A Review of Training Methods and Instructional Techniques

Implications for Behavioral Skills Training in U.S. Astronauts

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Introduction

Long-duration space missions (LDM) place unique physical, environmental and psychological demands on crewmembers that directly affect their ability to live and work in space. A growing body of research on crews working for extended periods in isolated, confined environments reveals the existence of psychological and performance problems in varying degrees of magnitude. The research has also demonstrated that although the environment plays a cathartic role, many of these problems are due to interpersonal frictions (Wood, Lugg, Hysong, & Harm, 1999), and affect each individual differently. Consequently, crewmembers often turn to maladaptive behaviors as coping mechanisms, resulting in decreased productivity and psychological discomfort.

From this body of research, critical skills have been identified that can help a crewmember better navigate the psychological challenges of long duration space flight. Although most people lack several of these skills, most of them can be learned; thus, a training program can be designed to teach crewmembers effective leadership, teamwork, and self-care

strategies that will help minimize the emergence of maladaptive behaviors. Thus, it is the purpose of this report is twofold:

- To review the training literature to help determine the optimal instructional methods to use in delivering psychological skill training to the U.S. Astronaut Expedition Corps, and

- To detail the structure and content of the proposed Astronaut Expedition Corps Psychological Training Program.

Why Train?

Until recently, no systematic psychological training system existed for expedition astronauts. Pre-mission psychological training consisted of a briefing on the potential psychological problems that crewmembers may encounter during their mission, and coping techniques that had helped others in the past. Reports from astronauts who have stayed on Mir suggested that a simple briefing was insufficient preparation for months of confined, isolated living with people of other cultures. Therefore, a comprehensive system of psychological training for long-duration expeditions is in currently in its initial stages to ensure continued optimal performance from the crewmembers during the mission. Several modules of this psychological training flow are already in being offered, evaluated, and refined, as the system continues to grow and develop.

Critics of psychological training argue that psychological fitness is something best addressed by means of selection. It is, in fact, possible to devise a selection system to identify psychologically hardy candidates for long duration mission assignments. A newly implemented computer-based psychological testing system in conjunction with a psychiatric screening and an in-depth suitability interview process form the current system for selecting astronaut candidates. However, the probability of finding applicants who possess adequate levels of *all* of the necessary critical skills in addition to being technically proficient is very low. The number of people that would have to be assessed in order to find one individual that intrinsically met all of the psychological criteria would be cost prohibitive.

Table 1 illustrates this point rather clearly. The center column presents the estimated cost of selecting twenty astronauts for psychological hardiness. Assuming a validity coefficient of .3 for the selection system (the generally accepted average, Schmidt & Hunter, 1998) and a desired success rate of 90%, it would take screening 2000 candidates to find the desired twenty astronauts.

The rightmost column presents the estimated cost of selecting twenty trainable astronauts, and subsequently training them. Assuming equal per-candidate selection costs and validity coefficients, as well as the current selection ratio of .20, we see that it only takes 100 candidates obtain a success rate of 67%. We can assume from this rate that the selected candidates are lacking in certain areas, but that they are generally competent enough to benefit from training. Adding the cost of training twenty candidates to the cost of selecting twenty from a pool of 100, it becomes evident that the selection-only scenario is four times as expensive as the selection-plus-training scenario.

Based on this analysis, it is clearly much more cost effective to use a selection system to identify people with certain basic qualities, and train them so that they are proficient in a series of critical, learnable skills. Training has the added benefit of ensuring that all

members have a standard level of the given quality or skill with which they can operate (Lowenberg & Conrad, 1998; Quiñones & Ehrenstein, 1997). Just as the technical skills needed for space flight are taught through a systematic training syllabus with both classroom and practical sessions, so the training for long duration space flight must include a training program to address the issues of interpersonal relations, confinement and leadership.

• Table 1. Hypothetical cost comparison of selecting 20 high ability astronauts vs. selecting and training 20 moderate ability astronauts[a].

Line Item	Selection Only	Selection + Training
• Total selection cost per candidate	$1.00	$1.00
• Estimated cost of three four-day off the shelf training modules per candidate	N/A	$3.00
• Total cost of selection and training per candidate	$1.00	$4.00
• Selection system validity coefficient [b]	0.3	0.3
• Number of open positions	20	20
• Desired success ratio[c]	0.9	0.67
• Selection ratio required to achieve desired success ratio given the selection system validity coefficient [d]	0.01	0.2
• Number of applicants needed to achieve required selection ratio	*2000*	*100*
• Total cost of selection	$2,000.00	$400.00
• Total cost of training selected candidates	N/A	$60.00
Grand total (hypothetical)	**$2,000**	**$460.00**
Ratio of selection only to selection+training		4.38

Critical Psychological Skills for U.S. Expedition Corps Astronauts

A recent validation study (Galarza & Holland, 1999) using subject matter expert interviews and archival data established that there are ten critical skills and qualities necessary to maintain psychological health in a long duration mission. These skills can be summarized into three basic themes that describe the psychological requirement domain in a long

[a] Note. Actual training and selection costs are considered proprietary information; the absolute numbers listed here are therefore fictitious. However, the relative amounts listed in the table (e.g., the cost of training per candidate compared to the cost of selection per candidate) are generally accurate, within a reasonable margin or error.
[b] *validity coefficient:* an index of the predictive power of a selection tool. The closer it is to 1.0, the more predictive power it has. The validity of most psychological tests averages around .3, the value used here.
[c] Success ratio refers to the ratio of hires that would succeed (assuming no interventions of any kind) to the total number of hires. A success ratio of .9 means that 9 out of 10 hires would be perform successfully; a .67 ratio means that only 2 out of 3 would perform successfully, thus suggesting that the people hired are on the average of lower ability than those in the .9 success ratio pool.
[d] Based on Taylor-Russell utility model (Taylor & Russel, 1939); 50% base rate was used. Selection ratio refers to the ratio of selected candidates to the total number of candidates; in this case we assume that all 20 positions will be filled.

duration space environment: (a) **self-care and management**, (b) **teamwork**, and (c) **leadership**. Most people do not excel at most of these. In order to ensure that crewmembers participating in long duration missions have a certain level of proficiency in all of the aforementioned skills, they must be trained appropriately.

Development of the Critical Skills

Based on extensive literature reviews and debriefings with astronauts and mission support experts, the selection project team developed a two-part questionnaire. Part I consists of a list of 47 proficiencies and behavioral indicators for each proficiency. Experts rated the importance of each proficiency for long- and short-duration missions. Part II consists of a list of 42 working conditions and environmental demands of long- and short-duration flights. For each demand, the experts rated its importance and probability of occurrence. A group of experts reviewed and revised the questionnaire by using a computerized group decision support system that facilitates the group ranking and editing of items in a questionnaire.

Data Collection and Analysis

Twenty U.S., Russian, and European astronauts, cosmonauts, and mission support experts who had flown or directly supported long-duration space missions completed either computerized or hard-copy versions of the critical LDM proficiencies and job demands questionnaire. In Part I of the questionnaire, the experts rated the criticality for 47 listed proficiencies. In Part II of the questionnaire the experts provided criticality and probability of occurrence ratings for 42 job and environmental demands of LDM.

The proficiencies were analyzed both qualitatively and quantitatively. Five independent experts categorized the 47 astronaut proficiencies in the questionnaire into ten factors. Additionally, the proficiencies were classified statistically via factor analysis; results revealed a set of factor categories similar to that of the expert classification. Similar analyses were conducted on Part II of the questionnaire, which reflected the working conditions and environmental demands of LDM.

Results

Part I -- Critical Factors

Table 2 lists the critical factors (in order of decreasing criticality) for LDM and SDM (short duration missions). Sample proficiencies for the critical factors appear in Table 3. The results of Part I of the study provided an empirically based categorization of critical non-technical skills required for adaptability to long-duration space missions.

- Table 2. Critical factors and sample skills required for long-and short-duration space missions.

LDM Critical Factors (listed in order of criticality for LDM)	SDM Critical Factors (in order of criticality for SDM)
Factor 1: Mental/Emotional Stability	Factor 2: Performance under stressful conditions
Factor 2: Performance under stressful conditions	Factor 1: Mental/Emotional Stability
Factor 3: Group living skills	Factor 7: Judgment/ Decision Making
Factor 4: Teamwork skills	Factor 4: Teamwork skills
Factor 5: Family Issues	Factor 8: Conscientiousness

Factor 6: Motivation   Factor 5: Family Issues
Factor 7: Judgment/ Decision Making Factor 3: Group living skills
Factor 8: Conscientiousness   Factor 6: Motivation
Factor 9: Communication skills   Factor 9: Communication skills
Factor 10: Leadership capability   Factor 10: Leadership capability

One of the most important findings in this study was that the importance of these ten critical skills is different for SDM and LDM. The results reveal that mental and emotional stability and group living skills are more critical for LDM than for SDM. The increased criticality of these skills and their impact on potential astronaut adaptability to LDM must be taken into consideration in the design of astronaut selection, training and psychological support for such missions.

Part II -- Working Conditions and Environmental Demands

Part II of the study consisted of an examination of critical working conditions of international long-duration space missions with an emphasis on space station working conditions. Results indicated that the most critical job and environmental demands of international LDM can be categorized in the following areas: (1) separation from family and friends; difficult living circumstances (type of food, noise, quality of light); (2) crowding and habitability issues in confinement (limited private space, noise); (3) work load, work tasks, and recreational issues; (4) health, safety, and risk issues; (5) nature, composition and dynamics of heterogeneous international crews; (6) demands for interactions with external groups (mission control, the media); (7) high visibility of work and human errors; and (8) interactions with complex systems, and artificial life support systems.

Based on the empirical results of this operational study, and in the judgment of the expert raters, the unique LDM job demands and working conditions identified in the study can significantly affect an astronaut's adaptability and performance during missions. Therefore, SDM and LDM critical job demands and astronaut proficiencies should be taken into consideration when developing psychological selection, training, and support tools and procedures that will facilitate human adaptability to long-duration space missions.

- Table 3. Sample critical proficiencies for each of the factors

	Factors	Sample proficiencies (partial list)
1.	Mental/Emotional Stability	Freedom from mental disorder, emotional stability, self-control, self-confidence
2.	Performance under stressful conditions	Ability to perform under threat to life stress, performance under stressful conditions, flexibility and adaptability, ability to cope with limited personal stress
3.	Group living skills	Group living and interaction skills, adaptability to crew diversity, multicultural adaptability
4.	Teamwork skills	Teamwork skills such as conflict resolution and cooperation, priority of team over personal goals, followership skill

5.	Family Issues	Ability to cope with prolonged separation from family and friends
6.	Motivation	Achievement motivation, intrinsic work motivation, perseverance, goal orientation
7.	Judgment/ Decision Making	Exercising sound judgment, situational awareness and vigilance
8.	Conscientiousness	Responsibility, attention to detail, integrity
9.	Communication skills	Interpersonal communication skills
10.	Leadership capability	Team leadership, effective resource management, accountability

Review of Instructional Techniques

The training literature is replete with methods, tools and techniques to help individuals learn better; many of the newer tools are refinements designed to reduce training time or increase learning content. However, not all techniques work equally well in all situations. It is also important to note that not everyone responds equally well to the same types of techniques.

According to the learning literature, different people have different styles of learning. Kolb's theory of experiential learning (Kolb, 1985) posits that people vary along two dimensions in their learning: information input (abstract conception vs. concrete experience), and information processing (reflective observation vs. active experimentation). Highly efficient learners use all four aspects of learning; however, most people developed a preferred style of input and processing. Kolb thus proposes four learning styles: "(a) divergers (reflective observation + concrete experience), who are imaginative and excel at generating ideas; (b) assimilators (reflective observation + abstract conception), who think sequentially and are good inductive reasoners; (c) convergers (active experimentation + abstract conception), who are good at the practical application of theory; and (d) accomodators (active experimentation + concrete experience), who have an intuitive trial-and-error learning style."(Fujii, 1996) p. 270. Consequently, the effectiveness of any given training technique necessarily varies as a function of the trainees' preferred learning style. It is nevertheless prudent to review the literature on training techniques, as different techniques are better suited for certain topics, regardless of individual learning style. What follows is a discussion of the most widely used techniques, along with their advantages and disadvantages.

Information-based methods

Information based methods are the most widely used in training; their goal is to simply convey information or impart knowledge, whether it refers to steps involved in a procedure, factual knowledge, or background information. Methods such as, lectures, slide presentations, and conferences, are all considered information based methods. Advantages include cost effectiveness, ease of implementation, and efficiency-- that is, a large amount of information can be conveyed to a large number of people in a single session (Salas & Cannon-Bowers, 1997). The main drawback to these methods, however, is that there is no opportunity to practice the knowledge that has been imparted. We know from cognitive learning theories that use of multiple sensory modalities results in deeper information processing, which in turn facilitates learning. We also know that

distributed practice of a task[a] results in better mastery of the task than massed practice[b](Eysenck & Keane, 1995). These characteristics are mostly absent in the majority of information-based methods, making them ill-suited for imparting anything other than factual or background information. Two methods in particular, the standard lecture and the conference will be discussed in more detail.

Lecture

Formally defined, a lecture is a "semi-formal discourse in which the instructor presents a series of events, facts, concepts, or principles" (Lowenberg & Conrad, 1998), p. 299. Most lectures today involve some sort of audiovisual aid, for example overhead viewgraphs or 35mm slides. Although some would argue that these audiovisual aids should not be classified as a demonstration-based method, to the extent that they simply aid the lecturer in imparting the information he/she has planned to disseminate, (as opposed to demonstrating a the mechanics of a procedure) they can safely be subsumed as part of the lecture method.

One of the most advantageous features of the lecture method is its ability to deliver large amounts of information to large numbers of people, at a very low cost. Furthermore, if one considers distance learning technologies, such as closed circuit and public television, the number of potential students that could be reached with one lecture session becomes even greater. However, the lecture method has been the subject of much opposition; critics argue that lectures do not allow the opportunity for learners to clarify material, or to receive feedback on the material they have learned. In cases where large audiences are involved, it is also difficult for the lecturer to present the material in such a way that people with different abilities and interests will understand it comparably (Goldstein, 1993). Nevertheless, the literature indicates that the lecture method is appropriate for knowledge acquisition. It is not appropriate for activities that require complex responses.

Conference

The conference is a variation of the lecture method, where a small group of participants convenes to discuss a given topic in depth. The conference overcomes several of the lecture's shortcomings: it provides direct feedback, promotes individual participation, and allows participants to clarify any material they do not understand. Because the learners enjoy more interactive participation, their learning process is more effective than with passive, one-way communication. Interactive learning promotes appropriate feedback, and motivation, which is consistent with the principles of operant learning (Weiss, 1991). However, most conferences are limited to a maximum of fifteen students, making them less cost-effective than the lecture method. Further, participants should possess similar backgrounds (about the topic in question) for the discussion to be fruitful. Nevertheless, the conference is particularly suited for disseminating complex conceptual data. (Lowenberg & Conrad, 1998)

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[a] *Distributed practice*: practicing a task for several short periods over a long period of time.
[b] *Massed practice:* practicing a task for one long, uninterrupted period of time.

Demonstration-based methods

Audiovisual techniques

Audiovisual techniques (AVT) refer to such devices as slides, videotapes, recordings and films. These instructional methods can be used for a variety of subjects, and are especially suitable for each of the following:

1) Demonstrating step-by-step or complex procedures,

2) Presenting dynamic events that unfold over time (e.g., a cooking show)

3) Presenting events that cannot be recreated in the classroom.

Audiovisual techniques are also especially useful when there is a shortage of competent instructors. However, critics of such techniques strongly oppose the use of AVT as a stand-alone training tool. It suffers from many of the same shortcomings as the lecture method, namely, lack of opportunity for feedback and clarification (Goldstein, 1991). Further, the up-front cost of developing a custom AVT can be quite substantive, while purchasing a commercially available tool may not provide all of the desired training (Lowenberg & Conrad, 1998). It is thus most frequently recommended to use AVTs in conjunction with other methods (Goldstein, 1993; Salas & Cannon-Bowers, 1997).

Practice-based methods

Practice based methods are those which allow the learner to rehearse the material learned, so that he or she may receive immediate feedback on his or her performance. Proponents of such methods are quick to point out, however, that practice alone does not equate to training. "To be effective, practice needs to be guided by cueing, feedback, coaching, or any other mechanism that helps the trainee to understand, organize, and assimilate the learning objectives" (Salas & Cannon-Bowers, 1997), p. 267. Nevertheless, practice-based methods provide the highest level of interactivity, and are critical to team training. Several techniques are available that fall under this category. Four of them will be discussed herein: behavior modeling, business games, role-play, and simulations.

Behavior modeling

Behavior modeling has its roots in social cognitive theory (Bandura, 1977), which posits that social behavior is learned via observation, imitation, and reinforcement. Behavior modeling proposes that "new behaviors can be learned by systematically exposing a trainee to a target behavior. The trainee rehearses the target behavior, receives positive reinforcement for successful performance, and repeats the sequence until learning is successful" (Lowenberg & Conrad, 1998), p. 303. This particular technique has been well studied, and many researchers see it as an effective technique (e.g., (Burke & Day, 1986; Latham, 1989; Latham & Saari, 1979; Mayer & Russell, 1987; Meyer & Raich, 1983; Sorcher, 1971). Because of its social learning theory roots, this technique is particularly useful for interpersonal skills, and is praised for its ability to directly affect behavioral change. However, because the technique relies heavily on observation and imitation, behavior modeling is not suitable for teaching internal processes such as brainstorming, reading, or logic. Furthermore, due to the interactive nature of the technique only a limited number of people can be trained at any given time. Cost is also an important factor with behavior modeling, in which the task in question is an important influence. For example, the task may require costly equipment or may be hazardous to a completely untrained

individual (e.g., learning to fly a fighter plane). In such an event, a lower-risk technique, such as a simulator, may be more appropriate.

One specific variation of behavior modeling deserves special mention. *Active interlocking modeling* (AIM) is a learning protocol where individuals are teamed up into pairs. One individual performs half of the task while the other one observes. The partners switch roles, and the second individual performs the second half of the task while the first observes. A study conducted on flight simulation trainees found that there was a 20% savings in overall training time, with no loss of training quality (Arthur, Day, Bennett, McNelly, & Jordan, 1997). The authors also claim that the protocol works for any task that can be modeled in the traditional style. Although clearly more research is necessary to identify the optimal conditions for the use of AIM, this protocol shows potential for reducing the cost of traditional behavior modeling.

Business games

> A business game is a contrived situation which imbeds players in a simulated business environment where they must make management-type decision from time to time, and their choices at one time generally affect the environmental conditions under which subsequent decisions must be made. Further, the interaction between decisions and environment is determined by a refereeing process which is not open to argument from the players. (Dill, Jackson & Sweeney, 1961, quoted in (Goldstein, 1993), p. 274)

Early business games were designed to teach basic business skills, such as resource allocation and competitive advantage. However, more modern games teach interpersonal skills, such as communication and conflict management. Business games are also the foundation from which assessment centers[a] are derived. Business games, (discussed below) provide excellent opportunities to practice decision making, problem-solving, and interpersonal interaction skills. In addition, because of the highly controlled environment, situations that would normally take a very long time on the job can be practiced and developed in a much shorter time frame in the business game. Furthermore, business games provide opportunities for individualized, immediate, and detailed performance feedback.

Business games suffer from several drawbacks; by far the worst of these is cost. There is a voluminous amount of work and cost involved in developing a business game. Even a commercially available business game (e.g. The Looking Glass), where the development cost has been recovered, can cost over $4000 per trainee (Center for Creative Leadership, 1999). Further, the game is usually limited to a small number of participants, making it difficult for many people to be trained in a short period of time.

Role Play

Role-playing is a technique where trainees act out simulated roles. It is most commonly used in the training of interpersonal skills, attitude change, and decision making (Allen & Forman, 1984; Goldstein, 1991; Ivancevich & Smith, 1981; Vaught & Pettit, 1988; Wehrenberg, 1986). Role play can be considered a specific type of behavior modeling, that is, one where the task being rehearsed is an interpersonal role. As such, it shares the same strengths and weaknesses as behavior modeling. It is most effective in the teaching

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[a] *Assessment centers:* A combination of role-plays, business games, and other related tests designed to evaluate an individual on a multitude of dimensions. Most commonly used to assess managerial potential for promotion purposes, although it can be used for developmental purposes as well.

of interpersonal skills such as communication, negotiation, and conflict resolution (Goldstein, 1993).

Simulations

Simulations are controlled environments used for training purposes. Although the best known simulations consist of machine simulators (such as airplane or driving simulators), simulations need not limit themselves to such devices. One of the best known non-machine simulations in the business world is the Looking Glass Experience, where participants spend five days in a fictitious corporate scenario learning leadership skills. Regardless of whether or not a machine is involved, simulations share several characteristics:

1) *Psychological fidelity*. One of the defining characteristics of a simulation is to replicate the work environment as much as possible, so that all the behavioral processes necessary to perform the job are reproduced. Depending on the task, this may or may not require a certain degree of physical fidelity -- recreating the actual physical environment in terms of equipment, surroundings, etc. (e.g., an aircraft simulator has a high degree of physical fidelity, due to the nature of the task).

2) *Controlled reproducibility*. One of the main goals of a simulation is standardization. The simulation allows the trainers to deliver the necessary conditions for training time after time, thus ensuring that everyone receives the same experience. In addition, because the simulation is a controlled setting created by the trainers, time can be compressed, expanded, or repeated, depending on the need.

3) *Safety considerations*. Simulations allow the trainees to practice the relevant tasks in a low risk situation. This could refer to health or life risk, such as in the case of an aircraft simulator, or financial risk, such as in the case of a business simulation.

Because simulators are highly controlled by the trainer/developer, they provide the opportunity to effectively use learning principles such as appropriate feedback, distributed practice, and maximized training transfer. However, because of their potential for very high psychological and physical fidelity, simulators tend to be very expensive, both to develop and construct. Nevertheless, because of their fidelity, intensity, and opportunity for customized learning, simulations are a highly effective training method.

Field experiential training simulations

Because of the population of trainees under discussion herein, one particular kind of simulation deserves special attention. Field experiential training, also known as outdoor training, is a training technique where an intact work group goes on a weekend (or week long) trip to a remote outdoor location, and are presented with a series of physical challenges, which are designed to encourage cooperation, trust, and risk taking. This type of training has become increasingly popular as an executive development tool, as well as a team-building technique. According to proponents of this type of training, the principal goal of this outdoor training is the fostering of emotional and intellectual risk taking; skills typically learned include receptivity, feelings of competence and control, and increased situational awareness (Van Zwieten, 1984). However, this particular type of training leaves much room for charlatanry, and some researchers advise caution before engaging in this type of training. Reputable experiential trainers should be proficient in a variety of skills, including organizational communication, change management, and team building; they should also communicate frequently with the customer to adequately assess and

address their needs (Gall, 1987). Therefore, experiential training should be approached with caution, and in its proper context.

Programmed Instruction

Programmed instruction refers to any device or material that uses reinforcement principles to systematically present information to the learner (Goldstein, 1993). Although this can be accomplished in a variety of ways, the overarching concept is the same, regardless of execution. This method dates back to the 1950's , where a series of specially designed pamphlets were used; material was presented, the trainee was quizzed for knowledge/understanding, and, depending on his/her answers, either moved on to the next section of the pamphlet or referred to the appropriate section for review. This is known as branching, and is the foundation for most computer aided instruction. The paper and pencil method allowed for a limited number of branches. However, with the advent of computers, a much larger number of branches are possible, allowing for a more customized learning experience.

Programmed instruction offers several benefits. First, it allows the use of learning principles, particularly the introduction of feedback and reinforcement. Further, the branching method allows for individualized instruction, potentially saving time, money and effort among the higher ability trainees. Finally, programmed materials (whether computerized or by paper) are easily packaged and distributed, and can be consumed at the trainee's convenience. On the negative side, programmed instruction is time consuming and expensive to develop; the more customization desired, the more time consuming the development. Programmed instruction also focuses on factual materials, and therefore is very low on the practice component of training. Furthermore, programmed instruction that is distributed directly to the trainee assumes that he/she will follow the prescribed curriculum (this issue is diminished somewhat in computer aided instruction), and that he/she is motivated to complete the training from start to finish.

Computer-aided instruction

Computer Aided Instruction (CAI) refers to any training, tutorial, or programmed instruction that is delivered by means of a computer. CAI is not so much a technique as it is a method of delivery. For example, a lecture can be delivered via videoconferencing technology or digital video disc (DVD), through a computer. Similarly, one could attach a limited controls set to transform the computer into an aircraft simulator. Programmed instruction, discussed above, takes on new life when delivered via computer. It is thus important to recognize CAI as a delivery method, not an instructional technique. However, most CAI is associated with one of two types of instructional systems: Drill and practice programs, and tutorials. In the drill and practice system, an instructor presents material to the entire class, then uses the individual computer terminals to present problems, or opportunities for practice. The teacher can present individualized material on the terminals, and provide individual or group-level feedback, as well as keep track of class performance. In contrast, all of the material is presented through the computer in a tutorial style program. The tutorial may use multimedia to present the material more effectively, and provides opportunities for practice and immediate feedback for the trainee.

The main advantage to CAI over non-computerized methods lies in its effectiveness. Research has indicated that it takes less time to train a given amount of material via CAI than via other methods. (US Civil Service Commission, 1971, cited in (Goldstein, 1993)), with no loss in effectiveness of training compared to traditional methods. Most research indicates that individuals trained via CAI perform as well as or better than traditionally

trained individuals; no studies have found the contrary. CAI achieves this via its potential to individualize instruction and provide feedback and reinforcement.. However, like many of the more individualized techniques, the cost of CAI is a serious concern. Despite the plummeting costs of computer hardware, content and form development are still expensive. Furthermore, the learning potential is limited to the material in the program. Unlike a human being, who can field questions, and use related information to better convey a message, the computer is limited to the material in the program.

Summary of training techniques

The majority of training techniques fall under one of three general categories: information-based, demonstration-based, and practice-based methods.   Information based techniques, such as lectures and conferences are designed to impart large amounts of factual information to many people simultaneously, making them very efficient and cost-effective. However, because they are usually unidirectional, they are not suitable for learning procedures or skills; their main strength is in the dissemination of factual or background information

Demonstration-based methods, such as recordings, films, and slides, are most useful for imparting procedural information. They excel at demonstrating complex or step by step procedures; in the case of a recording, it is possible to rewind and re-play specific portions of the demonstration as necessary. They are also especially useful for demonstrating events or procedures that cannot be recreated in the classroom. Like information-based methods, however, demonstration-based methods are unidirectional, and allow no opportunity for clarification or feedback; further, depending on the topic, development costs can be quite high.

Practice-based methods, such as behavior modeling, role-play, and simulations, are designed to allow the learner to rehearse the material being learned, and receive feedback on his or her performance. Practice-based methods are best suited for learning interpersonal skills, complicated procedures, or the use of tools or equipment (such as an airplane, or a computer). Because of their feedback and practice design, learning occurs more quickly and with better retention. However, most practice-based methods can only be used in small groups, and are usually very expensive to develop.

Many of the methods discussed above can be delivered in a computerized environment. Computer aided instruction (CAI) has been shown to be very efficient, in that it decreases the amount of time necessary for trainees to learn the material, with no loss in effectiveness of training.   However, like many of the practice-based methods, development costs are very expensive, and the learning potential is limited to the material in the program.

The general consensus of the research literature on training is that all techniques have their strengths and weaknesses, and that the best training programs combine multiple training techniques; this allows trainees to use multiple sensory modalities, and engage the material from different perspectives, thus ensuring a more effective, more enduring result.

Application of Instructional Techniques to Critical Skills

As discussed in the previous section, not all instructional techniques are equally suited for all tasks. This section discusses research that support the use of specific instructional

techniques for each of the ten critical factors. In general, the consensus seems to be that a combination of techniques, usually following the information, demonstration, and practice (IDP) format (Salas & Cannon-Bowers, 1997), is most appropriate. This format simply states that for certain types of tasks, a combination of techniques should be used: an information based technique, such as a lecture, to impart the relevant information; followed by a demonstration based technique, such as a video, to impart the relevant procedural knowledge; and finally a practice based technique, to allow the learner an opportunity to rehearse and receive performance feedback. Use of all three, in that specific order, makes maximum use of the learning principles that maximize knowledge and skill acquisition. (Cannon Bowers & Salas, 1997)

Self-Care and Management Themes

Long duration flight, confinement and close personal contact place unique stressors on crew persons that are not found on a short flight. This will be especially true for the mixed culture crews expected to staff the space station. Consequently, crew persons must have unique attributes and trained skills in order to be able to function and deal with these stressors. The unique and difficult living and working conditions of ISS missions will challenge ISS crew members' mental and emotional stability, effective adaptability and performance under stress, level of motivation ability to cope with various stressors (e.g. separations from family), effective judgment and decision making, and level of conscientiousness.   Effective self-care and self-management strategies are needed to successfully adapt and thrive in this environment. Many of these strategies can be learned through appropriate training.

Performance Under Stress

This factor refers to an applicant's ability to perform his or her duties effectively despite threat-to-life and other stressful conditions. This includes coping with limited personal space, reductions in social relationships, coping with decreased personal autonomy, flexibility.

From a training perspective, performance under stress is an amorphous, multifaceted, highly complex skill; instructional objectives include clarifying crewmember roles and expectations (both on and off duty), increasing situational awareness, reducing stress and anxiety. Because of its broad spectrum, a combination of instructional techniques would be most useful. Barrios Choplin, McCraty, & Cryer, (1997) examined the effectiveness of a training program "designed to help people increase productivity through improved health, communication, goal clarity, positive mood, and job satisfaction, and through the reduction of tension, burnout, physical symptoms of stress, and negative mood" (p. 193). This training program consisted of four training modules, each of which used a combination of different techniques.   Results showed significant decreases in blood pressure, tension, and anxiety in trainees as compared to a control group. Another study examined the impact of preparatory information on performance under stress (delivered in lecture format).   The researchers found that people who were given preparatory information reported less anxiety than people who were not given such information, were more confident in their abilities, and performed better than those who did not receive preparatory information (Inzana, Driskell, Salas, & Johnston, 1996) . Yet another study found that stress inoculation training, a technique where participants are immersed in a controlled version of a high-stress situation, effectively reduces performance anxiety, state anxiety, and enhances performance under stress (Saunders, Driskell, Johnston, & Salas, 1996). Stress inoculation training is a three-step process that closely resembles the IDP

format. Thus, the research seems to indicate that such a complex skill as performance under stress is best addressed with a combination of training techniques.

Motivation

This factor deals with a crew member's drive and perseverance; specifically, a crew member's intrinsic work motivation, achievement motivation, goal orientation, motivation to work under difficult working conditions, to perform laboratory work and routine tasks, and to maintain physical ability.

Intrinsic motivation refers to an individual's innate drive or interest in an activity or behavior, simply because he or she finds it interesting or enjoyable. As such, intrinsic motivation is not directly trainable (E. Deci, personal communication, April 3, 1999; R. Ryan, personal communication, March 18, 1999). That is, it is not possible to train an individual to be more intrinsically motivated to do something. It is possible, however, to change the conditions surrounding an activity (e.g., the physical environment, the interpersonal interactions, the social culture) in such a way as to enhance or undermine intrinsic motivation. For example, the use of mental imagery has been said to enhance intrinsic motivation to perform a task (Martin & Hall, 1995). Other research suggests that a climate of perceived mastery is positively correlated with intrinsic motivation (Kavussanu & Roberts, 1996).

Intrinsic motivation, however, is not the only goal-directed behavior that is of relevance. Goal orientation, the tendency to set goals as a way to motivate oneself into engaging in a certain behavior, is important, relevant, and trainable. Research suggests that setting specific, difficult (but achievable) goals results in higher performance and more goal-directed behaviors than setting ambiguous goals or not goals at all (Latham, 1989; Latham & Kinne, 1974). Thus, the ability to set adequately difficult goals for oneself is a useful skill in keeping crew members productive, a skill that can be learned. (Ivancevich & Smith, 1981) noted that employees of a company with a formal goal-setting program were more effective and satisfied after having been trained by means of a lecture, videotape, and role play than those employees who had not completed the training. Thus, engaging in appropriate goal-setting, is another way to directly influence crew member motivation.

Another relevant goal-directed behavior is achievement motivation. Achievement motivation refers to an individual's tendencies toward accomplishment and success. Research has repeatedly associated increases in achievement motivation with increases in performance (Aronoff & Litevin, 1971; Durand, 1975; Kanfer, 1990). There are several instances of achievement motivation training programs in the literature; (Durand, 1983) presents an abridged training program (approx. 10 hours) composed of lecture, games, and exercises to increase achievement motivation. Results showed increased productivity in trainees two years after training compared to productivity before training. (Aronoff & Litevin, 1971) examined a five-day workshop that combines lecture, discussion, and business game, and found more rapid corporate advancement in trainees as compared to a control group in a longitudinal follow-up study.

It appears that, although difficult, there are certain aspects of motivation that can be trained, especially when accomplished via a combination of training techniques.

Conscientiousness

This factor refers to a crew member's level of responsible and conscientious behavior, effective time management, organization, and integrity. In the psychology literature,

conscientiousness is treated as a personality trait, not a skill. As such, and in a similar vein as intrinsic motivation (see p. 15) and mental and emotional stability (see p. 17), it is very difficult to train for conscientiousness. Like mental and emotional stability, the conscientiousness trait is best addressed during the selection process. Certain conscientious behaviors, such as efficient time management, and organizational skills, however, can benefit from training. Hanel, Martin, & Koop, (1982) tested a self-instructional time management manual in an institutional setting; compared to a best-selling time management book, participants in the manual condition showed increased use of time management practices immediately after training as well as after a significant period of time. Another study used a combination of lecture, role play, and self-assessment to teach time management skills, and found that trainees reported increased perceptions of control over time 4 to 5 months after training (Macan, 1996). Yet another study used a similar combination of techniques and found significant increases in time management skills in trainees compared to a control group (Orpen, 1994). Thus, a combination of information, demonstration, and practice-based methods can be helpful in increasing time-management and organizational skills in crew members.

Judgment and Decision-Making

This factor refers to a crew member's ability to exercise sound judgment and effectively utilize available resources to solve problems or make good decisions. This includes problem solving and appropriate risk taking.

Many consulting firms and publication houses offer training materials of some sort on problem solving (e.g., GN Resources, Personnel Decisions, Inc., Jossey-Bass Publishers, Center for Creative Leadership, etc.), thus suggesting that problem-solving is a learnable skill. Some concentrate on specific kinds of problem solving, like risk assessment, or the decision-making portion of problem solving. Most of these training programs (i.e., those that go beyond simply reference books) tend to combine lecture, audiovisual materials, and problem solving exercises e.g., (GN Resources Inc., 1998). Research has also devoted attention to the adequate training of problem solving skills. (Duckworth, 1983) advocated the use of a mix of information, demonstration, and precise as an efficient way to teach problem solving. (Cooley, 1997) also suggested an IDP mix of techniques to effectively train individuals in problem solving skills. Tannenbaum & Yukl (1992) and Pliske & Psotka (1986) advocate CAI to teach problem solving, due to their feedback opportunities and (in the case of CAI) individualized training. Tannenbaum & Yukl also advocate simulations as an alternative to CAI also for its feedback and practice opportunities. Although the research varies in the prescription of a specific technique, the techniques share one very important thing: all the aforementioned research advocates interactive training, that is, one that allows the individual to practice problem solving and receive feedback. Thus, whether delivered by computer or more conventional means, the information-demonstration-practice paradigm seems to be the protocol of choice.

Family Issues

This factor refers to a crew member's ability to cope with prolonged separation from family and friends.   Family separation is a significant source of mood and morale change in people who work in extreme environments (Palinkas, 1992; Wood, Hysong, Lugg, & Harm, 2000). Many of the same underlying training issues that relate to performance under stress (see p. 14) are also relevant to family issues, and thus will not be repeated here. Because the issue here is one of training to counteract the stressful effects of a negative situation (i.e., coping), instead of to learn a specific skill, stress inoculation training (also known as stress exposure training) lends itself especially well to this scenario

(Cannon-Bowers & Salas, 1998). Stress innoculation training (SIT) is a specialized type of IDP formatted training, where the trainees go through a three-stage training intervention: "(a) an initial stage, in which information is provided regarding stress and stress effects, (b) a skills training phase, in which specific cognitive and behavioral skills are acquired, and (c) the final stage of application and practice of these skills under conditions that increasingly approximate the criterion environment" (Cannon-Bowers & Salas, 1998, p. 195). Meta-analytic research suggests that this kind of training is especially effective in for reducing performance anxiety, state anxiety, and enhancing performance under stress (Saunders et al., 1996).

Mental and emotional stability

Mental and emotional stability refers to a crewmember's freedom from mental disorder, emotional stability, self-control, and self-confidence. All of these characteristics are traits for which an individual can be selected. That is, because these are primarily traits, and not skills, these are issues that are best addressed during the selection process. Freedom from mental disorder and emotional stability can be assessed during the select-out process, while self-control and self-confidence can be assessed during the select-in process.

D R A F T

Teamwork Themes

The skills, behaviors, and strategies of teamwork and group living are essential for the effective adaptability and performance of a multicultural crew in the ISS environment. It is crucial that crew persons understand the need for teamwork to make a long duration flight successful, and the recognition that competitive-based behavior is not acceptable. But the teamwork role is not just confined to the crew, because for space flights, the expedition must also work constructively with a control center, and look upon the center as a supportive resource, even part of the team, and not as an adversary. Consequently, both crew members and ground personnel must be trained to work together as a singular entity.

Group Living

This factor refers to a crew member's ability to adapt effectively to a group living arrangement, to enjoy living with others, to interact appropriately and effectively with people from diverse cultures.

Multiple skills are necessary to live harmoniously with others, particularly people of different cultures. The literature on training group living skills is virtually non-existent; however, group living entails a diversity of skills and issues for which training research does exist. This includes interpersonal skills, boundary setting, (that is, the clarification of crewmember roles and expectations, both on and off duty), organizational attitudes, and values.

A variety of methods have been used to teach interpersonal skills. Some advocate the use of programmed instruction(Bennett Jr. & Arthur Jr., 1997), others prefer CAI (Kass, Burke, Blevis, & Williamson, 1993), while still others prefer a combination of methods (Kurtz, Marshall, & Banspach, 1985) . However, the majority of the literature seems to converge around practice-based techniques such as behavior modeling (Baldwin, 1992; Burke & Day, 1986; Goldstein, 1993; Neider, 1981), simulations , and business games (Goldstein & Gilliam, 1990; Goldstein, 1980; Goldstein, 1991; Tannenbaum & Yukl, 1992).

Training individuals to adopt certain organizational and/or cultural values is a more difficult task; such adoptions require attitude change on behalf of the trainee, one of the most difficult things to accomplish through training. Because attitude change involves cognitive, affective, and behavioral change, a combination of several different methods is necessary to address not only all of the issues involved in group living, but also to effectuate the necessary attitude change to maintain harmonious relationships among crew members (Lindsley, 1998).

Teamwork and Communication

Teamwork refers to a crew member's ability to develop cordial and effective working relationships with others. This includes establishing and maintaining good personal relations, cooperating with others, providing constructive feedback, contributing to team morale, and demonstrating tact, diplomacy, and composure in professional and personal interactions with others. As shall be discussed below, good communication among team members is critical to all of the aforementioned abilities, and is therefore considered in conjunction with teamwork.

It is important to note that a team is more than the simple sum of its members; one of the most important aspects of effective teamwork is sharing knowledge among team members about both the task and the team itself (Cannon Bowers & Salas, 1997). Thus, developing shared mental models in a team is, according to recent research, crucial for healthy team functioning (Cannon-Bowers, Salas, & Converse, 1993; Serfaty, Entin, & Johston, 1998). An adaptive coordination training program, composed of instruction, demonstration, practice, and feedback, was demonstrated to significantly increase team performance (Serfaty et al., 1998). Other research also suggests the use of multiple techniques to increase coordination and cooperation (Swezey & Salas, 1992). Multi-technique training has also been used in the development of self-directed teams (Ray, 1995). Because of the complexity involved in coordinating the behavior of multiple individuals simultaneously, the literature seems to agree the most appropriate method to train for teamwork is a combination of techniques. What is still under investigation, is the content of the training; as discussed above, recent research points to the development of shared mental models (that is, the situation where everyone in the team has a common conceptualization of the task and the surrounding environment) as a means to enhance effective teamwork (Cannon-Bowers & Salas, 1998; Cannon-Bowers et al., 1993; Salas & Cannon-Bowers, 1997).

Leadership Themes

Studies of the historical record of various expeditions and from expedition leadership psychological research have shown that the leader of any long expedition characterized by confinement, isolation and group living, must fulfill a unique role (Cazes, Rosnet, Bachelard, Le Scanff, & Rivolier, 1996; Godwin, 1987). The traditional pyramidal leadership structure and accompanying autocratic style is not effective in this situation. This has also been the collective experience of the astronauts who flew on Mir.

The consensus of specialists reviewing the history of expeditions and the review of research in the areas of leadership and expeditions, autonomous teams, and teams in extreme environments is that a flat hierarchy with a situational leadership style is required in which the leader creates and supports the emotional and physical climate needed to facilitate good working conditions. In that sense, the leader may be thought of as an orchestrator, or conductor, whose credibility is established through their experience and

approachability, and whose self identity as a leader does not need to be publicly nurtured through the establishment of a bottom heavy pyramidal hierarchy.

The underlying skills that a leader of this sort would need to be effective are mostly interpersonal in nature, whether that refers to conflict management, negotiation skills, coaching, or other similar skills. Research points to practice-based methods when developing interpersonal skills. In a meta-analysis of 70 training studies, Burke & Day (1986) found that behavior modeling was the most effective training technique for interpersonal skills. Other researchers have found similar results (Baldwin, 1992; Goldstein, 1993; Neider, 1981). A qualitative review of the literature suggests that simulations and business games (a type of behavior modeling themselves) are also highly suitable for the training or interpersonal skills (Tannenbaum & Yukl, 1992). One study suggested sensitivity training as a potential training technique (Carroll, Paine, & Ivancevich, 1972). However, this particular study was based on a survey of trainers, who were asked what was most popularly used; at the time the study was published, sensitivity training was a highly fashionable activity, thus explaining the findings. More recent research suggests that sensitivity training is ill suited for interpersonal skills training (Burke & Day, 1986). It appears then, that the consensus of the literature is that practice-based methods, such as role-playing, simulations, and behavior modeling are best suited for developing interpersonal skills in trainees.

Cross-cultural issues

There is a myriad of research on cross cultural training, both in government agencies, (Chemers, 1968; Corbell, 1992; Fiedler, Mitchell, & Triandis, 1970; Grace & Hofland, 1967; Habel, 1996; Landis, 1983; Lau & Blanchard, 1975; Stolurow & Santhai, 1966; Wise, Hannaman, Kozumplik, Franke, & Leaver, 1998) and the general scientific community (Bhagat & Prien, 1996; Black & Mendenhall, 1990; Fowler, 1994; Kealey & Protheroe, 1996; Moscow, 1969; Richards, 1997; Thomas, 1996). Cross-cultural issues were not singled out as a factor in the validation study (Galarza & Holland, 1999), because they are embedded in all of the factors. That is, any of the ten factors could involve cross-cultural issues. Consequently, a separate system for cross-cultural issues is not presented here. Nevertheless the literature on cross-cultural training is substantive enough to warrant some attention here.

Training individuals in the particulars of another culture can be a daunting task. Culture covers a wide spectrum of topics, including customs and values, education and socialization processes, religion, social organization, and culture change (Stolurow & Santhai, 1966). Early government research turned to programmed instruction as a means of providing trainees information about a foreign culture (Chemers, 1968; Grace & Hofland, 1967). The culture assimilator in particular (Fiedler et al., 1970), a series of self-administered programmed culture training manuals became a popular training tool. Newer research, however, suggests that one type of cross-cultural training does not fit all situations. Although the culture assimilator is useful for practical information and general awareness, it is not effective at developing the interpersonal skills necessary to effectively interact with individuals of other cultures (Kealey & Protheroe, 1996). This is consistent with other existing training methods research (e.g., Bennett Jr. & Arthur Jr., 1997), including the research reviewed in this report. Most current research in the area of cross-cultural training suggests that in order to attain effective interpersonal skills, a combination of experiential techniques and audio visual materials is necessary (Black & Mendenhall, 1990; Kealey & Protheroe, 1996).

Approach

The research literature on training and on each of the ten critical factors prescribes a multi-modal approach to training. This section presents the currently recommended plan for the Expedition Interpersonal Training, which consists of informational seminars, active workshops, and experiential training. The training flow described below represents an initial seminar and active workshop training plan that is currently being offered, consistent with the multi-modal approach prescribed in the literature. A longer-term plan, which will include the current offerings, is being concurrently designed by the BHPG to improve and expand upon this original design.

The training flow consists of an introductory briefing on the Expedition Training Program, followed by a panel seminar workshop, and experiential training modules. The participants include US and non-US astronauts. The seminars are offered once per year and include both lectures and discussion sessions with the audience. The experiential modules are also offered once per year, and involve discussion, active learning, and (where appropriate) opportunities to practice the material presented in the seminar workshop.

Introductory Briefings

Introductory Meeting on Training Objectives- First, the importance and the objectives of the overall training program will be presented, along with a summary of each element of the flow, and a clear definition of what will be expected of each participant. These objectives will be presented at the Monday morning Astronaut Office meeting.

Panel Seminars/Discussions

Panel seminars will include presentations and discussion of the unique conditions imposed on individuals by expeditions to extreme environments. Samples of scenarios that have occurred on prior expeditions will be discussed to illustrate the uniqueness of expedition (as opposed to short-term) missions. The seminar panelists (along with training participants) will also discuss lessons learned from prior historical, analogue, and space expeditions on self-management, leadership, teamwork/Group living, medical issues, and cross-cultural skills and proficiencies needed to successfully adapt to long-duration space missions. Panel seminars are intended for large group of 30-60 participants (contrary to active workshops designed for smaller groups of 12 participants). The following is a list and description of planned panel seminars.

1. Lessons learned from Historic Expeditions -This panel seminar is an introductory or background seminar on prior expeditions. It consists of a lecture summarizing the history of various expeditions in which isolation and physical stress have affected the expedition outcome, followed by a discussion with the audience on the lessons learned from these environments.

2. Self-Care and Self-Management Issues - This panel seminar addresses the lessons learned from analogue environments that pertain to astronaut proficiencies, behaviors, and situations related to self-management and care. Panelists lecture on basic issues, examples, and strategies related to effective self-management and self-care during expeditions. A significant portion of the material for this seminar is drawn on prior

expeditions in historical, analogue, and space environments. Cross-cultural issues related to self-management and self-care proficiencies are also addressed.   The presentation is followed by an in-depth discussion of cases and issues presented in the lecture.

3. Leadership Issues - This panel seminar addresses the lessons learned from analogue environments that pertain to astronaut proficiencies, behaviors, and situations related to effective leadership. Panelists lecture on basic issues, examples, and strategies related to effective leadership during expeditions. A significant portion of the material for this seminar is drawn from on prior expeditions in historical, analogue, and space environments. Cross-cultural issues related to leadership proficiencies are also addressed.. The presentation is followed by an in-depth discussion of cases and issues presented in the lecture.

4. Teamwork Issues - This panel seminar addresses the lessons learned from analogue environments that pertain to astronaut proficiencies, behaviors, and situations related to effective teamwork. Panelists lecture on basic issues, examples, and strategies related to effective teamwork during expeditions. A significant portion of the material for this seminar is drawn from on prior expeditions in historical, analogue, and space environments. Cross-cultural issues related to leadership proficiencies are also addressed.. The presentation is followed by an in-depth discussion of cases and issues presented in the lecture

5. Lessons learned from the Mir and Skylab Experiences- This panel seminar is offfered for non-Russian crew persons only, and is conducted by the crew persons and mission support personnel from the NASA/Mir and Skylab programs. Personal experiences are discussed to sensitize individuals to the unique features an international long-duration space mission and to some of the self-management, self-care, interpersonal, teamwork, group living and leadership issues that have been experienced in prior long-duration space flight.

7. Cross-Cultural Seminars - Currently, several other directorates at JSC provide a variety of cross-cultural seminars on a voluntary basis. We recommend that individuals working in or with individuals from a particular culture take one standard course on living and working with natives from the host culture, preferably prior to attending the expedition training seminars. In addition to these generalized cross-cultural seminars, a specialized seminar is offered where the themes of self-care/self-management, teamwork, and leadership, are discussed in the context of Russian, Japanese, and American cultures. More cultures will be added as the program develops.

Experiential Training Modules

11. These training modules follow a modified simulation format. The target audience is a small group of approximately 12 participants per session. Currently, three experiential modules, are offered: Outdoor survival training, cold weather training, and chamber training. Outdoor survival training. In this training module, currently conducted by the National Outdoor Leadership School, participants spend two weeks in an outdoor campsite, with the goal of refining their leadership and teamwork skills. Effective and ineffective leadership and expedition behaviors are discussed. Participants receive ample opportunity to practice the skills learned and the material presented in the seminar workshop.

12. <u>Cold weather training</u>. In this training module, participants spend two weeks in an outdoor site in Canada, with the goal of developing cold survival and teamwork skills. Participants receive ample opportunity to practice the skills learned and the material presented in the seminar workshop.

13. <u>Chamber training</u>. In this training module, participants spend seven days in a 20-foot locked chamber, with the goal of simulating some of the working conditions prevalent in ISS. Participants complete written exercises directly relevant to the issues of self-care/self-management, leadership, and teamwork, and receive ample time to discuss and practice the skills learned in the seminar workshop.

Summary and Concluding Remarks

The literature on space and other extreme environments has demonstrated a clear need for psychological training of long-duration mission crew members. Ten psychological skills have been identified as critical for successful performance during long-duration missions, most of which can be learned through training. A review of the training literature reveals three basic categories of instructional techniques (information, demonstration, and practice based methods), each of which has different strengths, weaknesses, and optimal uses. The literature on learning also reveals that different people have different learning styles, and that the optimal learning style is a function of individual characteristics. Consequently, the highest amount of training transfer occurs when a combination of methods, from each of the categories, is used to deliver training on a specific skill or subject.   Based on this review of the literature, an initial seminar and experiential module plan is offered to deliver psychological training for long-duration expedition astronauts.

As a concluding remark, we would like to emphasize that this report constitutes simply the beginning of what should be a continuously improving training program. As more astronauts spend more time in space, and more is discovered about both the critical psychological issues and training technology, the content and delivery methods of the seminars and workshops can be refined and altered, in order to deliver a highly customized, highly effective product in the most efficient manner.

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Appendix A: Linkage Matrix of Critical Skills to Training Methods

Critical Skill	Instructional Objectives	Training Methods	Comments
Mental and Emotional Stability	• N/A	• N/A	This is a trait, not a skill. Should be assessed during selection process
Performance under stress	• Complex, multifaceted performance • Information about team goals, responsibilities, & interdependencies • Clarifying teammate roles and expectations • Situational awareness • Self-regulatory / metacognitive skills • Organizational attitudes and values • Stress / anxiety reduction	• Audiovisual techniques, videodisc • Lecture • Lecture • Information, demonstration, practice (IDP) • Behavior modeling (BMOD) • Mentoring • IDP, stress inoculation	This can be summarized into IDP; information can be a lecture; demonstration can be a film or other audiovisual technique; behavior modeling falls under practice. An integrated approach could be done, alternatively each of the instructional objectives could be scattered throughout training
Group Living	• Attitude change • Organizational attitudes and values • Interpersonal skills	• Combination of methods • Interactive techniques • Lecture	Attitude change is one of the most difficult things to accomplish through training. According to Lindsley (1998), the combination should include techniques such as group discussions, readings, films, cultural assimilators (for diversity training), role playing, and simulations. Interactive techniques include programmed instruction (PI), computer aided instruction (CAI), IDP, BMOD, simulations, and business games. Any of these, especially CAI,

Critical Skill	Instructional Objectives	Training Methods	Comments
	• Clarifying teammate roles and expectations • Communication • Assertiveness	• IDP, BMOD, business games • IDP	simulations, and practice sessions, can be accomplished via an AIM protocol, which produces equal results at a 50% time savings
Teamwork	• Attitude change	• Combination of methods • Lecture • Lecture • IDP, BMOD, business games • Mentoring	See Skill 3 (group living) above for discussion of attitude change and combination of methods
Family Issues	• Self-regulatory /metacognitive skills • Stress / anxiety reduction	• BMOD • IDP, stress inoculation	
Motivation	• N/A	• N/A	The literature simply doesn't support this. There are some examples of training for achievement motivation; results are mixed at best, and they usually take at least 5 FULL days to complete (expensive!!). Something like goal setting, which is a specific area of motivation, could benefit from training (such as IDP). Motivation in general, however, is a psychological condition, not a skill; as a result, the appropriate course of action is to make sure all the

LEGEND -- IDP: Information, demonstration, practice; BMOD: Behavior modeling

Critical Skill	Instructional Objectives	Training Methods	Comments
			environmental conditions are such that people stay motivated, not train people to get motivated in bad conditions. (BTW, Rich Ryan, one of the big wigs of intrinsic motivation and self-determination, agrees with me).
Judgment & Decision-Making	• Assertiveness	• IDP	
Conscientiousness	• N/A	• N/A	This is a trait, not a skill. Should be assessed during selection process. Certain conscientious skills, such as time management and organizational skills, can be addressed with IDP or BMOD
Communication	• Communication • Interpersonal skills	• IDP, BMOD, business games • Interactive techniques	See critical factor 3 for list of interactive techniques
Leadership	• Information about team goals, responsibilities, & interdependencies • Communication • Interpersonal skills	• Lecture • IDP, BMOD, business games • Interactive techniques	

LEGEND -- IDP: Information, demonstration, practice; BMOD: Behavior modeling