirable and appropriate under the conditions. The research task is identifying <u>patterns of personal attributes</u> which, in the aggregate, will promote group harmony and encourage a high level of performance. The issue is not only finding people with good or

positive qualities, but finding people whose qualities intermesh in a good or positive way. The issue is exceedingly complex, because so many variables need to be entertained. As Kubis (Ref. 75 p. 60) notes:

> ...even with consideration restricted to personality-related variables (interests, attitudes, traits) alone, the number is so great that the analysis of distinguishable patterns becomes an insurmountable task. There are, for example, 2^n different patterns in a group if each of the n characteristics were to be categorized on the minimal high-low dichotomy...

The search for crew compatibility, then is likely to be limited only by the number of dimensions upon which people can be meaningfully compared. But the search must continue. Social compatibility emerged as the foremost factor in analyses of supervisory ratings and peer nominations at polar stations and compatibility has been related to whether or not the antarctic adventurers had a "good year" or a "bad year" (48, 49, 51, 52, 53, 87, 103). In simulation research by Altman and Haythorn and their colleagues, isolated and confined groups who had incompatible needs showed increased stress, withdrawal, and territorial behaviors. In addition, they made more attempts to withdraw from the study (3, 4, 5, 59, 60, 61, 62).

In the discussion to follow, compatibility factors are organized into three categories. The first category, class factors, includes those qualities or attributes associated with membership in a biological class, social category, or demographic group. The second category, semi-universal appeal factors, consists of those qualities or attributes expected to make an astronaut attractive to, and compatible with, a

wide range of other people. These are the personal qualities that are expected to be valued by anyone (or just about anyone) who is with the astronaut in an isolated and confined group. The third category, idiosyncratic appeal factors, encompasses those personal attributes or qualities expected to vary in desirability depending on the attributes or qualities of the other people in the group. These are the qualities that are likely to be valued by some people who might be with the astronaut in an isolated and confined group.

1. Class Factors and Crew Compatibility

To some extent, crew compatibility will depend on the biological and social groups from which the crew members are drawn. Important variables include sex, age bracket, and race or ethnicity.

a. Sex

Space travel has been a male dominated enterprise, but women astronauts are in training and it is recognized that in the long run some sort of sexual parity is likely to be achieved (104). Extremely little is known about women in space. Women have visited polar stations, lived in underwater habitats, participated in fallout shelter studies, but the vast bulk of the data come from all-male preserves.

Several issues are involved when we consider women entering space as a part of mixed-sex crews. The least of these is whether or not women are equipped for the rigors of life in space. Early doubts seem to be giving way to a conviction that women can do the job and have the right to be there. This conviction seems to reflect, in part, an increasing recognition of women's capabilities outside of the traditionally feminine sphere, and in part a growing recognition that technical systems are as easily engineered to meet women's needs as men's needs.

More pressing are issues concerning the social dynamics within a heterosexual crew. At the conjectural level, one can forecast both advantages and disadvantages with a mixed-sex crew. On the one hand, inclusion of members of the opposite sex can create diversity and help reinstate otherwise relinquished role behaviors. On the other hand, jealousies may arise as the result of crew members "pairing off." A terminated relationship could prove devastating. Then, too, there may be a certain awkwardness dealing with the opposite sex under conditions of isolation and confinement, and at least some people are worried about society's perceptions of possible goings-on in the capsule.

At least two factors will work against the formation of potentially disruptive heterosexual bonds. First, sexual needs during space flight may not be similar to those on earth. In times of crisis, change, or even distraction, sexual needs may be considered of minor or no importance. It is at least possible that the space environment will be sufficiently artificial to the space traveller that sex will not be perceived as a pressing need for a very extended period of time, even a year or more.

Second, there is at least some suggestion that people within small, relatively closed social systems tend to choose, as partners, people from outside that system. They seem to recognize that endogamous choices can fan jealousies and reduce privacy to a dangerously low level. The findings are tentative, however, and come from kibbutzim (114) and residential colleges (30) which maintain relatively permeable boundaries.

Finally, there are the related problems of feeling at ease around members of the opposite sex and societal misgivings about the space party. Berry (16) suggests that natural processes of social change may ease

these latter problems:

> ...The issue of mixing of sexes in space crews in the future may not be the delicate one it has been traditionally expected to be. Sexual mores have changed significantly in the U.S. and throughout the world. As a consequence, living in close proximity with persons of the opposite sex may seem to future space crews a comfortable and natural thing. The population from which astronauts will be drawn in future years will more than likely have spent their years in university training, studying and working in mixed groups, and living in sexually unsegregated dormitories. Indeed, many universities throughout the U.S. now feature such arrangements...

b. Age

Although polar camps, subaquatic dwellings, and space simulators have tended to be male preserves, inhabitants have varied appreciably in terms of age. The groups thusfar studied have contained subjects varying in age from their late teens to middle age. Subjects who have deviated noticeably from the group's mean age have, like other members, been physically and mentally fit to stand the environmental rigours and make positive contributions to the group. Within the ranges studied, age has not emerged as an appreciable source of friction.

Indeed, it is possible to find certain advantages to having an appreciable age mix within a crew. A mature indiviudal may serve as a parent-surrogate and thereby satisfy important emotional needs of the other crew members (93). In addition, we might hypothesize that the intellectual flexibility of youth (fluid intelligence) coupled with the storehouse of facts which develops with age (crystallized intelligence) can enhance a group's problem solving potential.

Age-related changes over time, however, may pose problems on truly extended missions. Thusfar, even the longest studies have involved a very small segment of the participants' life spans. But developmental changes which are undetectable on short missions may become prominent on missions measured in years. Work in the newly emerging field of adult developmental psychology suggests people undergo fairly pronounced changes at several points during their adulthood. On a two year mission, for example, someone approaching 40 might have a major change of interests and goals. These changes might reduce the person's fitness for the technical side of the mission, and also his or her social compatibility. At present, missions are not measured in years, our knowledge of adult development is modest, and it may well be that commitment to a mission may present major changes of interests and identity. However, age-related changes require consideration when planning a truly extended mission.

c. Race or Ethnicity

Although US-USSR missions and missions involving crew members drawn from traditionally rivalrous Eastern bloc nations have been proclaimed resounding successes, there is always the chance that prolonged isolation and confinement will bring long-standing prejudices to the fore. Although Kanas and Fedderson (70) have discussed some of the implications of ethnically mixed missions, race or ethnicity have not been major variables in studies of isolated and confined groups. The race relations literature, however, provides some basis for optimism. Specifically, certain conditions associated with life in space may reduce the risk that ethnically mixed crews will prove incompatible.

First, some prejudice appears to be the result of an assumption that people from other ethnic groups maintain attitudes which are different from one's own (65, 109). In fact, astronauts are likely to discover that they have many interests and values in common (for example, those centering around the mission). Such similarities should militate against prejudice.

Some prejudice flows from the perception of low social status rather than the perception of race or ethnicity per se (1, 7). Since space voyagers are likely to come from a highly select population in terms of ability, education, and health, pre-mission status is unlikely to contribute to prejudice.

Third, under certain kinds of conditions, interaction is likely to lead to a reduction of prejudice (1, 7). Two of the most important conditions - cooperation and the pursuit of common goals - are likely to be found in space missions. Indeed, space environments may ultimately prove useful for reducing prejudice.

Because of the many differences between terrestial and extraterrestial environments, these three points are better considered hypotheses to be tested than conclusions that may be drawn. Furthermore, the technical and social requirements of each mission will have to be carefully appraised in light of the cultural and subcultural variability within the pool from which the astronauts are to be drawn.

2. Semi-Universal Appeal Factors

Certain characteristics are likely to make a person a generally desirable partner under conditions of isolation, confinement, and stress. These are categorized as semi-universal appeal factors because there is a high degree of concensus concerning their value. They include attractive-

ness, competence, cooperativeness, emotional stability, and social versatility.

a. Attractiveness

Rawls, Hopper, and Rawls (94) instructed college students to "List as many things as you can possibly think of that would determine how closely you would be willing to interact with another individual." The other person's attractiveness in terms of such things as cleanliness, appearance, dress, and general demeanor emerged as a major consideration. The search for more complex bases for social compatibility should not cause a general attractiveness factor to be overlooked.

b. Competence

Sustained and effective task performance will be essential for mission success. Poor or incompetent performance under conditions of danger is likely to have a disruptive effect because of recognition that it jeopardizes everyone's welfare. Gunderson and Nelson (52) found that "task motivation" related to "good years" and "bad years" in the Antarctic, and Shears and Gunderson (103) reported that both personal motivation and perceptions of the group's achievements were related to satisfaction with the Antarctic assignment. Studies undertaken by the Alaskan Air Command also suggest that marginal performance is correlated with poor adjustment and dissatisfaction (99) and Day (29) has discussed the adverse reactions generated by crew members who failed to fulfill their performance requirements in the days of sailing ships. The goof-off or slouch poses an unacceptable threat to group harmony, particularly in the case of relatively small missions where each crew member has an essential part to play.

c. Cooperativeness

Space voyagers are embarked on a highly interdependent venture which requires utmost cooperation for success. According to McClintock (83), people vary in terms of their interests in coordinating their efforts for mutual gains. He identifies three types of motivation or motives:

> Own gain motivation refers to a preference for doing as well as one can for oneself regardless of how one's choices affect other people. If it is in one's personal interest to choose a course which happens to benefit someone else, it is this course which is chosen. If, however, the greatest personal gains come from actions harmful to someone else, knowledge of the likely harm has little deterrant effect.
>
> Relative gain motivation prompts one to receive a higher level of rewards than the other people in the relationship. The important consideration for the person governed by relative-gain motivation is to "best" and "come out on top."
>
> Joint gain motivation refers to preferences for courses of action which produce benefits for other people, as well as for oneself. Joint gain motivation involves both a sensitivity to other peoples' needs and a concern for their welfare.

McClintock and his associates view each individual as more or less consistently governed by one of these three motives. Each stems from early childhood socialization and reflects both familial and cultural values. A better understanding of these motives may prove of use in the flight personnel selection process, or for establishing the most effective reward structures in the space capsule microsociety.

Kelley and Stahelski (72) have examined the effects of pairing people with cooperative and noncooperative orientations. As one might expect, pairing people with cooperative orientations leads to a high level of cooperation; pairing people with noncooperative orientations leads to a low level of cooperation. Of particular interest, though, is the finding that pairing people with cooperative and noncooperative orientations does not yield an intermediate level of cooperative activity; the cooperator is brought down to the noncooperator's low level.

Relevant to both competence and cooperativeness is Helmreich's (64) work on the achievement orientation or need achievement. Classically, need achievement has been defined as a persistent preference for engaging in success-related activities (9). People with high need achievement have many admirable qualities, but problems may arise on board a space vehicle if attaining standards of excellence involves "prima donna" behaviors or a put down of other members of the crew. According to Helmreich, need achievement can be reconceptualized as subsuming three independent factors. Work orientation refers to motivation to work hard because work is a valuable activity in and of itself. Mastery orientation refers to a desire to continually improve one's own best performance. Competition refers to an attempt to do better than other people. Helmreich suggests that the combined interests of task accomplishment and social compatibility will be best served if crew members show a strong work and mastery orientation but relatively little competitiveness.

d. Emotional Stability

A highly emotional or uncontrolled individual poses an unacceptable threat in any hazardous environment. Accordingly, it has been noted

that Antarctic personnel place high premium on having calm, even-tempered, emotionally mature companions (35, 80). Much more is known about selecting out candidates who are likely to prove immature and troublesome than about choosing for inclusion people who meet unusually high standards of personal and social adjustment (92).

e. Social Versatility

As noted earlier, accompanying space flight is restricted opportunity to perform varied social roles. Persons who can easily engage in a wide range of role-related behaviors in flight can help reinstate for one another some of the lost opportunities. The value of such versatility is expected to be inversely proportional to crew size and directly proportional to mission duration.

There are many types of versatility which might be studied, but the one which is receiving the most attention is versatility in enacting behaviors associated, in Western society, with masculine and feminine roles. Men are expected to adopt the task-oriented instrumental role and women are expected to adopt the socioemotionally oriented expressive role. Men are expected to be autonomous, independent, somewhat dominating and aggressive, and emotionally inhibited. Women are expected to be warm and nurturant and openly display their feelings.

Recent research by Spence and Helmreich (64) shows that whereas people tend to adopt the attitudes and behaviors commonly associated with their sex, some people are adept at performing both the instrumental and the expressive roles. Such people, who are referred to as androgynous, appear able to strive towards goals while remaining sensitive to other peoples' needs and concerns. They have a flexibility which should yield benefits for themselves and for the people with whom they interact.

3. Idiosyncratic Appeal Factors

Finally, there are those personal qualities and attributes whose effects can be gauged only while simultaneously considering the qualities and attributes of the other people in the group. In some cases it is peoples' similarities that make for compatibility; in other cases, peoples' differences intermesh. Idiosyncratic appeal factors include attitude and value homogeneity, skill complementarity, and need compatibility.

a. Attitude and Value Homogeneity

Conflict of social, moral and ethical values has proven to be a problem in some of the fallout shelter studies (99) and almost all reviewers have tended to accept the position that homogeneous attitudes, values and interests will militate against intragroup conflict. The expectation that crews composed of individuals with shared attitudes and values will tend to be compatible is certainly supported by studies in other contexts. Results from the field and from the laboratory have been spectacularly consistent: attitudinal similarity is a powerful determinant of mutual attraction. It has been repeatedly found that the proportion of shared attitudes determines the extent to which people find each other attractive (19). Careful selection and indoctrination procedures should help insure a high proportion of shared attitudes. However, attitudinal homogeneity will necessarily decline as crew size is increased.

Attitudes also vary in terms of their relevance to the group. Whereas a group may allow considerable lattitude for differences of opinion in areas unrelated to the group's purposes and tasks, dissimilarity on issues closer to home can spark spirited reactions (97). It would thus seem of use to identify those issues upon which attitudinal agreement is likely to be important given the conditions of that particular mission.

b. Skill Complementarity

As noted by Haythorn and his associates, interlocking or complementary abilities should also enhance group compatibility (63). One type is skill complementarity which exists when one person is skilled in an area where the other person is unskilled. Another is cognitive complementarity which exists when people have nonoverlapping knowledge and must learn from or rely upon each other. Complementary abilities should allow each crew member to contribute to the crew's welfare, sensitize each to the importance of the others' contributions, and in consequence promote solidarity and morale. However, there is little or no research characterized by systematic efforts to relate complementary and overlapping abilities to compatibility within isolated and confined groups.

c. Need Compatibility

A recurrent theme in the interpersonal attraction literature is that peoples' needs may fit together in such a way as to affect group compatibility. Particularly important for present purposes is Haythorn's version (58, 59, 60, 61, 62, 63) which has been tested under conditions of isolation and confinement. This involves three patterns of needs:

a. Congruent needs are similarly appearing needs of such a nature that the satisfaction of one person's needs results in the satisfaction of the other person's needs. For example, two people who have needs to affiliate could find mutual satisfaction by affiliating with one another.

b. Complementary needs are different appearing needs of such a nature that the satisfaction of one person's need results in the satisfaction of the other person's need. For example, a person

who has a need to dominate might establish a satisfying relationship with a person who has a need to be submissive.

c. Competitive needs are of such a nature that the satisfaction of one person's need results in the frustration or aggravation of the other person's need. This might occur, for example, in a group of people each of whom is striving for dominance.

In some cases, then, similar needs will provide a basis for compatibility; in other cases, different needs will serve these ends. For example, Berman and Miller (15) found that people who liked each other were similar in terms of need for achievement but dissimilar in terms of needs for dominance. Also, it should be noted that different types of incompatibilities are likely to lead to different kinds of responses. In the Altman and Haythorn studies, some kinds of incompatibilities led to withdrawal and other kinds to increased territoriality.

Two other findings are of note. First, as the Altman and Haythorn research shows, incompatibilities which are inconsequential under normal conditions are magnified under conditions of prolonged isolation and confinement. Second, there is some evidence that need compatibility may gain in importance as a relationship progresses from the acquaintanceship stage to intimacy (73). Thus, we might hypothesize that need compatibility will gain salience on long term missions where voyagers are likely to become very intimately acquainted.

III. CREW SOCIAL STRUCTURE

In the present context, social structure refers to the power and influence patterns and social rules which help determine crew members' typical reactions to one another. Such patterns and rules may be prescribed (in which we speak of formal structures) or they may emerge in the course of group interaction (in which case we speak of informal structures). The division of labor, authority, and coordination are some of the concepts that may be entered into a formal structural analysis (17). Social structure is external to the individual, and at a higher level of abstraction.

Structural factors constrain individual behavior. They encourage dependability in performance and often make it possible for one person to substitute for another without a major disruption in group functioning. Increased formal structure or "organization" should thus be expected to promote predictability and stability within a space crew. Properly manipulated, structural factors can provide a high degree of control over a mission. Overzealous attempts to manipulate structure to "increase organization," however, can come to grief.

First, flexibility as well as dependability is a requirement for effective group performance. Formal social structures are planned on the basis of the anticipated and known. They are likely to prove inadequate in light of the unanticipated or unknown. For example, a polar expedition described by W. Smith (107) was intended to have highly defined work roles with each person having specific responsibilities such as driving or taking geological measurements. However, an icy blast through the SnoCat's

floorboard made sustained driving unbearable, and the efforts required for the geological measurements made them difficult for the geologist to conduct alone. A flexible formal social structure is likely to be particularly important for space travellers, since they will typically operate under conditions that are poorly understood or likely to change.

Second, flexibility is also required for individuals to satisfy their personal needs. Well-being requires some behavioral variety. Rigid social structures limit behavioral options. Conditions of isolation and confinement can intensify the problem, since (as previously noted) supplementary relationships with people outside of the crew are likely to be held in abeyance.

To cope with conditions that were ignored or misinterpreted during the planning phase, and to gain satisfactions unobtainable within the formal structure, groups may develop informal or emergent structures which conflict with or supplement those set forth in the official organizational plan. For example, in Smith's (107) polar traverse party, there was a breakdown of pre-assigned duties. People took turns driving, and offered the geologist assistance. In addition, patterns of social influence and friendship emerged which differed from the task-oriented relationships addressed by the original plan. The informal structuring of the tasks required about a week; the emergence of an informal status hierarchy and friendship network took about three weeks.

Given such considerations, it may be tempting to rely on emergent informal structures. However, even as there are risks from an excessively rigid formal structure there are risks from a very loose or nonexistent structure. Informal structures may be unreliable or pose special problems of their own.

First, formal structures clarify rights and obligations and establish standards for performance. Within such structures people know what is expected of them as workers and as people and find it easy to gauge their degree of success. Informal structures may not clarify rights and obligations or provide firm standards to gauge personal accomplishment. Clear expectations and standards may be important for morale. Weybrew's (119) review of the adjustment of submariners suggests that crew members with clearly defined roles maintained more favorable attitudes during submergence than did crew members with poorly defined roles.

Second, small groups about to undergo a period of isolation and confinement may believe that they don't really need a leader and may give little thought to the possibility that they need to develop rules and enforce them (25). Congeniality and dedication may seem to suffice. Later, a severe penalty may be incurred for such laissez-faire attitudes. Even as a bridge must be built to cope with maximum stress, not simply with the average stress upon it over a prolonged period of time, space crews must be able to cope with maximum challenge. A laissez-faire attitude that is sufficient under normal conditions may prove grossly insufficient under challenging conditions. For example, situations may arise which require prompt action and do not allow the luxury of a leisurely discussion of responsibilities and approaches. The designation of responsibility and enforcement power which flows from the formal organization structure may not guarantee correct action in an emergency, but it may lower the likelihood of disaster by default.

The problem, then, is one of achieving balance between organization and flexibility. Formal or imposed social structures will to some

extent reflect ignorance or misperceptions of the actual conditions in space, and some degree of insensitivity to the crew's human needs. Informal structures are sure to arise. From a planning point of view, the trick is to create conditions such that the two structures complement and supplement one another rather than conflict.

A. The Division of Labor - Space Crew Roles

For some time, at least, there will be no idle passengers on space missions. Each member of the expedition will be expected to perform some sort of role which is essential to the mission. As Berry (Ref. 16, p. 1142) notes:

> ...in order to ensure that crew interaction is orderly and does not become a source of friction, roles must be strictly defined. The assignation of specific roles has been a feature of past space flight missions and will be a feature of future ones. As space crews grow larger and mission length increases, organizational structure will become even more important...

1. Types of Roles

Four types of roles would seem to be important on missions of any appreciable size. These include (1) flight operations roles; (2) scientific-investigative roles; (3) environmental support roles, and (4) personnel support roles. On small missions, we would expect some "doubling up" such that a given individual serves more than one role. On very large missions, we would expect many different people within each role category.

Flight operation roles involve command, navigation, flight engineering, systems monitoring, and tele-communications. Historically the first to

develop, such roles remain the most essential on any mission. Scientific-investigative roles involve research functions. Occupants of such roles are expected to generate new data which has relevance beyond the immediate flight. Although perhaps not essential for any one mission, scientific-investigative roles in the aggregate help justify space exploration. Environmental support roles involve management of supplies and maintenance of facilities. Environmental support roles are essential for a mission, and on small missions easily combined with flight operations roles. On truly large missions, such roles might range from the equivalent of a quartermaster general to the equivalent of a personal steward or "houseboy." Personnel support roles involve maintaining physical and mental health, satisfying the psychological needs of the individual, and boosting the morale of the crew as a whole. On small missions, this may require no more than a physician well trained in group dynamics and interpersonal relations. On large missions, a fairly elaborate personnel support subsystem might evolve. Personnel support roles are expected to gain salience as missions become prolonged.

Although these different roles are intended to complement and supplement one another to the benefit of the overall system, there is some potential for conflict among the people who are likely to hold these different roles. First, systematic differences in personal backgrounds and values may generate on-board frictions. For example, flight operations and scientific-investigative personnel may not see eye to eye on the importance of collecting data for use in the future. Education and socioeconomic standing may set both flight operations and scientific-investigative personnel apart from environmental support workers. People within different

occupational groups may have incompatible tastes. For example, Doll and Gunderson (34) reported that scientific-technical personnel in the Antarctic preferred classical or "long haired" music, while navy support personnel preferred country and western. Although such differences may seem minor, they may not remain so under conditions of prolonged confinement.

A second problem arises if some roles are seen as more important than others. For example, environmental support roles may be assigned low status by other crew members, and personnel expected to risk their lives in extra-vehicular activity might see personnel support workers as frivolous. We can expect crew members to be likely to see people who have the "less important" jobs as not fully carrying their own weight, and over time people performing such work may lose self esteem.

Yet another threat is that people within a role category will form factions or cliques with boundaries which discourage friendly interaction with members of other cliques or with non-affiliated individuals. Factions may show a certain amount of prejudice against one another, or attempt to reach "special interest" goals which are incompatible with the overall plan for the mission. For example, scientific-investigative personnel might argue in favor of a dangerous, but curiosity satisfying, change in course.

It is thus necessary to insure good communication and cordial relations among different formal subsystems or informal factions. Likert (78) has suggested that this can be achieved by having certain individuals maintain simultaneous membership in two or more subsystems, factions, or groups. A person serving this linking pin function is likely to understand the needs and views of each group and to be able

to represent each to the other. We do know from Tektite that participation in the activities of two or more subgroups improves intergroup relations in isolated and confined groups (99). In Tektite, benefits accrued from having the engineers and the scientist-aquanauts play active roles in each others' field of expertise.

2. Role to Role Personnel Rotation

There would appear to be certain advantages to allowing crew members to perform many different tasks prescribed by the organizational chart. Shurley et. al. (104) suggests that role rotation and personnel exchange can:

a. allow people to gain other people's perspectives;

b. foster tolerance for behaviors that are perceived as idiosyncratic but actually due to structural or role variables;

c. encourage mutual problem solving; and

d. help meet some of the needs frustrated by the abandonment of terrestial roles.

To this roster of benefits we might add:

e. provide welcome variability in a relatively unchanging environment;

f. lead to a breakdown of invidious status distinctions;

g. underscore the importance of each role for the integrity of the overall mission.

Kahn (69) has advanced a system whereby organizational requirements are satisfied while still providing each individual organizational member with as much flexibility and variety as possible. In the present context, the process would first begin by determining the shortest length of time

that it is economically feasible and psychologically meaningful for working at a given task, such as navigating, analyzing data, or working in the galley. For purposes of illustration let us assume this unit of time to be two hours. Time task units are referred to as work modules. From the grand perspective, a large scale mission might consist of thousands of modules involving scores of crew members performing hundreds of tasks. Under conventional forms of organization, a mission would consist of a certain number of "shifts" or "watches" each of which requires repetitive activities on the individual's part.

Under Kahn's system, a crew member might be allowed to qualify for several different kinds of tasks (such as navigating, analyzing data, and working in the galley) and then construct his or her own schedule using the requisite number of modules. For example, one crew member might choose two modules of navigating, one of analyzing data, and one of working in the galley to satisfy the requirements of an eight hour watch. Still another might change job content by day of the week.

Moreover, Kahn's system would provide a crew member with the opportunity to vary the way he or she distributes work in the course of the overall mission. For example, rather than standing one watch a day, a person might stand two watches one day and none the next. Thus, within the limits established by the individual's qualifications and the organization's needs, crew members could, in effect, construct their own jobs. From the overall perspective, the mission would still consist of thousands of modules involving hundreds of tasks. However, the mission's requirements would be satisfied without requiring each participant to do the same thing at the same time week after week.

B. Authority Structures and Leadership Activities

Authority structures establish influence patterns within a group. An organization sponsoring a space mission can influence activities on board by investing certain people with the right to exert influence, awarding tokens of rank and status to remind others of this right, and giving this person control of available sanctions. In effect, the sponsor delegates its own authority to the crew leader in the hopes that he or she will manage the material and human resources in such a way that the sponsor's goals are achieved.

Heavy demands are likely to be placed upon people performing leadership functions in space capsule microsocieties. These demands are expected to become increasingly burdensome as the mission continues.

First, there will be incredible task requirements. For a long time to come, astronauts will be expected to safely operate what is tantamount to an experimental craft in a hostile environment. Although there will be advance preparation, and some degree of communication with resource people on Earth, supplies will steadily deplenish and as distance increases it will become increasingly difficult to maintain good communication with Earth. For all intents and purposes, all problems will have to be solved using the highly limited resources available in the closed environment of the space capsule.

Second, the demands on leaders' interpersonal skills are likely to be equally or even more formidable. We don't really know how people will relate under conditions of months or years of isolation and confinement, but expectations tend to be grim. Someone in a leadership role will have to be consummate in interpersonal relationships.

A failure to fulfill the requirements of leadership can lead to severe penalties for the group. In the 1959-1960 fallout shelter studies (112, 113) a deliberately passive role on the part of the shelter commander was credited with a general lowering of standards of behavior and a loss of interest in matters of civil defense. The Georgia Fallout Shelter Studies also found that mismanagement led to increased friction and decreased morale (55, 56, 57). Competent leaders, on the other hand, may serve as models whose enthusiasm and even temper are emulated by the crew. They can prevent factionalism, and ease group members through troubled relationships.

How can we ensure good leadership on extended duration space flights? One possibility is to create positions with immense social power and then find the best possible persons to fill them. Underlying prescriptions for strong and well-defined leadership roles are (1) a conviction that there must be a strong advocate of the sponsor's interests on board; (2) an assumption that only a single individual's decison can be fast enough to stave off certain dangers; (3) an assumption that crew members will feel at home because they are used to functioning in hierarchical structures; and (4) presumed benefits from maintaining a form of organization similar to one commonly found on Earth. Certain components of this rationale, however, are open to question. For example, not all potential crew members will be used to functioning around the clock in formal hierarchical structures, and it has not been proven that a space capsule microsociety has much to gain from mimicking a form of organization prevalent on Earth. Furthermore, prolonged separation from Earth may undermine vested authority. This has been well stated by Haythorn (59):

"Leadership and other behavioral patterns are clearly determined to some degree by role expectations and behavioral prescriptions of larger segments of organizations and societies than are fully represented in the small group. When groups are isolated from contact with the larger society, these prescriptions and expectations cannot be as frequently and strongly reinforced as they normally are. There appears under these conditions, to be a strong tendency for group behavior to become more directly a function of the needs, abilities, and expectations of the group members and less related to society than is normally the case. Leadership under such circumstances is unable to rely as strongly on formal role relationships and must depend more on the individual capabilities of the men to whom leadership is assigned."

The social power which gives rise to leadership influence rests on several bases (43). These include legitimate power, reward power, punishment power, referent power, and expert power. Legitimate power, a result of the sheer act of being delegated authority, may decline as the ties between the macrosociety and microsociety are weakened. Reward power and punishment power may also be reduced as Earth becomes remote. For example, an augmented or docked paycheck may lose significance in a microsociety where regular currency is not used, and it is difficult to "fire" someone who has no place to retreat. Referent power and expert power may be less susceptible to loss. Referent power results from being a likeable or charismatic individual; specifically, a person with whom others in the group seek to identify. Expert power, as the name implies, is based upon technical competence and human relations skills.

1. Autocratic and Participative Structures

In autocratic decision making structures, individuals are accorded the right to make decisions personally. In participative structures, followers' inputs are actively entertained. Participative arrangements include (1) consultative decision making, in which the leader seeks opinions of informal leaders and of rank and file; (2) representative democracies; and (3) full democracies, which involve voting or concensus-seeking by all group members.

Early "leadership climate" research undertaken on the eve of World War II suggested many advantages to the democratic approach (77). The picture which has emerged since, however, contains many complexities, and it is now recognized that the optimum point along the autocratic-democratic continuum depends upon such things as the personalities of the group members, the distribution of knowledge and skills within the group, and the group's size and organization. For example, people from traditionally authoritarian societies, or who score high on measures of authoritarianism, tend to prefer autocratic, hierarchical structures (116). When a leader's skills and abilities are clearly superior to those of the other people in the group, an autocracy offers protection against ill-advised recommendations from the group. When speed is of the essence, democratic structures may prove unweildy, particularly if the group is large and/or involves unanimity rule (108). On the other hand, non-authoritarian individuals tend to prefer democratic decision making structures and procedures. When each member in the group has talents and skills, each can make valuable contributions to the ultimate decision. Most reviewers believe that the modal group members can offer very useful

information, and conclude that far more often than not the quality of a decision will be enhanced by membership participation (71, 74). If the group is small, or very well organized, it may be ready to respond without any significant loss of time. Finally, rank and file members are likely to feel more personal commitment to decisions which they have helped make than to decisions which have been imposed from above (23, 71, 74).

It may be neither necessary nor desirable to establish structures and procedures such that all decisions can be traced to one point on the autocratic --- democratic scale. There may be some advantages from making some types of decisions autocratically (for example, those concerning action in an immediate emergency) and some democratically (for example, those concerning a re-apportionment of work or responsibility within the crew). An analysis of situations, personnel, and likely scenarios would seem helpful for maximizing the advantages and minimizing the disadvantages associated with various leadership structures.

The literature has much more to say about relatively autocratic, hierarchical structures than those of the more democratic variety. This may reflect, in part, the fact that many of the isolated and confined groups studied in natural settings have been organized along military and paramilitary lines, and an assumption that future space crews will also be organized in accordance with the military model. Issues concerning hierarchical structures include social distance, status congruity, and command solidarity.

a. Social Distance

There is no question but that workers in almost every setting

studied express strong preference for close, friendly, sympathetic leaders who demonstrate a personal interest in them (78). In the "Deep Freeze" studies, the most esteemed leaders tended to actively participate in the men's activities, establish personal relationships with each man, and seek consultation on matters that affected the men (99). On the other hand, a certain amount of social distance is often seen as a requirement for taking necessary but unpopular actions (121). Long duration space flight is expected to involve physical conditions which make the continued maintenance of social distance quite difficult.

b. Status Congruity

There is some indication that if hierarchical structures are used, crew members' positions should be congruent with their normal positions and with those prescribed by the official organizational chart.

First, the hierarchical ordering of crew members on board should bear a reasonable correspondence to their hierarchical ordering in their everyday terrestial roles. In a military crew, for example, a high ranking officer should not be made subordinate to a low ranking officer. Status incongruency is seen as a likely source of psychological stress and interpersonal conflict. Indeed, creating conditions of status incongruence (for example, having enlisted men control a squad of officers on a ditch digging detail) was one of the "brainwashing" techniques which undermined the morale of American POW's in Korea (98).

Second, a substantial discrepancy between the formal and informal structures can also be problematic. Consequently, advocates of hierarchical structures recommend against situations where a duly appointed leader is consistently ignored in favor of an informal purveyor of encouragement and advice.

Good selection procedures, coupled with a detailed study of the crew as a crew prior to departure, should minimize this problem.

c. Command Solidarity

It is considered essential by some theorists that the leader maintain solidarity with the person who is second in charge. Ships' masters recognized this need by refusing to "dress down" the first mate in the presence of the crew (29). Certain problems emerging in the Douglas simulation study were traced to the leader's critical comments about the second in command (99). A failure to maintain solidarity raises the possibility of a dangerous coalition between the second in command and a lower subordinate (20).

2. Task and Socioemotional Leadership Roles

Repeatedly, distinctions have been made between task activities (also known as initation of structure and concern for production) which help the group get the job done or move towards its goals, and socioemotional activities (also known as showing consideration and concern for people) which promote harmonious relations within the group. Group functioning requires people who take the initiative in each of these areas. Socioemotional leadership is seen as at least as important as task leadership, and perhaps more so judging by some of the reseach.

It is not clear that the same individual can satisfactorily fill both task and socioemotional leadership roles. The pioneering research by Bales and his associates (10, 11, 12, 13, 14) found that some people engaged in more task and socioemotional activities than others, and as a result were offered leadership status. But it was also found that the person who engaged in the most task activities was not the same

person who performed the most socioemotional activities. There were, in effect, two leaders; the task leader, who was rated as having the best ideas, offering the most guidance, and being most influential in forming the group's opinions, and the socioemotional leader, who was the best liked. The usual explanation for the emergence of the second leader is that a task leader's sense of purpose gives rise to heavy-handed activities (unpopular orders, sharp criticism, etc.) which hurts peoples' feelings. The second leader emerges to smooth things over and restore equilibrium to the group.

But it should be noted that the initial studies involved emergent group structures. That is, unacquainted individuals joined a discussion, and social structure emerged as interaction progressed. The task leader took a role of power and influence, and it may have been his presumptiousness that caused the internal conflicts. According to Burke (18), when a leader is designated by a higher authority and is hence perceived as "legitimate," group members are more accepting of heavy-handed task acts and the need for a second leader diminishes. The issue, however, is far from resolved, and Katz and Kahn (71) have recently concluded that only under rare conditions are task and socioemotional leadership roles best filled by the same individual.

3. Structure, Personality, and Leadership Effectiveness

A prevalent theme is that certain kinds of people will make better leaders than other kinds of people. Summarizing the results of scores of studies, Mann (81) reported that intelligence, adjustment, and extraversion bear a substantial relationship to leadership, and that dominance, masculinity, and interpersonal sensitivity are somewhat less

closely related to leadership. Observations of Sealab II led Radloff and Helmreich (93) to suggest that people under stress in isolation and confinement may not need a young, action-oriented leader as much as a mature individual who inspires identification and provides reassurance. Citing work by Misui and Shirakashi (85) and Cooper (24), Kubis (75) derived the following composite picture of the effective space crew leader:

> ... he elicits the best from his men... is himself personally conpetent... is interested primarily in results and achievement... but is always aware of the normal human needs of the group and attempts to provide opportunity for their satisfaction...

A person who can lead competently under one set of conditions may prove ineffective under other conditions. Properties of the situation and properties of the leader will combine to yield a given level of performance (22, 41, 42, 71, 81). Perhaps the most promising theory which simultaneously considers situational and personality factors is Fiedler's (41, 42) contingency theory of leadership. Concerned with predicting performance rather than satisfaction or morale, contingency theory has been tested successfully in many military and civilian settings, and deserves close attention from space mission planners. The independent variables are situational favorableness and leadership style, and the dependent variable is leadership effectiveness.

Situational favorableness refers to structural and social climate variables which make a group "easy" or "difficult" to lead. These include (1) the extent to which the leader is accepted and respected

by the group; (2) the extent to which the group's goals are clear and structured; and (3) the extent to which the leader has been invested with the power to reward and punish group members.

Leadership style refers to the leader's orientation towards tasks and people. This is determined by asking the leader to evaluate the least preferred coworker (LPC) with whom he or she has ever worked. High scorers, who tend to give favorable ratings to the least preferred co-worker, are relatively socioemotional in outlook. Low scorers, that is people who assign harsh ratings to their least preferred co-worker, have more of a no-nonsense task orientation.

Leadership effectiveness, the dependent variable, is operationalized by any objective measure of task accomplishment.

According to contingency theory, different degrees of situational favorableness require different types of leaders. Under conditions of very high or very low situational favorableness, the task-oriented low LPC leader is likely to prove most effective. As Jacobs (66) so aptly puts it, the leader can afford to be firm when accepted by the group, pursuing clear goals, and invested with power to reward and punish. He or she must be firm when rejected by the group, grappling with ambiguous goals, and lacking the power to reward or punish. Under conditions of intermediate favorableness, the interpersonal sensitivity of the high LPC leader is likely to be of use for working through the moderately troubled relations within the group, thereby freeing the group to continue toward its' goal.

Careful planning may be able to create and maintain a high degree of situational favorableness on short term missions, but such conditions

may be difficult to sustain on prolonged flights. For example, it may be relatively easy to link the leader's evaluation of crew members to the latter's continuation and advancement within the space program. But as already noted, as the link with Earth becomes tenuous, traditional bribes and threats may lose force. Thus, whereas task-oriented, low LPC leaders may do best on carefully planned short flights, socioemotionally oriented, high LPC leaders may have an edge on longer flights. This is assuming, of course, that on long distant flights conditions do not deteriorate beyond repair.

a. Coordination Through Social Norms

The coordination of individuals is in part achieved through social norms. These are socially devised rules and standards which provide both guidelines for interpretation and evaluation and regulations for individual conduct. Normative structure refers to the entire set of interlocking norms in use by a group. On a U.S. space flight, the crew's normative structure will be in part derived from society's norms, in part derived from NASA's norms, and in part derived in the course of interaction within the group.

A group which maintains an elaborate and clearly defined set of norms is expected to function smoothly. But norms which are too rigid or too strictly enforced can have dysfunctional consequences. Some flexibility is required to encourage innovative behaviors, to allow social variety, and to minimize the dangers of ostracism.

It is important to gain a better picture of space crew norms and their likely rationales. Dysfunctional norms may evolve which impose excessive restrictions on behaviors which do not threaten group

stability or detract from mission goals. On the other hand, there may be some important conduct areas requiring normative constraints which the normative structure does not cover. In other words, there might be some value in an independent analysis of required and optional behaviors and verification that the normative structure is built and enforced appropriately. The process of norm enforcement or conformity is dealt with in the next section.

Crews are likely to seek norms which (1) coordinate themselves in pursuit of the common goals, and (2) regulate interpersonal relations during the flight. With respect to the latter, some norms are likely to be aimed at the minimization or control of hostility. Social norms can, to some extent, dictate under what conditions hostile reactions are acceptable, and the manner or form in which the hostility can be expressed. Indeed, there is considerable evidence that such norms have evolved in isolated and confined groups. Since the early 1960's it has been repeatedly noted that although isolated and confined individuals can become resentful of and antagonistic towards each other, these feelings are suppressed for the sake of the mission (42, 69, 70). In addition, many of those hostilities which are expressed tend to be directed away from fellow crew and towards inanimate objects or outside authorities (69, 70). It simply isn't known whether or not normative constraints can contain hostilities over a period of months or years.

IV. CREW DYNAMICS

In the present section, our focus turns to some social processes that are likely to occur within small crews. After briefly considering the general course of social relations under conditions of prolonged isolation and confinement, we shall consider the specific topics of conformity, cohesiveness, and interpersonal conflict.

A. Space Crew as Family

For the duration of the flight, the gratifications normally sought from one's family or other living group will have to be sought from the crew. Whether or not the interim family will prove rewarding should depend on its ability and willingness to offer reference points for social comparison, validate self-concepts, and provide stimulation, approval, and support.

Studies of isolated and confined groups suggest that tensions on board are likely to rise and morale to decline over time. Not all studies suggest this. For example, despite the dangerous and harsh conditions of Sealab II, at the end of the 15 day mission morale was high and most aquanauts were ready for more. However, in the Antarctic, Gunderson and Mahan (51) and Gunderson and Nelson (53) found that work satisfaction, social relatios, and group accomplishment deteriorated. In the 1964 Boeing 30-day simulation, increased time was associated with (1) increased annoyances, interpersonal conflicts, irritability and hostility; (2) decreased feelings of being happy, comfortable, and satisfied; and (3) increased dislike for the experimenter (99). Illustrative also is the following partial summary of a fallout shelter study (Ref. 99, p. 68):

"...projective tests showed feelings of depression, increased irritability, friction, feelings of dissatisfaction, disgust, and discomfort. Confinement produced a general depressive mood - this was also confirmed by the personal diaries. During the... last 4 days, no positive mood relationship existed..."

Rohrer's (96) observations suggest that deterioration does not continue indefinitely. He has identified three stages of reaction to prolonged isolation, confinement, and stress.

The first stage is a period of heightened anxiety brought about by the perceived dangers in the situation. If moderate (rather than excessive), heightened anxiety should improve alertness and performance. The second stage, which emerges as the crew settles down to a routine day-to-day existence, is depression. Moods during this second stage are likely to result in regrets about having joined the mission. The third stage is a period of anticipation which occurs as the end of the mission looms near. Emotionality, aggressiveness, and rowdy behavior are likely. This emotionality can be dangerous because, as Kanas and Fedderson (70) have noted, at the end of the mission many complicated operations may have to be performed.

Departing from one stage and entering another does not appear to be as dependent upon the absolute passage of time as upon the relative passage of time; relative, that is, to the beginning and end of the mission. A fair amount of evidence suggests that whether the mission lasts days, weeks, or months, morale reaches a low ebb somewhere between the 1/2 and 2/3 way mark. For example, Palmai (90) reported that morale

reached a low ebb somewhere around the second third of an antarctic stay. In 30 day submarine missions, morale reaches low ebb at about day 15; in 8 week missions, during the 4th and 5th week (99). In the McDonnell-Douglas 90 day shelter simulation, crew morale was rated as good except for a period of 10 days somewhere around 2/3 of the way through the mission (99). One and two-week confinements in fallout shelter simulations undertaken by the American Institute for Research also showed a pattern of high tension following entry, depression towards the midpoint, and heightened emotionality towards release (99). The results are not entirely in accord, for as already noted, some reports make no mention of an upswing in morale towards the end of a mission, and, in Sealab II, morale didn't decline over time (93). However, many studies suggest that mood is related to psychological anchor points, whether these points be relatively close or relatively far apart in time.

B. Cohesiveness

Some groups show more sparkle and verve than do others. In some groups, interaction is spirited and lively, and members are highly involved, both with each other, and with group activities. Cohesiveness refers to the solidarity or "groupiness" of a group. Since cohesive groups are considered "better" groups, and since cohesiveness has implications for group functioning, both the antecedents and consequences of cohesiveness are of interest. Although originally intended to be a unitary construct, cohesiveness sometimes designates a group with energy, drive, and a strong sense of purpose, and other times a group characterized by interpersonal harmony. Whereas drive and amiability often covary, it is possible for a group to be characterized by one of these attributes but not by the other.

In some cases, adverse conditions and suffering seem to increase cohesiveness (45). In effect, undergoing a trying initiation encourages people to rationalize the discomfort by telling themselves that membership in the group is extremely desirable. However, most discussions focus on the rewards or satisfactions of group membership as the major cause of cohesiveness. Cartwright (22), for example, has defined cohesiveness as the sum of the satisfactions which membership accords all the members of the group. Satisfaction is likely to be high to the extent that the group (1) engages in activities that the members find intrinsically satisfying; (2) pursues goals of importance to the members; (3) provides social support and emotional gratifications; and (4) serves ulterior motives. Thus, a crew might be expected to be cohesive when the crew members (1) enjoy flight and adventure; (2) subscribe to the mission's overall goals; (3) encourage each other; and (4) provide welcome relief from alternative activities.

Group goals are likely to have a major impact on the tone of interpersonal relations within the group. The isolation and confinement literature, for example, suggests that individuals may be able to suppress their differences in the interests of goup goals. In Sealab II, for example, some aquanauts commented that teammates who didn't always see eye-to-eye were able to get along for the period of the mission. Group goals deserve careful attention when planning a mission.

First, it should be useful to identify goals of superordinate status. A superordinate goal is one which is (1) shared by all group members, and (2) overrides individual goals which, if pursued, might

encourage behaviors detrimental to the mission. Such goals (1) must be accepted rather than imposed; (2) require cooperative activity; and (3) represent more than glowing slogans.

Second, steps might be taken to ensure that group goals are clear and well understood. Discussing antarctic groups, Natani and Shurley (86) have noted that scientists are given a brief introduction to the "big picture" at an orientation conference, but that their goals remain basically individualistic. Navy personnel are given only a minimal understanding of their science support role, with the result that they find it difficult to become firmly committed to the overall mission. When goals are ambiguous socioemotional activities are likely to take precedence over task activities.

Finally, it may be difficult to remain committed to distant goals over prolonged periods of time. It may thus be desirable to have a number of interim goals which can be pursued and savored. Perhaps this has been best expressed by Sells and Gunderson (Ref. 101, p. 82):

> "...To maintain group integrity and motivation of group members, the void between initiation of a mission and final attainment of its goals must be filled with richly detailed programs of activities that permit achievement of meaningful interim goals. It is also important that both the ultimate and intermediate goals be expressed in a manner that permits assessment of success in such a way that it is compatible with supervisory controls, available rewards, and individual career growth..."

Helmreich (64) and Radloff and Helmreich's (93) work suggests that with each successive mission the rewards for participation are likely

to dwindle, with the result that cohesiveness may also decline. Both the costs of space travel (risk, discomfort, and so forth) and the rewards (increased feelings of competence, social recognition, and so forth) may be expected to decrease as technological and other factors conspire to make space travel safer and more routine. However, the rate at which the costs may be expected to decline is not likely to be as fast as the rate at which the rewards will decline. For a while, at least, the risks and discomforts of space travel are likely to become increasingly less justified by the benefits, and this is likely to adversely affect crew morale.

Cohesive groups are often efficient and effective (79). However, the relationship between cohesiveness and performance is not entirely straightforward. First, successful performance can be a cause, rather than an effect, of cohesiveness. Second, social norms mediate the relationship between cohesiveness and performance. If the normative structure supports performance-related activities, then cohesiveness is likely to improve performance. If, on the other hand, norms support limiting output or "goofing off," cohesiveness may undermine performance. In addition, cohesiveness is likely to increase conformity.

C. Conformity

A certain amount of social activity aimed at eliciting conformity to group norms is generally regarded as beneficial, because it promotes coordination of efforts and a sharing of values within the group. However, such influence processes have certain potentially adverse effects which may become pronounced under conditions of isolation and confinement.

First, some problems that confront groups require novel solutions. Strong conformity pressures can inhibit the flow of creative ideas, particularly

in a cohesive group. Individuals may fear that unorthodox suggestions will undermine morale or yield personal rejection. Special "brainstorming" instructions, which discourage censorship, do spur creativity, but there remains an inbiting effect due to group membership, especially in military groups .

Janis (67, 68) has coined the term groupthink to refer to conditions under which efforts to maintain group harmony undermine critical thought and lead to poor decisions. Space crews appear to be quite vulnerable, since groupthink becomes likely when (1) the group is concerned with maintaining amiability, (2) there is little or no communication with people outside of the group, and (3) the group is confronted with a threatening situation. Among the most important characteristics of groupthink are:

a. false optimism and a lack of caution,

b. direct pressures on nonconformers,

c. a fear of disapproval for expressing new alternatives,

d. an illusion of unanimity,

e. the emergence of "mind guards" who protect the leader from criticism, and

f. efforts to deny or rationalize all ill-omens.

There are three useful safeguards against groupthink in space crews. First, any external input is likely to be of value. On smaller missions, this might be accomplished through telecommunication consultations; on larger missions, one or two "outsiders" might be asked to comment on the inner group of decision makers' ideas. Second, one or more members of the decision making group might be appointed "devil's advocate" to

challenge the majority's views. Also, Janis suggests that if time permits, there is some advantage to "sleeping on a decision" and then reconsidering before taking action.

A second problem is that strong conformity pressures can include a form of ostracism which is unacceptable under space flight conditions. A person who operates outside of the group's norms is likely to trigger a specific series of events (97). The initial reaction is an increase in communications intended to bring that person back into line. If these attempts are unsuccessful, communication ceases and the deviant is ignored. Under normal conditions, such ostracism may simply result in the deviant leaving the group.

Under conditions of isolation and confinement, the deviant cannot leave the group. The isolate may display pathological characteristics associated with the "long eye" syndrome (sometimes described as the result of a "twelve foot stare in a ten foot room") (54, 96). Noted primarily in polar camps, this syndrome may involve hallucinations, tears, loss of appetite, silence, suspiciousness, and sloth. This is not only extremely punishing to the rejected individual; it penalizes the group by robbing it of the services of one of its members. This can be a major problem in small crews which begin the mission only minimally staffed.

D. Interpersonal Conflict

Discussions of intragroup conflict tend to stress conflict's adverse or deleterious effects. Certainly, conflict which destroys morale, or makes it difficult or impossible to reach group goals, must be averted. However, conflict is natural and inevitable, and has some functional as well as dysfunctional consequences (95).

a. Conflict is necessary for establishing group norms. Subsequent conflict tends to arouse norms, and in this way contribute to cohesiveness or solidarity.

b. Conflict is a requirement for change. A certain amount of deviation and controversy surrounds innovative ideas and the clarification or altering of goals.

c. Several theories of personality, predominately the psychodynamic theories, suggest that conflict has a cartharctic effect of drawing-off tensions and restoring equilibrium. Thus, conflicts should retard rising tensions within the group. Furthermore, it is believed that conflict on a small scale can avert conflict on a large scale. That is, minor conflicts can prevent tensions, mounting to the point that there is likely to be a major "blow up."

A certain amount of conflict is not only inevitable, then, it may be of some advantage to the group. The question is how to set limits and manage conflicts in such a way that they do not become destructive. To some extent, almost everything that we have touched upon thusfar relates to this issue. For example, crews may be composed in such a way as to minimize initial incompatibilities, and leaders chosen in part on the basis of ability to maintain equilibrium within the group. Here we shall thus consider the additional factors of human relations training, the use of pre-formed or established groups, and communication.

1. Human Relations Training

Both task and socioemotional training can be expected to help reduce interpersonal conflicts. First, people who don't know what to expect

and don't know how to do their jobs are likely to frustrate and annoy one another. In addition, people who are unskilled may respond to a poor overall level of performance by acting towards one another in negative ways (104). Second, both Kubis (75) and Berry (16) have advocated direct training in human relations. Such training may involve the entire crew, or, if this is impossible, crew members who are in managerial roles or who are to be personnel support specialists. Training in interpersonal relations was considered valuable by subjects in the Douglas simulation study (99).

2. The Use of Established Groups

The use of established (as compared to newly formed) groups may help minimize interpersonal frictions. First, assembling the group well before the mission provides an opportunity to actively observe the separate personalities in interaction and to take remedial action if the necessary degree of compatibility is not achieved. Studying the group as a group would provide a back-up to the initial selection process (91, 92). Second, group formation involves a number of stages, one of which is characterized by interpersonal conflict ("storming"). There is some questions as to whether this stage precedes or follows coordination in pursuit of task goals (63, 105), but there is agreement that at some point group development requires thrashing out norms, testing limits, and reconciling interpersonal differences. Use of a well established group which has already passed through the "storming" phase would keep some of these conflicts out of the spacecraft.

Not all microsocieties in space will be closed systems. There is likely to be some turnover in orbiting laboratories or settlements. This

raises the problem of introducing and assimilating newcomers into the group. According to a recent review by Crandall (26), because newcomers don't share the continuing members' knowledge and attitudes, they are likely to unintentionally act in disruptive ways and to be seen as disloyal to the group. Aware of this problem, newcomers themselves are likely to be anxious and prone to conform. Crandall and Moreland (27) found that groups of newcomers are likely to treat each other preferentially, and view themselves as a "group within a group," a perception which would seem to only aggravate the assimilation problem.

Crandall describes several methods for easing the integration of newcomers into on-going groups. First, there is pre-entry therapy, which encourages anxiety control and reduces the need to conform. Second, newcomers can be presented models in the form of current or former group members prior to their entry. Third, newcomers may be given candid and realistic (as compared to guarded and idealistic) information about the group. Finally, newcomers can be sponsored; that is, an established group member can introduce and tutor each newcomer. All of these procedures are likely to reduce conflict and attrition.

3. Communication

Communication flow will also affect the tone of interpersonal relations within the crew. In small missions, crew members may be homogeneous in terms of intellect, education, socioeconomic background, and other factors which should facilitate communication and understanding. In larger crews, we would expect increasing heterogeneity to impede the flow of communication. We would also expect more indirect forms of communication; that is, communication through intermediaries. Each

point in the chain provides a new opportunity for message distortion and misunderstanding.

Communication with people outside of the space capsule may help maintain cordial relations within it. Personal communications systems which make it possible to converse with family and friends have the potential for reducing anxiety concerning events at home and for reducing dependency upon fellow crew members for the satisfaction of all interpersonal needs. Accordingly, Berry (16) argues that space voyagers should be given ample opportunity to communicate with the people who are important to them personally, and that a scrambler system or comparable device should be used to ensure privacy:

> As early as Gemini 7, efforts were made to combat the potentially demoralizing effects [separation from family and friends] might produce by supplying crewmen with news of events on Earth and arranging for them to talk with their families. These steps should be continued in future space flight missions, with all possible efforts being made to ensure that communications can be conducted privately...

News from home could presumably be anxiety-provoking rather than anxiety-reducing. Family left behind may resent the separation and communicate this in subtle and not so subtle ways. News of a death in the family, or a "Dear John" message could have a tremendously demoralizing effect.

Censorship, however, is a rather complex issue. If crew members discover a policy of censorship exists, their imaginations might run away with themselves. The impact of occasional bad news may pale into

insignificance in comparison to the fantasies forthcoming from a recognition that "Ground control may be keeping something from me." In some cases, sound judgment may warrant the selective transmission of news. However, strong arguments can be marshalled against general censorship policies which could undermine ground control's overall credibility.

V. DIRECTIONS FOR FUTURE RESEARCH

Over the past two decades, social and behavioral scientists have come up with many findings which may shed some light on prolonged living in space. Nonetheless, one cannot help but be more impressed by what we do not know than by what has already been discovered. Many important issues remain unaddressed, and many others have received only negligible attention. We need to know more about every aspect of group dynamics in space, but the gaps in our knowledge become increasingly prominent as we consider increasingly larger crews and increasingly longer missions.

In this section, we shall consider some of the major limitations of the social psychological research completed thusfar, and review some of the research settings and tools which are likely to prove productive. We shall then consider some representative research issues in the areas of composition, structure, and dynamics.

A. Limitations of the Available Data

We do not have that much data concerning the social psychological aspects of extended space flight, and much of the data that we do have has severe limitations. Indeed, a fairly extensive disclaimer underscoring the tenuousness of offered findings is de rigeur in most original research reports, and in all serious literature reviews. There are two major shortcomings in the available data. First, most of it has been gathered under conditions which do not approximate the degree of isolation, confinement and risk expected to typify long duration space flight. Second, data collected under conditions which do approximate some of the conditions of space capsule microsocieties is also collected under conditions which

make it very difficult to preserve methodological rigor or achieve a high degree of control.

1. Nonrepresentative Subjects and Situations

Many social psychological studies which might be cited in discussion of long duration space flight involve subjects, tasks, and settings which bear little or no correspondence to those likely to be encountered in space. For example, many of the "classical" studies in group dynamics involve college sophomores who are brought together to perform specially contrived tasks under conditions which do not include appreciable isolation, confinement, or risk. The results of such studies are not necessarily inapplicable to space capsule microsocieties, and repetitive findings which point to the same general conclusion may extrapolate quite well. Nonetheless, considering such studies it is necessary to keep in mind the kinds of variables which could render a generalization invalid.

First, most studies of small groups are limited to a very constricted range of subjects (all males; all college sophomores; all naval personnel, etc.). There may be appreciable differences between these subjects and people who participate in space missions.

Second, most studies involve subjects who are basically unacquainted with one another prior to the experiment. There may be substantial differences between such groups and the pre-formed groups likely to be sent into space.

Third, many studies which purport to use groups in fact study individuals or aggregates of individuals. In some studies, the "other people" in the group are carefully trained confederates of the experimenter, or even electronically simulated people. Space crews will consist of

highly interdependent individuals who will mutually and reciprocally influence each others' behavior.

Fourth, most studies involve only a limited span of time. This makes it difficult to generalize to on-going groups which are likely to be subject to temporal dynamics.

Fifth, most studies do not involve prolonged isolation and confinement or pronounced physical risk. Some studies, such as those conducted in polar camps, underwater environments, and spaceship simulators of varying degrees of fidelity, capture some of the elements of a space capsule microsociety and thereby reduce some of the dangers associated with generalizing results. Even in these latter studies, however, the conditions of long duration space flight are approximated rather than duplicated. For one thing, although such studies seem "long term" when compared with most small group studies, they are "short term" when compared with the anticipated requirements of many space missions. For example, the longest space simulator studies terminate between 90 and 105 days, and "wintering over" at a polar camp requires, at the outside, a year commitment (99). An interplanetary mission will consume the better part of two years (16, 101). Then, too, simulation studies, polar studies, fallout shelter studies, and even underwater studies usually don't capture the extreme element of danger or earn the participants the high degree of recognition likely to be associated with such ventures as the first interplanetary mission.

2. Trials and Tribulations in the Field

It is always difficult to conduct good research, but the difficulties are multiplied when the researcher enters an exotic environment. These

obstacles are not insurmountable, but they have handicapped researchers, and occasionally forced them to abandon preferred procedures and techniques. To the extent investigators are forced to eliminate control conditions, use gross rather than refined measures, or rely on impressions and memories, the lattitude for error in their observations is increased.

First, it may be difficult for the investigator to actually participate in a group undergoing isolation, confinement, and risk. There may be severe constraints on the number of people who can participate, and inquisitive individuals who are not essential for getting the immediate job done may have to be left behind. As a result, some researchers have been forced to study events before or after the mission, rather than during the mission itself.

Second, researchers able to accompany a mission may find it difficult to build the necessary rapport with the other members of the group. Unless a researcher is making some very clear contributions to group welfare (for example, by serving as cook) he or she may be seen as a drain on group resources and become a target for resentment. In addition, certain research activities may threaten the group, the clearest example being attempts to identify unpopular group members.

Third, in some remote environments, space and weight restrictions preclude the presence of useful research equipment.

Fourth, in some remote environments, electronic surveillance may be chosen over participant observation. That such things as videomonitors can be put to good use is shown in much of the underwater habitat research. However, electronic surveillance has itself certain limitations. Much of the action may take place out of the surveillance gear's range, and

the quality of the signals may be poor. Such gear may have to be installed in a rather inaccessible location (for example, outside of the capsule) with the result that it becomes almost impossible to adjust or fix.

Reviewing the literature, one cannot help but be impressed by the bravery and ingenuity of the researchers who have ventured into exotic environments. Nonetheless, it is important to remember that not all of the barriers to good research have been successfully overcome, and the results of such studies must be interpreted with these limitations in mind.

B. Opportunities for Future Research

We have, at our disposal, many ways for learning more about the social psychological aspects of long duration space flight. Each basic approach has characteristic strengths and weaknesses, and, to some extent, the strengths of one approach can help offset the weaknesses of another. Hopefully, future researchers, like their predecessors, will not be committed to a narrow range of research settings, procedures, and techniques.

1. Archival Research

Archival studies are based upon pre-existing records. The records investigated may be public or confidential, and may be as recent as today's newspaper or as old as the written word. Day (29) has made use of archival data in his account of life on sailing ships, and Perry (92) has proposed psychohistorical studies of explorers and adventurers to identify the personality factors that promote competent performance. Archival research has only recently gained serious attention from psychologists, but there have already been many promising developments in the areas of content analysis and statistical techniques.

2. Field Studies

Field research involves people in their natural settings and environments. Most of the field studies conducted under conditions approximating long duration space flight have taken place in polar environments and in submarines and other underwater habitats. A major compilation published in 1974 cites 50 original research papers in the former category and 58 in the latter (99).

Exploration parties other than those involved in polar and undersea expeditions appear to have received little attention, a notable exception being Emerson's study of an assault on the Himalayas (37). Mountain climbers, rafters, desert explorers, long distance bicyclists and seafaring groups exist in abundance. It should be relatively inexpensive and easy for adventurous social scientists to accompany their expeditions.

Of course, the most pertinent field studies are those conducted in space itself. Berry, for example, believes that an extended Skylab mission may be able to provide enough medical and psychological information for planning an interplanetary mission (16). It is urged that all future space expeditions include full provision for studying the voyagers' interpersonal relations.

3. Laboratory Research

Laboratory research involves studying people in special environments where it is possible to maintain a high degree of control. Adherents of this research approach attempt to create conditions which reflect the naturally-occurring conditions of interest, and to assess behavior reflective of that which occurs under those naturally occurring conditions. As Gerard and Conolley (Ref. 44 p. 242) note, such studies are predicated

"on the faith that human beings are human beings, and that social influence phenomena occurring anywhere and at any time can be interpreted within the same basic framework."

Of particular relevance in the present context are laboratory studies which attempt to capture elements of isolation and confinement (included in this category are simulation studies). The 1974 compilation includes fewer original laboratory studies (n=71) than field studies (n=108). Of the laboratory studies, 31 involved direct attempts to simulate space capsules, 19 involved attempts to simulate fallout shelters, and 21 ~~of which~~ were conducted without significant attempts to disguise the laboratory environment.

Laboratory simulations of space flight do not duplicate the conditions of space flight, but they would seem to come a lot closer than the conditions of any other kind of laboratory study. Simulations can incorporate high degrees of isolation and confinement, even if they cannot include such elements as weightlessness and risk. In addition, a clever investigator can reproduce many of the space capsule's environmental features within the simulator. It is possible, for example, to provide subjects with the same area, volume, furniture, and rations that they would have to live with in space. Perhaps the most important feature of the simulation studies is that they provide the opportunity to obtain longitudinal data under highly controlled conditions.

Many of the simulation studies conducted thusfar follow one of two patterns. One is carefully addressing social psychological variables but in a crude or minimal simulation setting. The other pattern involves simulations which have a ring of authenticity but which accord social

psychological variables only tangential concern. What we need, of course, is studies which carefully explore social psychological variables in artfully simulated space capsules. Simulation studies have considerable potential which is yet to be realized, and shortcomings in some of the expensive simulation studies conducted in the past should not prevent future attempts.

C. Issues in Crew Composition

The effects of variations in group size and the members' characteristics are not well understood. Across all studies there has been substantial variation in size and in the memberships' characteristics. But most individual studies which have been prompted by a particular set of interests and involve a standardized set of measures and techniques involved groups of constant size or personality variations which fall within a highly constricted range. For example, space simulator studies have rarely involved "crews" of more than three of four members, and whereas comparisons have been made of groups containing people with differing personalities, the people in such groups have tended to be adult males who were all attending college or were all serving in the military. There would appear to be some value encouraging studies which incorporate, within one framework, more substantial variations in group size and composition.

1. Size

There is, of course, an advantage to emphasizing research using groups of that size required to staff an impending mission. However, systematic research on varying group size is important for planning future missions or missions where crew size is to some extent optional. In the task area, crew size affects the pool of skills and ability,

motivation, and organization. In the socioemotional area, increasing size is expected to increase social stimulation, provide more friendship options, and increase the opportunity to exercise role-related behaviors. However, not all of these effects are well understood, and we lack the necessary bearings for using variations in group size to predict them. Does a given size effect occur incrementally, by leaps and bounds, or at a varying rate? Does it continue indefinitely, or reach an asymptote or plateau? Clearly such knowledge would prove of use for planning multiperson missions.

The most interesting issues involving group size extend into the areas of composition, structure, and dynamics. For example, how can we obtain the most appropriate pool of task and socioemotional skills? How can we accentuate the motivational advantages of working in groups while minimizing the motivational losses? Crew size is important largely because it will interact with other variables to produce both quantitative and qualitative changes in interpersonal behaviors.

2. Personal Characteristics of Crew Members

As indicated earlier, the personal attributes of group members may be organized into three categories. These are (1) attributes associated with membership in a large social class or group; (2) attributes deemed desirable or undesirable by most people who are undergoing isolation and confinement, and (3) attributes deemed desirable or undesirable by some kinds of people who are undergoing isolation and confinement. These were labeled class factors, semi-universal appeal factors, and idiosyncratic appeal factors, respectively. Class factors include variables associated with sex, age, and ethnicity.

With the exception of one or two polar and underwater habitat studies (most notably Tektite) and some fallout shelter studies, subjects have been almost exclusively male. Studies which have involved women have either involved very few, or have not focused sharply on sex or gender variables. More research is needed on the reactions of all female groups and mixed sex groups under conditions of prolonged isolation, confinement, and stress. Subjects for such studies might be chosen in such a way as to ensure appreciable variation in their degree of sex-typing or masculinity-femininity. This would make it possible to gain much more knowledge about androgynous and nonandrogynous individuals.

The possibility that overt or covert heterosexual pairings might prove disruptive requires serious study. Most encouraging are those findings which suggest that members of relatively isolated and confined groups tend not to get romantically involved and develop, instead, more brotherly and sisterly relationships with one another (30, 114). It must be stressed, however, that these findings come from only partially closed social systems, and although outside romantic partners may have been a bit inaccessible they were still available.

Appreciable age variation is found within many of the fallout shelter, underwater, and polar groups thusfar studied. There is considerable anecdotal evidence that, within a fairly extensive range, age variations have few or no appreciable effects. There is a substantial pool of potential astronauts in the 20's to 40's age bracket, but with an eye to the future, we need to identify the conditions under which a person is likely to be seen as "too young" or "too old" by the rest of the crew. We don't know that much about the risks posed by people who are immature, people who

are undergoing age-related declines, or intergenerational conflicts. Furthermore, we know little about the natural developmental changes which might affect a person's suitability in the course of a truly extended mission. Finally, there should be follow up to Radloff and Helmreich's findings regarding the value of a mature and wise parent-surrogate (93).

For most purposes, calendar age is less significant than variables we associate with it. That is, whereas capacities and skills are first acquired and then lost in a fairly set sequence, the rate of maturation and decline varies from individual to individual. In most cases it is better to use the age-related variables rather than age itself as the focal point for research.

US/USSR, USSR/DDR and USSR/Polish missions suggest that people can overcome subcultural or ethnic differences and work together in space. Furthermore, the race relations literature suggests that selection procedures which favor competent, high status individuals and the imposition of tasks which require the coordination of efforts in pursuit of common goals should strongly militate against prejudice and discrimination. Nonetheless, we must explore the possibility that certain kinds of sub-cultural differences could generate severe incompatibilities, and that prolonged isolation and confinement may cause otherwise suppressed hostilities to rise to the fore. Identifying such differences and finding ways to eliminate or contain prejudicial attitudes and discriminatory acts must be given greater priority in future research.

Semi-universal appeal factors include attractiveness, competence,

emotional stability, and social versatility. Given that the need to staff large missions or to simultaneously staff a number of different missions will necessarily result in decreased selectivity and increased crew heterogeneity, we need to know more about the attributes which make an individual personally appealing in light of space crew norms. It might be useful, in this regard, to devise and validate an instrument for identifying personal characteristics which crew members are likely to find distasteful or annoying. This might involve a listing of personal characteristics to be rated in terms of irritation value (unkempt hair, dirty fingernails, a squeaky voice, etc.). Once perfected this scale could be used in two ways. First, norms could be established which could provide a basis for eliminating "unattractive" space crew candidates. Second, the instrument could be used for weeding out "finicky" individuals who find too many human frailties aversive.

Discussions of competence have generally focused on task competence; that is, the person's technical skills and work motivation. However, competence research might be extended to include interpersonal or socio-emotional competence as well. Along with studies of competence involving performance measures, we need additional studies involving peer perceptions and ratings. For some purposes, actual competence may be less important than perceived competence. For example, a competent crew member who is not seen as such may have as adverse an effect on performance and morale as an incompetent crew member whose inadequacies are correctly identified. Alternatively, an incompetent person who is able to convey an impression of knowledge and skill may have a calming effect on the rest of the crew.

Many of the research questions surrounding emotional stability are questions of selection. Much more is known about how to exclude

people who are liable to react badly than how to choose people of exceptional psychological health (91, 92). Whatever the ultimate screening procedures, there is no getting around the fact that as more and more people are chosen for space missions a few "high risk" individuals will inadvertently be chosen. We need to know more about the kinds of supports or props that can be used to help people preserve or restore their emotional stability under conditions of isolation and confinement.

As in the case of competence, crew perceptions may be as important as facts when it comes to the effects of emotional instability. Acts which result in the inferrance that the performer is emotionally unstable (whether or not that inference is correct) may demoralize the crew. Of particular interest is identifying those conditions under which undue significance is read into an outburst or other act, with the result that a functioning crew member is considered no longer a member of the team.

As indicated earlier, social versatility is important because people who can engage in varied role behaviors in flight can reinstate, for one another, otherwise lost behavioral opportunities. The androgyny research represents an important effort in this area. This kind of research should be continued and extended beyond the sex role area.

Finally, our discussion of compatibility turned to the ways that peoples' idiosyncrases combine to affect how they get along with one another. Included here were attitudinal homogeneity, skill complementarity, and need compatibility.

A superabundance of research points to the conclusion that attitude and value similarity is a powerful determinant of interpersonal attraction (19). On the other hand, one would hope to find, within a given crew,

sufficient attitudinal variability to generate interaction and combat groupthink. What is the appropriate balance between similarity and differences in attitudes, opinions and beliefs? One hypothesis is that it is essential to share certain general values, but to show variability in terms of the ways these values are expressed.

Skill complementarity is a very important factor which, as Haythorn has repeatedly noted, received little or no attention. Perhaps it is time to go beyond molar analyses of individual tasks and the persons proposed to perform them, and attempt fine analyses of aggregates of tasks and groups of individuals. Attention must be directed to socioemotional as well as task skills, and include "informal" skills as well as those which are more easily assessed.

Finally, research to date suggests that it would be both useful and desirable to mount a massive effort aimed at better understanding of need compatibility. Such a program should attempt to (1) identify relevant needs; (2) show how they fit together, and (3) spell out the consequences of compatibility and incompatibility. Ultimately, screening procedures may be devised for weeding-out candidates whose needs are too likely to conflict, or ways found for keeping competitive needs under control. Researchers involved in such a program should remain sensitive to the possibility that incompatibility may not be a problem if conditions conspire to prevent crew members from detecting their differences, and that incompatibilities that disrupt one group may not affect another.

D. Issues in Crew Structure

In the present review, structural variables are super-individual forces which limit or constrain people's options, thereby increasing

the predictability of their behavior. For convenience, structural factors were taken to include roles, authority structures, and norms. The central issue is finding ways to achieve an optimal balance between structure and flexibility, such that crew members can perform well when confronted with either routine or unexpected conditions.

1. Roles

Roles provide structure through establishing rights and obligations and promoting patterned interaction among people in interlocking roles. Preceding each mission it might prove useful to identify the necessary and optional crew member roles which are likely to make the mission a success. Procedures must be found to insure role clarity; that is, encourage shared perceptions concerning the nature of the different roles.

Of continuing interest is the threat that people in similar work roles may form factions or blocs which conflict with one another or discourage interaction with nonaffiliated individuals. Techniques are needed to detect and combat own group bias, promote inter-faction communication, and encourage far-ranging friendship networks. One hypothesis is that if people within subgroups are dissimilar in terms of their off-duty interests, but have off-duty interests similar to those maintained by people in other subgroups, the potential for conflict is reduced.

Closely related to the problem of reducing factionalism is the problem of identifying and ensuring those conditions under which each crew member recognizes the other crew members' importance. Perhaps the critical variable here is perceived fairness: that is, a conviction that everyone is carrying his or her weight and receives rewards that are appropriate given the level of his or her contributions. We need to know more about

perceived fairness and equity under conditions of isolation, confinement and risk.

Finally, writers who advocate role rotation suggest further research into building variability into the daily lives of space voyagers. We need to find techniques for selecting people who can competently perform more than one role, and for devising roles in such a way that several can be competently handled by a given individual. Of particular interest would be a task analysis which would make it possible to conceptualize a mission in terms of work modules. In open social systems, work modules provide workers with increased challenge and flexibility. In closed social systems, we might expect their value to be enhanced.

2. Authority Structures

Influence structures, leadership activities, and decision making processes have received a fair amount of attention in the studies reviewed in this paper, but the general area of authority and leadership remains "wide open" for future research. Certain alternatives have received little attention, and many studies have treated as incompatible alternatives which might in fact complement and supplement one another. Investigators in this area would do well to entertain a wider range of decision making alternatives, and remain sensitive to the possibility that a given type of authority structure is not likely to be equally suitable for all kinds of groups.

One issue is finding the optimal distribution of leadership behaviors within the group. Specifically, to what extent should various task and socioemotional leadership behaviors be concentrated in the hands of a specific leader (and back-up leaders) as compared to distributed among

the different members of the group? Of particular interest in light of Burke's (18) arguments is determining the extent to which a given individual should attempt to manage both task and socioemotional leadership roles.

Our review suggests that decision-making procedures which lie at different locations along the autocratic-democratic continuum have different strengths and weaknesses. For example, autocratic procedures promote speed, and democratic procedures promote acceptance of the decision. Here we need to address such possibilities as mixed procedures (which allow for certain matters to be handled autocratically and other matters democratically) and techniques for overcoming the disadvantages associated with an otherwise good procedure (for example, procedures to gain group acceptance of autocratic decisions, or to speed-up the processes through which democratic decisions are made).

For some missions, it may prove advisable to have a forceful leader who is sharply differentiated from the rest of the crew. Techniques must be found to prevent a loss of social distance and a commensurate loss of power. Research possibilities include (1) varying pre-mission status; (2) manipulating the rituals and symbols of rank (3) identifying group tasks or activities that should be avoided by the leader and (4) identifying useful "distancing maneuvers" (such as retiring to private quarters) which can help restore an appropriate degree of aloofness.

Fiedler's contingency theory of leadership (40, 41) suggests a number of potentially useful lines of study. Efforts must extend beyond assessing the situational favorableness of a given mission and then

choosing the leader with the most promising style. First, it should be recognized that situational favorableness may fluctuate over time. Second, the possibility that leadership style is neither inflexible nor firmly ingrained must be explored. Further research is required to discover if space crew leaders could learn to identify shifts in situational favorableness, and adapt their styles accordingly.

3. Norms

Additional research is needed to gain a better understanding of norm evolution and enforcement under conditions of isolation and confinement. To conduct this research, we first need better ways to assess group norms. These measures should be sensitive to variations in both quality and strength, responsive to changes over time, and able to tap both formal and informal norms in each of three major spheres of existence: work, leisure, and living. One goal is to understand norms well enough to establish reasonable, workable formal rules, and to encourage the development of informal norms which complement and supplement, rather than defeat, official organizational requirements.

E. Issues in Crew Dynamics

Finally, much more needs to be learned about the likely course of social interaction within the space capsule microsociety. We need to develop better procedures for studying social interaction in general, as well as conduct studies on specific topics such as cohesiveness, conformity, and the management of interpersonal tensions.

1. Studying the Space Crew Family

To better understand the dynamics that might be expected within the space crew "family," there is a need for longitudinal studies of

interaction in isolated and confined groups. To accomplish this well, ingenuity and innovation will be required. More detailed systems are required for coding on-going behavior, and group dynamicists need to apply recently developed and highly sophisticated data analysis techniques.

The coding of the natural course of interaction will yield correlational data. There have been two developments which have increased the potential value of this kind of data. First, advances in computer technology have made it possible to examine the interrelationships among many different variables. Second, cross-lag analysis has made it possible to use correlational data to unravel temporal sequences of events. Together, these developments make it possible to control selected variables and take long strides towards distinguishing between cause and effect. Correlations do not prove causation, but developments in recent years have led to a reduction in the discrepancy between the strengths of the causal inferences forthcoming from experimental and correlational results.

2. Cohesiveness

Cohesiveness, as indicated earlier, rests primarily on the rewards and satisfactions associated with membership in a group. Many rewards are associated with the attainment (or expected attainment) of group goals. Ways must be found to encourage crew to endorse goals which require cooperative activity to attain and which are superordinate, in the sense that they override potentially conflicting individual goals. Of particular interest is discovering how to establish goals which can sustain enthusiasm over prolonged uneventful periods. Finally, ways might be sought to prevent or retard a decrease in the level of rewards (relative to costs) which is expected as space travel becomes commonplace.

3. Conformity

Associated with closed social systems is a high risk of groupthink. Many of the remedies proposed for groupthink presuppose a social system with a relatively permeable boundary. More research is needed on the emergence and control of groupthink under conditions of isolation and confinement. In addition, ways have to be found to prevent rejection sufficiently harsh to produce the "long eye" syndrome.

4. Interpersonal Conflict

A certain amount of conflict within a crew may prove to be highly functional. However, there is a continuing and justifiable fear that under the conditions of prolonged space flight, conflicts could escalate out of bounds. Training in interpersonal relations, pre-forming groups, and facilitating communication have been proposed for limiting or reducing interpersonal frictions.

First, more must be learned about the on-board diagnosis and management of interpersonal frictions and conflicts. Such research would be aimed at uncovering techniques that astronauts might use to identify and combat the underlying sources of interpersonal stress. It might address ways of recognizing and managing one's own rising tensions, as well as tensions in other people. One possibility is that some sort of "socioemotional buddy system" might prove of use. For example, each person might be assigned two other crew members who are expected to provide emotional support and intervene before minor squabbles get out of hand. (Two buddies are suggested in case the person gets into a conflict with one of them.) Satisfactory experiential training in interpersonal relations may require an authentic setting characterized by isolation, confinement and stress.

The available evidence suggests definite advantages to making sure that groups are well formed before they are sent off into space. More needs to be known, however, about enhancing group development and identifying the point at which a group is optimally primed for departure.

Personnel rotation is likely in the case of some orbiting missions. Many fascinating research questions are associated with the introduction and assimilation of newcomers. One possibility to explore is an advantage to using, as newcomers, people selected and trained along with those who have already entered space. Another possibility is that there is an advantage to letting the crew help select its own new members. Still another possibility is that assimilation is enhanced as a result of telecommunication with the newcomer prior to the newcomer's departure from Earth. Finally, it would be useful to know more about the kinds of conditions which will result in newcomers being given an extended period of grace.

How many people should be rotated or replaced at one time? In the military, piecemeal replacement has not been particularly successful. On the other hand, introducing large groups of newcomers means that (1) many people have to be socialized simultaneously and (2) oldertimers may feel particularly threatened. We also need to know who should be replaced during a given personnel exchange. For example, it may be desirable to rotate a small number of individuals from each role category (flight-operations, scientific-investigative, etc.) rather than simultaneously replace several people who perform similar functions.

Communications research is needed in three general areas. First, there is the issue of easing the flow of communication in a low-pressure environment with a high ambient noise level. Second, we need a better

understanding of informal communication patterns, given group size and composition. Third, there are many questions about the effects of various forms of telecommunication with people back on Earth.

Communication with home is seen as desirable for providing encouragement and support, allaying concerns about family affairs, and reaffirming the linkage with Earth. However, it is recognized that some communications may have an adverse effect on morale. Studies are needed to identify the conditions under which communications will prove damaging, and to find ways for preventing such conditions or providing compensations for them.

Technical difficulties and equipment restrictions will limit opportunity for communication with Earth. In some cases, two-way video and voice communication may be possible; in other cases, the best one might hope for (at present) is a one way communication from a powerful continuous wave transmitter on or near Earth.

Given strong arguments favoring good communication with home and given that the quantity and quality of such communication will vary across different missions, it seems useful to examine how various communications configurations affect the flow of information and influence emotional responses. Comparisons should be made of bidirectional and unidirectional communications. In addition, we need to know more about the effects of variations in the number of communication modalities that a communication system allows. For example, teletype permits linguistic communication; the telephone adds paralinguistic information; and television adds both proxemic and kinesic cues. In addition, since communication may be

delayed by a few seconds, it would be useful to know more about the effects of conversational lags. An electronically imposed hesitation, for example, might be interpreted as a sign of disinterest or a dull intellect. This research area is also of societal importance given impending developments in the area of private or personal communications systems.

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