INTRODUCTION

Human factors addresses humans in their active and interactive capacities, i.e., in the mental and physical activities they perform and in the contributions they make to achieving the goals of the mission. The overall goal of space human factors in NASA is to support the safety, productivity and reliability of both the on-board crew and the ground support staff. Safety and reliability are fundamental requirements that human factors shares with other disciplines, while productivity represents the defining contribution of the human factors discipline.

PROGRAMMATIC ORGANIZATION AND DIRECTION

Space Human Factors in NASA forms an essential component of two NASA HQ program offices, each with a complementary role to play. The Life Science Division of the Office of Space Science and Applications (OSSA) looks at human factors from a scientific perspective including connections with the biomedical sciences. The Life Science Division develops the human requirements that must be addressed in space-flight, including those associated with behavior and performance. The Information Science and Human Factors Division of the Office of Aeronautics, Exploration and Technology (OAET) is concerned with human factors as it relates to the design, development and implementation of technology products. Here, an understanding of humans’ ability to use and benefit from facilities and tools is a necessary element of the technology research and development process.

Human Factors has a special relationship to the mission activities that must be performed, and Human Factors programs begin with discipline-oriented mission analyses. The general content of the OSSA program is given in Figure 1. This figure indicates the emphasis on basic understanding of human requirements and capabilities as well as countermeasures to deal with human limitations or negative effects due to the space environment. Similar information for the OAET program is given in Figure 2, indicating an emphasis on crew station design and on human performance modeling, instrumentation for crew support, and integrated systems.

![Diagram](https://ntrs.nasa.gov/search.jsp?R=19920013082)

**Figure 1 - OSSA Human Factors Emphases**

Figure 2 also shows the OAET thrusts to which these human factors elements relate. Since human factors is a cross-cutting technology, the program impacts all thrust areas. However, human factors has a special relationship to Operations (where the actions of the human participants are central) and to Planetary Surface Explorations (where, because of distance, duration, and multiplicity of environments, the demands on human participants take on special importance).
In addition to its own internal planning, NASA regularly seeks the advice of special panels to help the Agency identify important issues and needs. These panels are comprised of university, industry, and government specialists. One such panel is the Space Science and Technology Advisory Committee (SSTAC). Figure 3 presents an abbreviated description of areas recently identified by the Human Factors subcommittee of SSTAC as representing important and timely research undertakings. All of the areas identified by SSTAC are contained within the broad structure of the combined Agency space human factors program, and their announcement by this subcommittee serves both to confirm the approach being taken and to give greater specificity to the identified research needs and opportunities.

**Figure 2 - OAET Human Factors Emphases**

**FIELD CENTER EMPHASSES**

Research within NASA is conducted primarily by and through the field centers. Much of this research is conducted in-house, with a significant amount being conducted through university or other granting arrangements. Human factors activity can be found at all of the major NASA centers. However, most space human factors research and development is concentrated between two centers: Ames Research Center (ARC), Moffett Field, CA, and Johnson Space Center (JSC), Houston TX. Work at the two centers complements each other, both in the nature of the approach taken and in areas of special emphasis and expertise. At ARC, the tendency is towards more development-based research, allowing the building blocks of understanding to be established, the extent and limitations of results to be assessed, and the space application to be developed. At JSC, the tendency is towards more implementation-based research, making a close connection with particular flight needs, and utilizing the Center's access to space simulation facilities and to the astronaut corps. Neither center presents a pure model but reflects, rather, a tendency or general approach. Considerations that drive the emphases also influence the location of specialty areas within the human factors discipline.

**Ames Research Center**
- Crew Factors
- Fatigue and Circadian Rhythm
- Human-Computer Interactions
- Visualization Sciences/Models/Technologies
- Cognitive Models
- Virtual Environments
- 3-D Audio

**Johnson Space Center**
- Selection
- Crew Training
- Weightlessness Simulation
- Clinical Support
- Models of Human Capabilities
- Humans/Computer Interfaces
- Standards and Guidelines for Man-Systems

**Figure 3 - High Priority Issues as Defined by SSTAC**

Human factors specialties for both ARC and JSC are given in Figure 4. At ARC, space research on crew fatigue and circadian rhythm as well as crew factors (crew communication and coordination) are natural outgrowths of ongoing aviation crew research, while in-house expertise in perceptual and cognitive sciences provide the
foundation for development of crew support
tools such as virtual environments and 3-D audio
displays. At JSC, Center responsibility for
selection, training, and crew well-being translate
into research to support these requirements and to
the establishment of standards to guarantee them.
Both centers are strongly involved in developing
models to understand and design to human
requirements, while both also emphasize the
emerging and dominating importance of
human/computer interactions. Laboratory
facilities at each center, reflecting the research
areas described, are listed in Figure 5.

<table>
<thead>
<tr>
<th>ARC Labs</th>
<th>JSC Labs</th>
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<tbody>
<tr>
<td>Visual Science and Technology</td>
<td>Anthropometry and Biomechanics</td>
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<td>Cognition</td>
<td>Human-Computer Interaction</td>
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<td>Virtual Reality</td>
<td>Graphics Analysis</td>
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<td>Crew Factors</td>
<td>Remote Operation Interaction</td>
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<td>Circadian Factors and Countermeasures</td>
<td>Weightlessness Environment Test Facility</td>
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<tr>
<td>Aviation Simulators/Analogs</td>
<td>Shuttle Simulation and Training Facility</td>
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Figure 5 - Facilities at ARC and JSC

FROM RESEARCH TO OPERATIONS

A ubiquitous problem for all research
organizations involves transitioning research
results for use by real people doing real jobs.
This is a highly complex and dynamic undertak-
ing that requires, at a minimum, establishing a
partnership between two quite diverse commu-
nities. The importance and difficulties of moving
from research to operations has already been
raised several times in this conference and
deserves considerably more attention. However,
I would like to concentrate here, not on the broad
transition issue but on the narrower and slightly
different issue of how researchers themselves
might think about and structure their activities to
better position themselves (and their findings) for
eventual application to space.

Human factors researchers, like other researchers,
select their methods and approaches based on the
demands of the questions to be answered. Some
questions are best addressed in the highly
controlled environment of the laboratory; others
tackle contextual factors and must be studied in
the field. Frequently, a variety of approaches is
needed to fully understand the contributions of
the various elements. Figure 6 lists a number of
research approaches.

Figure 6 - Research Approaches

For the space human factors researcher the task is
to plan his or her activities to "move" the research
to where it can inform spaceflight. This means
both understanding the aspect of human behavior
being studied and understanding how environ-
ments might change this behavior. The former
without the latter is unusable; the latter without
the former is unsupportable. Taking one
example, a phenomenon might be examined
initially in the laboratory, modeled and verified
for generalizability, and tested in the field. At
this point, a controlled investigation in an analog
environment or in space may be indicated. The
specific progression of the research will change
with the subject of investigation. However, in all
cases the mental set of the researcher must
include both building a solid scientific under-
standing and progressing towards the space
application.

SOAR '91

It is not possible in any one conference to discuss
all aspects of the NASA Space Human Factors
program as outlined in general terms above. In
this year's SOAR Conference, a small number of
topics have been selected for inclusion in the
Human Factors/Life Science track. The topics
selected fit the NASA perspective in the follow-
ing ways. The two sessions on Methods, Tools,
and Analysis provide an opportunity to discuss
and highlight recent advances in structural and
performance models and their utility in
understanding human performance in space. The
Virtual Reality session focuses our interests on
this new method of individually simulating a
desired environment. Such simulation can be
almost dimensionless and could be utilized, for instance, in support of onboard training for a Mars mission. The Human/Machine Interaction session underscores the importance of the emerging field of crew systems and the need to understand the dynamics of these systems as applied to separated and highly autonomous crews. Although these topics define only a subset of the ongoing NASA program, they are important both in their own right and reflect a confluence of interest and activity in NASA and the Air Force.