

## APPENDIX F

### BEHAVIOR AND PERFORMANCE WORKING GROUP - SUPPLEMENTAL MATERIAL

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Other NASA representatives present included Drs. Harry C. Holloway, Arnauld E. Nicogossian, Joan Vernikos, and Guy C. Fogleman. USRA staff present included Dr. Kenneth Hart, Ms. Sandra L. Adamson, and Dr. David Liskowsky.

## **F - 2 Detailed BP Countermeasures Research Priorities**

- A. With respect to psychiatric issues
- analyze the epidemiology and natural history of psychiatric illness in transplanted populations, deployed populations, and separated families
  - validate monitors preflight, inflight and postflight that improve objective assessment of essential behavior and performance factors in flight
  - identification of neural mechanisms, neurotransmitters, neural substrates that impact on optimal psychological performance: especially in areas of mood, well-being, motivation, reward
  - Research on the behavioral side effects of pharmacological countermeasures
  - study of circadian physiology and biochemical indices during spaceflight and their implications on the quality of rest and performance
  - development of proven methods for defining circadian cycles of humans that requires less intrusive implementation
- B. With respect to individual psychological development:
- develop a methodology to measure performance of meaningful tasks essential to mission safety and mission completion that is transparent to crew daily work
  - Assessment of job satisfaction for mission, ground and families of, mission crews.
  - Methodologies to quantify task errors (e.g. eye-hand coordination, visual memory of scenes, orientation of self and objects)
  - Research on cognitive processing, emotion, age and gender with respect to space missions
  - Research on the effect of noise, crowding and light on the health, sleep patterns, and mood of space mission and related crews.
  - Research on the effects of the space mission environment on sensory systems, motor systems and the cognitive process that enable them.
- C. With respect to group psychological development:
- Analysis of how healthy cultures are developed for small groups on space missions
  - Research on how leadership skills, command and control are developed and applied over the course of a space professional's career.
  - Research on group dynamics with respect to space missions
  - Research on communications and language with respect to international missions.

## **F-3 Report of the Behavior and Performance Working Group**

The Behavior and Performance Working Group met Wednesday May 22, 1996 and Thursday May 23 1996. After being addressed by both US and Russian Astronauts and Cosmonauts the BPWG prepared the following analysis and recommendations.

### Section 1

#### Identify Research Requirements

#### RECOMMENDATIONS

##### Areas of Focus

##### 1. Decreasing task errors

- Identify task errors in a measurable way

- Analyze error patterns;

  - e.g., eye-hand coordination, visual memory of scenes, orientation of objects, cognitive skills, coordination skills

- Human factors engineering or Behavior and Performance Principles research to “Design out” error

- Human factors engineering or Behavior and Performance Principles training to “Design out” error

- Embedded tests of performance for feedback to Mission team during the mission

  - including on board simulation of emergency procedures

- On board simulations to maintain task skills, especially those used later in the mission

- Analysis of components of performance skills for critical tasks in various crew positions to develop a standard for behavior patterns

- Study and define the current “Astronaut culture”

- Study how healthy cultures are developed for small groups in isolation and confinement on physically challenging, long duration scientific missions

##### 2. Reducing group conflict

- Feedback on individual and group performance be provided to those who select astronauts and astronaut teams.

- Use professional psychologists to observe, record, feedback and lead discussion on group interactions (crew, crew and ground, crew and family, family and ground)

- Obtain self reports on status of crew interaction, social dynamics and structure

- Strengthen mission crew - ground crew relationship through training including sections on conflict resolution, communication skills (active listening), etc.

- Train ground and crew teams in full group environments with the individuals who will be involved.

- Study the use of games as a tool to work out intra crew interactions (cross-cultural, new technology, environmental hazards, work schedules)

##### 3. Increasing job satisfaction

- Assess current sources of job satisfaction for mission crews, ground crews, other groups of NASA employees, families of mission crews

What sources are similar and which are different compared to other organizations  
How does NASA identify and reward desirable behavior and performance for astronauts?  
What other forms of identification and rewards are possible and desirable?  
How does NASA identify and discourage undesirable behavior and performance for astronauts?

What other forms of identification and discouragement are possible and desirable?

What are the current sources of dissatisfaction for astronauts?

How can these dissatisfactions be addressed?

Is there a track for career astronauts?

Why do experienced Astronauts leave NASA?

Is this desirable or not?

#### 4. Accomplishing scientific and other mission goals

How to measure success ?

Quantify DTOs, DSOs, technology goals, organizational goals, political goals

Develop metrics for scientific research

Publications in peer reviewed journals, prestigious peer selected awards (Nobel prize, etc.), citations in peer review journals

Develop metrics for Astronaut Corp (non-technical) that are mission dependent (i.e. there is a difference between long duration and short duration missions)

#### 5. Maintaining personal health, well being and social cohesiveness

Employ professional psychologists to help individuals define and maximize performance for personal/professional mental and physical health goals

Employ social or clinical psychologists or other professionals with special training or experience in cross cultural work to help space mission planners and teams define and maximize performance

## Section 2

Overarching scientific strategy

## RECOMMENDATIONS

Assess the status of basic and applied behavioral science research for planned space missions (preflight, flight and postflight for Space Crews, Ground Crews and Families of Crews) with respect to: selection, training, prevention, intervention, monitoring, evaluation and postvention for planned space missions  
The research is transdisciplinary and addresses the interrelationships between psychosocial, cultural and human factors.

## Section 3.

Psychosocial factors that are relevant to the Shuttle-Mir, analog, and International Space Station environments include crew composition and selection, ground-crew interaction, workload and its association with personal autonomy and control and individual mood, isolation and from and the ability

to cope with both mundane and unexpected events and circumstances, the relationship between crew members and their organizations both pre-flight and in-flight, and the differential access to support and resources among crew members.

Cultural factors include the organizational cultures involved in these settings, the culturally-influenced set of expectations and norms that regulate social interaction, including social support and rules of conflict, and language and cultural differences that influence the ability of crew members to communicate with one another both formally and informally.

Human factors include the influence of workload on individual and group performance, time allocation, training, and opportunity for exercise and leisure activities; and the influence on environmental conditions (noise, crowding, storage, light) on health, sleep patterns, mood, and task performance.

## RECOMMENDATIONS

Research should be conducted on psychosocial, cultural and human factors relevant to the Shuttle-Mir, analog, and International Space Station.

Research should be conducted to determine if human behavior and performance in the Shuttle Program, Shuttle Mir Space Program, and International Space Station are related in a fixed relationship regardless of environmental context or if they represent qualitatively different experiences that limit our ability to generalize from one experience/environment to the next.

### Section 4.

All behavior and performance research conducted as part of NASA's Life Sciences Program should involve a demonstration of the relationship between the critical questions addressed by the research and more fundamental questions related to human behavior and performance in general. For instance, research conducted on a manned space mission or space analog offers the potential of determining the extent to which state or trait characteristics influence behavior and performance. Similarly, the extent to which crew member autonomy or control over workload influences health, well-being and performance could provide greater insight into the role of self-efficacy and personal autonomy on human behavior and performance in general. Ultimately, research on behavior and performance in long-duration space missions should be designed and developed that meets and needs of the larger society for a greater understanding of behavior and performance as well as the more specific, programmatic needs of NASA and other national space agencies.

## RECOMMENDATIONS

1. Behavior and performance research conducted on long-duration manned space missions or analog environments with relevance to manned space missions should demonstrate a relevance to more fundamental questions of behavior and performance in general.

2. Research on behavior and performance for long-duration space missions should be designed to meet the needs of society at large, providing a greater understanding of behavior and performance as well as addressing the more specific, programmatic needs of NASA and other national space agencies.

#### Section 5.

Should research be conducted with space crew members themselves or with analog populations?

#### RECOMMENDATIONS

1. Priority should be given to analog studies for understanding behavior and performance during long-duration human space missions. Astronaut time is a scarce, valuable resource. To preserve that resource, specific justification for the need to have astronaut time should be required, as well as evidence of appropriate ground work.
2. Justification must be provided as to why a particular study should be conducted in space.
3. Proposals must also demonstrate the likelihood that data will be collected in a valid and reliable manner given the unique conditions of human missions and the organizational cultures involved.

#### Section 6.

The BPWG should provide programmatic oversight into the human behavior and performance research program at NASA. Such oversight is considered critical to accomplishing the goals and objectives as outlined in the WG Charter and in order to avoid redundancy in requirements definition. This oversight would involve assistance in the proposal review process, review of scientific guidelines, and evaluation of the products of NASA-funded behavior and performance research.

#### RECOMMENDATIONS

1. The BPWG should provide NASA Life Sciences with names of qualified individuals who could be used to review research proposals either as a panel or on an ad hoc basis. The BPWG recommends that members of the astronaut community be included in this review process, to insure that proposals are feasible and likely to produce valid and reliable data.
2. The BPWG should be given access to technical reports and publications resulting from NASA-funded research to determine whether program goals and objectives are being addressed and whether new requirements should be developed.
3. The BPWG should continue with its current membership to provide support to the Program Coordinator for Behavior and Performance, addressing the charter of the Behavior and Performance Working Group.

## GENERAL RECOMMENDATIONS

### 1. Research Programs to Emphasize

- A. Analysis of analog environment data with emphasis on commonality of lessons learned. Include full range, from laboratory studies at JSC to full up analogs in the Antarctic, or submarines.
- B. Work with Russian data, psychologists, psychiatrists; analyze their technique and experience: how they interview, test, select, (out and in), train, monitor, support, integrate crews, deselect. How did and do the Russians validate and refine their process? What did they try and discard? And why? What have they not tried? And why? A great deal of this work has already been done and the work needs to be integrated with current behavior and performance countermeasures. Activity in this area could be a prelude for a specific researcher who is interested in training or selection.
- C. Follow up for 1990 Rose-Helmreich study and cohort on selection of US Astronauts to assess the effectiveness of the research and to validate current and possibly future selection criteria and methods

2. Before research is carried out on astronauts careful consideration should be made as to whether or not the same research could be carried out on the ground in another environment such as a laboratory or analog environment. Previous research has documented a number of analog environments that have already offered or are offering the potential of providing a greater understanding of human behavior and performance during long-duration missions in space. Research should be conducted which moves beyond a description of each of these analog settings and a comparison of the extent to which these do or do not resemble long-duration manned space missions. This research should begin with a set of specific questions and then determine whether they can or cannot be answered with data already available (such as MIR or Skylab data) or data potentially available from an analog setting. Efforts should be made to provide answers to these questions with existing data or to conduct research in these analog environments that will provide answers to these questions.

3. Research should be conducted which describes the current organizational cultures which affect behavior and performance during human space missions. These organizational cultures are comprised of a system of norms, understandings and meanings that are shared and distributed among the members of an organization. In addition, research should be conducted that defines an optimal organizational culture for decreasing task errors, reducing group conflict, increasing job satisfaction, accomplishing mission scientific goals, and maintaining personal health, well-being and social cohesiveness. An optimal organizational culture should promote strong leadership and adherence to a common set of understandings, meanings and norms, while simultaneously promoting flexibility and individual autonomy.

4. Research should be conducted into procedures and methods for selection into the astronaut corps and formation of crews for specific flights by each national space program. Research should also be conducted that defines optimal procedures for screening in astronauts best qualified for performance in specific circumstances in specific crews.

5. Research should be conducted that will enhance individual performance, group performance and leadership. This research should identify the criteria necessary to evaluate performance and the methodology for both active and passive forms of training and countermeasures. Passive countermeasures include monitoring of individual and group behavior and performance pre-flight and in-flight, while active countermeasures include interventions designed to train personnel pre-flight and prevent decrements in performance in-flight. Research is also required to determine whether active interventions can be implemented using existing programs and protocols or whether entirely new interventions that are specifically designed to address the unique conditions and requirements of human space missions should be developed. A full range of problems need to be addressed from circadian rhythm to work volume (too much or too little).
6. Assessment of inflight hardware and software support is needed to supplement training, group development and dynamics, as well as individual cognitive and emotional health.
7. Assessment of time and task management methodologies are necessary for inter and intra group performance in both flight and ground teams.
8. Research on gender with respect to behavior and performance on space missions needs to be assessed with respect to space crews, ground crews, families.
9. Assessment of physiological and pharmacological countermeasures with respect to behavior and performance is necessary across a spectrum of challenges from pharmacological agents to neutralize Space Motion Sickness, exercise as a psychological countermeasure to some of the negative effects of microgravity, etc.
10. Assessment of the right amount of training is critical to avoid under or over training.
11. Assessment of leadership training and opportunities as part of the career path of astronauts is necessary