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The Influence of Culture on Space Developments

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For a quarter of this 20th century, humankind has been successfully extending its presence into space. The landing of men on the Moon in 1969 during the Apollo 11 mission broke our perceptual blinders—we were no longer earthbound as our ancestors had thought for centuries. Perhaps the real home of the human species lies on the high frontier. Just as the application of fire and tools changed our primitive forebears, so space technology and its accomplishments force modern men and women to change their image of our species. We now are free to explore and use the universe to improve the quality of human existence. Our new self-concept as "Earth people" may energize global efforts toward space development. The technological achievements of NASA and other national space agencies, along with private-sector space undertakings, contribute mightily toward the actualization of our human potential. The exploration and exploitation of space resources are altering our human culture here on Earth.

Such vision is necessary to put the endeavors of space scientists and technologists into a larger context. During the past 25 years, the feats of people in the National Aeronautics and Space Administration and the allied aerospace industry have advanced human culture. The next steps of space technology into the 21st century will transform that culture.

Culture—A Coping Strategy

Culture is a unique human invention. Our species created it to increase our ability to cope with the environment, to facilitate daily living. Thus, consciously and unconsciously, groups transmit it to following generations. The concept of culture provides a useful tool for understanding human behavior and its relationship to a particular physical environment.

Human beings created culture, or their social environment, in the form of practices, customs, and traditions for survival and development. Culture is the lifestyle that a particular group of people passes along to their descendants. Often in the process, awareness of the origin of contributions to this fund of wisdom is lost. Subsequent generations are conditioned to accept these "truths" about accepted behavior in a society; norms, values, ethics,

and taboos evolve. Culture is communicable knowledge which is both learned and unlearned, which is both overt and covert in practice, of which we may have either conscious or unconscious understanding. On this planet, human culture has been remarkable for its diversity, so that those who would operate successfully in an international arena have to learn skills for dealing effectively with cultural differences. The point is that culture is a powerful influence on human behavior as people adapt to unusual circumstances (Harris and Moran 1987).

The program manager for long-range studies at NASA's Office of Space Flight has listed some of the unusual circumstances on the high frontier that might influence the creation of a space culture: (1) weightlessness; (2) easy gravity control; (3) absence of atmosphere (unlimited high vacuum); (4) a comprehensive overview of the Earth's surface and atmosphere (for communication, observation, power transmission, etc.); (5) isolation from the Earth's biosphere (for hazardous processes); (6) an infinite natural reservoir for disposal of wastes and safe storage of radioactive products; (7) freely available light, heat, and power; (8) super-cold temperatures (infinite heat sink); (9) open areas for storage and structures; (10) a variety of non-diffuse (directed) types of radiation; (11) a magnetic field; (12) nonterrestrial raw materials; (13) absence of many Earth hazards (storms, floods, earthquakes, volcanoes, lightning, unpredictable temperatures and humidity, corrosion, pollution, etc.); (14) a potentially enjoyable, healthful, and stimulating environment for humans (Von Puttkamer 1985).

As the director of the California Space Institute, James R. Arnold, reminded us in a Los Angeles *Times* editorial (November 17, 1983), "Space is out there waiting for us to try out new ideas." In his view, the space station and other space bases to follow will give humans the time and place to learn, to experiment, to work, and even to play. In fact, the Soviets have already begun to do these things on their Mir space station. The formation of space culture has been under way now for over 25 years, and it is progressing rapidly.

Until now, only a handful of humans have actually lived in space. Whether Americans or Russians or their allies, these space pioneers were usually from a somewhat homogeneous background. Until the decade of the 80s, they came from subcultures like test pilots or the military and were mostly male. But, if we project to the next 25 years, it is obvious that the population in space will be increasingly multicultural and heterogeneous. Both Soviet and

American space flights, for example now include representatives of "allied" countries—cosmonauts or astronauts from "foreign" cultures. Just as on Earth there are human experiences that cut across most cultures, it would appear that living in space will become such a "cultural universal."

As we slowly extend our presence up there and establish human space communities in ever increasing numbers, there will be an urgent need for *cultural synergy*, be it on a space station or at a lunar base. Such synergy optimizes the differences between people, fosters cooperation, and directs energy toward goals and problem-solving in collaboration with others (Moran and Harris 1982). The very complexity of transporting people into space has stimulated the development of matrix or team management in the space program. Similarly, the creation of space habitats and colonies in a zero- or low-gravity environment will require synergistic strategies of leadership.

Current research in evolution indicates that harsh environments often result in innovation by species. The pattern of the past reveals that creatures are better at inventing and surviving when challenged by a difficult environment than they are when not challenged (Harrison and Connors 1984). The big jumps in species development seem to occur under such circumstances. Perhaps this will be true of the human race as we shift our attention from Earth-based to space-based resources. As the Apollo missions demonstrated, the very size, scope, and complexity of a space undertaking may be the catalyst for unleashing our potential and raising our culture to a new level. This may be the first time in human history that people can consciously design the kind of culture they wish to create in an alien environment slated for exploration and exploitation. The movement of people from their home planet to the "high ground" will transform both our culture and the human person. The editors of *Interstellar Migration and the Human Experience* remind us that "Migration into space may be a revolutionary step for humanity, but it is one that represents a continuity with our past" (Finney and Jones 1985).

Space planners can benefit immensely by utilizing the data base and insights of behavioral scientists (Connors, Harrison, and Akins 1985). Cultural anthropologists, for instance, offer a variety of approaches to cultural analysis. One method is called a systems analysis; here "systems" refers to an ordered assemblage of parts which form a whole. Thus, in planning space communities, one might utilize eight or more

systems, such as illustrated in figure 11. That is, the new space culture can be studied in terms of systems that are used to indicate relationships—for association, or social grouping; for economic and political purposes; for education and training; for health and recreation; for leadership and guidance (this last being the transcendent or philosophical system around which the space community might be organized). In *Living Systems* (1978), James Grier Miller has proposed a master paradigm for integration of both biological and social systems. Dr. Miller is currently engaged in research to apply his eight-level conceptualization of twenty subsystems to analysis of the cultural needs of future space communities (see his paper in this volume).

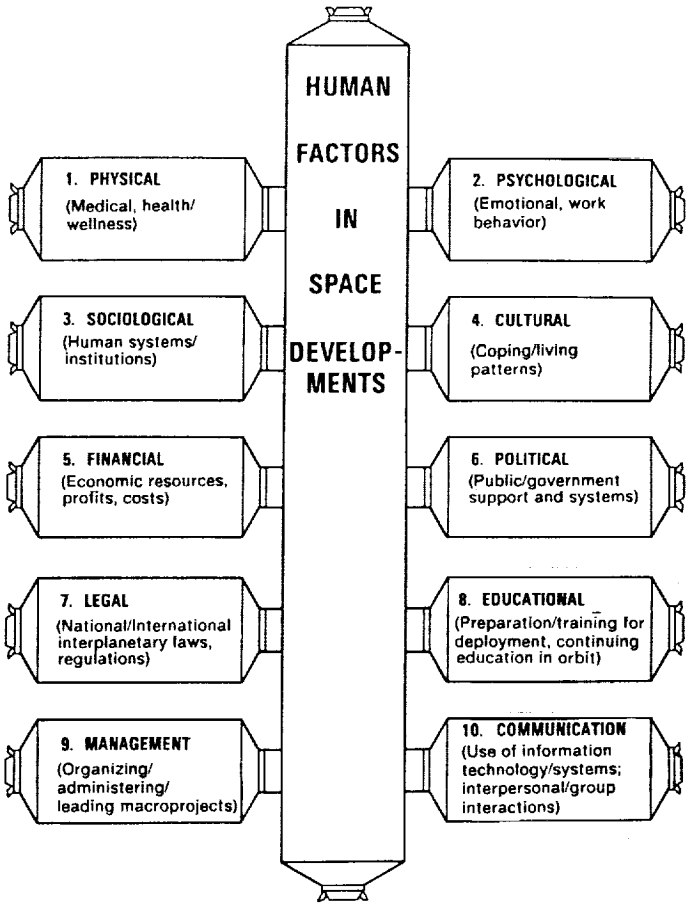

Figure 11

Systems for Analysis of a New Space Culture

Another way of preparing for a new cultural experience is by examining typical characteristics of culture. Some of these for a space community might be the following:

(1) Sense of self
(2) Communication
(3) Dress
(4) Food
(5) Time consciousness
(6) Relationships
(7) Values
(8) Beliefs
(9) Mental processes
(10) Work habits

These ten classes offer a simple model not only for assessing an existing culture but also for planning a new one, such as a culture in space. Although there are other characteristics for cultural analysis (such as rewards), analysis of the listed characteristics would be sufficient to prepare for a startup space community, such as that of the crew at a space station or a lunar outpost.

Because culture is so multifaceted and pervasive in human behavior, we cannot simply impose one form of Earth culture on a space community. Nor can space technologists continue to ignore the implications of culture (Hall 1985). If the space population is to be increased and broadened, so should the composition of space planners and decision-makers (as happened in miniature with the multidisciplinary group of participants at the 1984 NASA summer study at the California Space Institute.)

Organizational Culture in NASA and the Aerospace Industry

Culture has already unconsciously affected our future in space through the organizational cultures of the chief developers of space technology. A distinctive culture has emerged in the past 25 years within NASA itself, and this in turn has influenced the corporate cultures of NASA's principal contractors. NASA has been an atypical government agency that has been innovative in both technology and management, as well as in its relations with contractors (Harris 1985).

When NASA was established as a civilian Government entity in 1958, it inherited cultural biases from the several organizations from which it was derived. It acquired many of the traditional characteristics of Federal public administration, being subject to the constraints of Civil Service regulations, annual budget battles, congressional and lobby pressures, and changing public

opinion (Levine 1982). Since it was chartered to be mainly a research and development organization, NASA was dominated by the subcultures of the scientific, technological, and engineering fields. Its interface with the military and its astronaut personnel from the Armed Forces provided another stream of cultural influence. The introduction of the German rocket specialists under Wernher von Braun provided further cultural input, as have numerous academics and their universities, beginning with Robert Goddard of Clarke University and coming right down to participants in the latest NASA summer study on the campus of the University of California, San Diego.

Currently, the organizational culture of NASA is being altered by its interactions with other national space agencies, such as those of Japan and Europe, and even by its successful cooperation with the Soviets in the Apollo/Soyuz mission. To broaden its constituency further, NASA is attempting to reach out to nonaerospace business and involve companies in space industrialization; to expand its cooperative efforts with other Government departments, from weather and transportation to commerce and defense; to engage in joint endeavors with national academies and associations, such as the American Institute of Aeronautics and Astronautics (AIAA). The ongoing history of NASA manifests continuing alterations of its culture from crises (e.g., the *Challenger* disaster) and reactions (e.g., congressional investigations) and new inputs from Presidential commissions (e.g., the Rogers Commission report, 1986).

Just as groups of people develop national or macrocultures, so too do human institutions develop organizational or microcultures. NASA as an organization is a collection of humans who have set for this system objectives, missions, expectations, obligations, and roles. It has a unique culture which is influencing the course of space development. The NASA culture begins by setting organizational boundaries and powerfully affects the morale, performance, and productivity of its employees. Eventually, this influence spreads to contractors and suppliers. For example, as NASA began to plan for its next 25 years, Administrator James Beggs circulated a statement of goals and objectives to administrators and center directors. This statement from the first item enunciated demonstrates a future trend in NASA culture:

GOAL: Provide our people a creative environment and the best of facilities, support services, and management support so they can perform with excellence NASA's research, development, mission, and operational responsibilities.

(*Government Executive*, October 1983, p. 5)

To analyze this NASA culture, one can take the ten characteristics listed in the previous section or one can use a diagnostic instrument (see "Organizational Culture Survey Instrument," appendix A in Harris 1983). Perhaps figure 12 best illustrates the possible dimensions of this NASA culture.

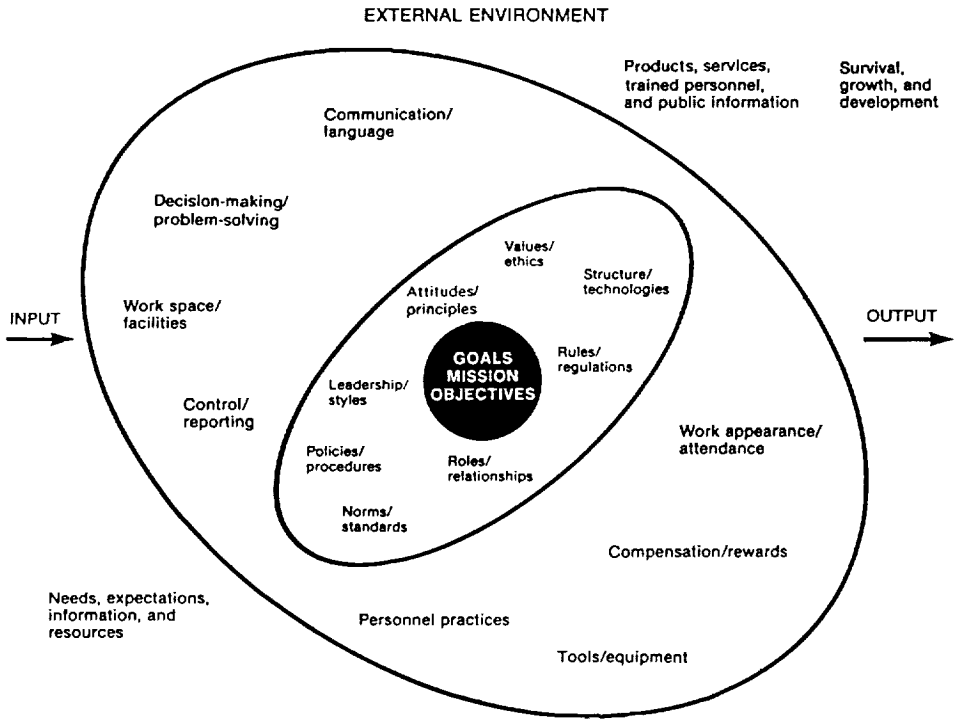

Figure 12

Aspects of NASA's Organizational Culture

The fact that NASA successfully completed its Apollo lunar missions would seem to indicate that its organizational culture was adequate. Since then, budget cuts, loss of talented personnel, and the *Challenger* accident have pointed up the need for cultural renewal. In 1986, as a result of the report of The Presidential Commission on the Space Shuttle Challenger Accident, reorganization got under way following the appointment, once again, of James C. Fletcher as NASA Administrator.

The issue of concern now is whether the agency's cultural focus will enable NASA to provide global leadership in the peaceful and commercial development of space. As NASA struggles with "organization shock," external forces demand that priority be given to military and scientific missions, leaving commercial satellite launchings and industrialization to the private sector. Other international space agencies—in Europe, Japan, and even the Third World—compete with NASA in launch capability. Confusion reigns over replacement of the fourth orbiter, development of alternative launch capability, and space station plans, so that NASA is an organization in profound transition, requiring transformational leadership (Tichy and Devanna 1986). This is especially true if NASA is to implement the vision outlined by the National Commission on Space (1986) in its bold report, *Pioneering the Space Frontier*.

As an example of the way NASA culture affects its space planning and management, consider the well-documented fact that the agency is leery of the behavioral sciences (Harrison 1986, Hall 1985, Douglas 1984). Since the organization is dominated by a technical mindset, it is uncomfortable with social scientists and their potential contributions. And yet the agency culture changes, as witnessed by the publication of the June 1988 report of the NASA Life Sciences Strategic Planning Study Committee, entitled *Exploring the Living Universe: A Strategy for Space Life Sciences*, and by requests for increased spending on the behavioral sciences in the FY89 budget.

As human presence in space is expanded with long-duration missions, NASA planners will have to confront issues of interpersonal and group living which until recently they avoided (Connors, Harrison, and Akins 1985). In interviews by flight surgeon Douglas (1984) with astronauts, the latter expressed regrets that they and their families did not benefit more from the services of psychiatrists and psychologists, particularly with

reference to group dynamics training. Oberg (1985) reveals that, on the other hand, in the culture of their space program, the Soviets are more prone to utilize such specialists. In fact, that author quotes the Soviet head of space biomedicine, Dr. Oleg Gazenko, as stating that the limitations to human living in space are not physical but psychological (p. 25); Oberg also notes that Svetlana Savitskaya, the second woman in space, suggested that a psychologist be included on long-duration flights to observe firsthand the individual stress and group dynamics (p. 32).

My purpose here is simply to bring to the reader's consciousness the reality that NASA does have a culture and that that culture pervades its decisions, plans, operations, and activities. One might even take the chapter headings of the volume *Corporate Cultures* and use them to assess NASA's values, heroes, rites and rituals, communications, and tribes (Deal and Kennedy 1982).

As reported in a variety of contemporary management books, from the one just mentioned to *In Search of Excellence*, research supports the conclusion that excellent organizations have strong functional cultures. Since its founding, NASA surely has created its share of space leaders, legends, myths, beliefs, symbols, visions, and goals—the stuff of meaningful organizational cultures. But, as Peters and Waterman reminded us,

> In the very institutions in which culture is so dominant, the highest levels of true autonomy occur. The culture regulates rigorously the few variables that do count, and provides meaning. But within those qualitative values (and in almost all other dimensions), people are encouraged to stick out, to innovate.
>
> (Peters and Waterman 1982)

Thus, if NASA is to provide the world with the technological springboard into the 21st century, these questions are in order:

(1) Does NASA now have the necessary innovative and entrepreneurial culture to provide leadership for its own renewal and the enormous human expansion into space? Or is it trapped inside both bureaucratic and technical cultures that inhibit its contributions to the next stage of space development?

(2) Has NASA adequately redefined and projected its present organizational image and purpose to its own personnel, the Congress, and the public at large? Or is it suffering again (as it did after three astronauts were killed in the Apollo capsule fire) from an identity crisis and a dysfunctional culture?

As NASA moves beyond its institutional beginnings into the next stage of organizational development, maturation would seem to require transformation. Perhaps the present structure is no longer suitable for this growth process and it needs to become a more autonomous agency. (Does the Tennessee Valley Authority provide a model for this structural change?) Perhaps it should be part of a global space agency that represents both public and private space interests—first in the free-enterprise nations and someday even in the Communist bloc. Perhaps NASA needs to enter into new relationships and ventures with contractors, whether in the aerospace industry or in other multinational industries.

It was encouraging to know that the 1984 NASA administrator advocated decentralization in the organization, putting operational responsibility at the center level. However, in 1986 the trend was being reversed with demand for strong headquarters management and inauguration of a new technical management information system. To meet the space challenges of the future, NASA would do well to consider planned changes in its own organizational culture. Technological, economic, political, and social changes by 2010 will demand such adjustments, and many present organizational structures, roles, operations, and arrangements (such as a centralized mission control) will be obsolete.

Emergence of a New Space Culture

The habitation of Skylab, Spacelab, Salyut, and Mir by a few dozen humans is the precedent not only for space station life but also for space culture. Whether astronauts or cosmonauts, they were humans learning to cope with a new environment marked by a lack of gravity. For most, it appears to have been an enjoyable experience, despite minor inconveniences caused by space sickness or excessive demands from experiment controllers on the ground. Whether inside or outside the space suits and capsules, these people learned to adapt and they proved that human life in space is possible, even practical. These innovators simply transported into space the

macroculture of the country that sponsored their space voyage. The U.S. astronauts reflected American culture, while their Soviet counterparts carried Russian culture into these prototypes of future space communities.

In the decade of the 1990s, the duration of missions and the number of humans in space will increase as more permanent types of space stations are constructed in orbit and expanded in size. Perhaps the Americans will name these initial space communities after their space pioneers and heroes, like Goddard, Von Braun, and Armstrong; while the Russians may name theirs after space luminaries like Tsiolkovsky, Korolev, and Gagarin. Then the real challenge of creating a new space culture will get under way. A major human activity of the 21st century will be the building of space communities. Already, Rep. George Brown (D—Calif.) has a bill pending before the U.S. Congress that would authorize NASA to provide leadership in space settlements.

The issue for consideration now is whether this process will be planned or unplanned. In the United States, for example, there exists a whole body of literature and research in cultural anthropology that could be most useful in the design of a space culture. Anthropologists are beginning to probe this new reality and to look for insights their field can contribute (see Finney's paper in this volume). Will NASA, for example, use the nation's anthropologists in the planning of a lunar base? If the human composition of that enterprise is to be multicultural, as is likely, will the agency call on international experts in cross-cultural psychology and anthropology? Perhaps NASA should join with its colleagues in the Japanese and European space agencies in sponsoring a summer study of behavioral scientists to address matters related to the emerging space culture.

Space gives us an opportunity to establish a living laboratory to promote peaceful international relations. For example, suppose the sponsors of a particular space station or base were to have as a goal the establishment of a synergistic society on the high frontier. Anthropologist Ruth Benedict and psychologist Abraham Maslow have already provided us with a glimpse of human behavior under such circumstances. Imagine a space community in which the cultural norms supported collaboration and cooperation rather than excessive individualism and competition. Consider space colonists who are selected because they demonstrate high synergy—that is, because they are

nonaggressive and seek what is mutually advantageous; they encourage both individual and group development; they operate on a win/win philosophy, or aim for group success; they share and work together for the common good. Such considerations take on special relevance in light of proposals for a joint U.S.A./U.S.S.R. mission to Mars. A space culture that espouses synergy might have a better chance for survival and development than one that did not. We should have learned something from the debacle of Fort Raleigh in 1594, the first "lost colony" of our English forebears.

Since culture formation seemingly occurs in response to the physical environment, consider briefly the situation faced by those seeking to establish the first permanent community on the Moon, a base from which we can explore other planets in the universe. It is a remote, alien environment. The long-term inhabitants would have to adapt their culture to cope with isolation, for they would be a quarter of a million miles away from home, family, and friends on Earth. The physical realities of life on the Moon would force its inhabitants to adapt their earthbound culture (Pitts 1985). Remember, the Moon lacks atmosphere, there is no weather there, and there are various kinds of radiation which require protective cover.

Back in 1969, astronauts Armstrong and Aldrin confirmed that the lunar surface was firm and could support massive weight. During the last visit to the Moon, Apollo 17, the first professional scientist on these missions, Dr. Harrison Schmitt, conducted geological studies, so we now have some idea of the composition of this body. But there is much we still do not know about the Moon, such as the nature of its poles and whether any of its craters were formed volcanically.

Before the turn of this century, it would seem advisable for NASA to follow a Soviet lead and undertake automated missions to gather lunar data if we are to plan adequately for the new space culture on the Moon's surface. At NASA's Johnson Space Center, scientists have a scheme for cultural expansion which begins with precursor exploration in a 1990-92 timeframe (Duke, Mendell, and Roberts 1985). It would require new technology development to exploit lunar resources and define the site for a research outpost and lunar base. The first two phases of site development would rely on automated and cybernated systems. In the third phase, permanent human occupancy by a small group of "astrotechnicians" is projected; then, in the fourth phase, an advanced base with more people would result, possibly by the year 2010.

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To illustrate why serious preparations for a Moon base should include studies of space culture by social scientists, let us view figure 13 in the context of a lunar base.

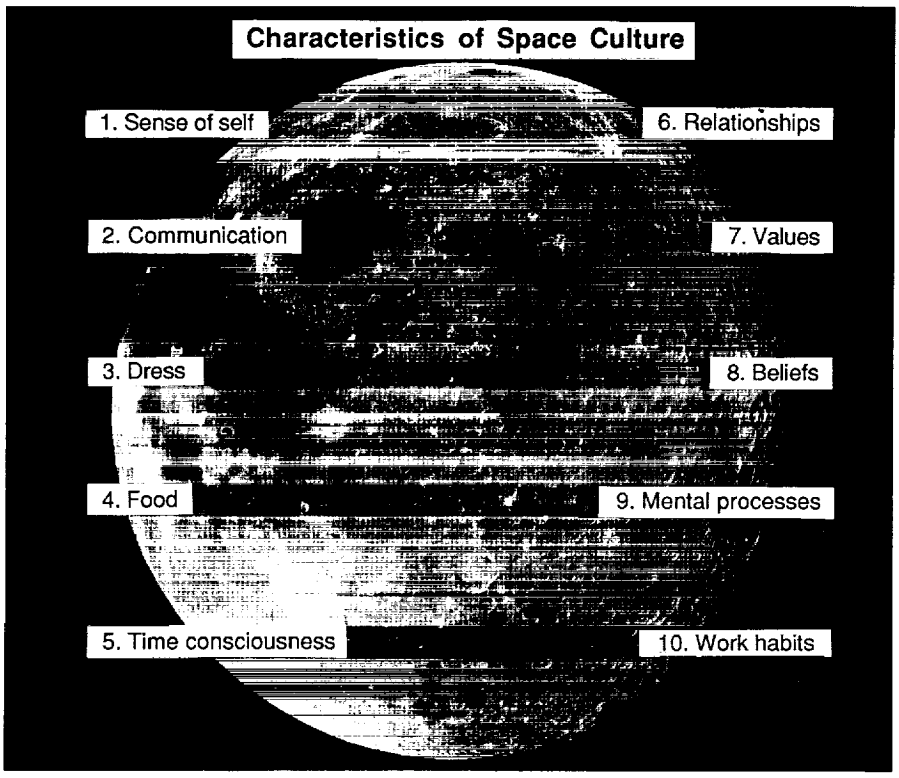

Figure 13

Characteristics of Space Culture

1. Sense of Self

Self-identity and self-acceptance are manifested differently in different cultures. The comfort we feel with ourselves and others, the physical or psychological space we maintain between ourselves and others—these are products of culture. For an international crew on a space station, as an example, there would be differing needs for privacy or personal space. One can speculate as to whether an international community on the Moon should, for the purpose of fostering such comfort, be structured as an open or a closed society. Personally, I would recommend an open, friendly, informal, and supportive community, such as expatriates often maintain among themselves when far away from their mother country. (Though the society of expatriates may be seen as closed to the surrounding society on Earth, such a perspective would be irrelevant in space where humans are alone.)

The space culture to emerge will validate individuals in new ways. First, there are the realities of no atmosphere and 1/6 gravity—certain to lead to interesting adaptations. With so much space and so few people, rugged individuals may develop (like the mountain men on the early Western frontier) or humans may learn to become more interdependent. Just as the American Great Plains affected the perspective of its inhabitants, so will the vast views of the universe affect lunar dwellers. Considering the confined quarters in the early stages, will the first colonists be ambivalent in behavior because of the difference between their sense of interior space and that of exterior space? Also, what happens to lunar colonists when they return to Earth after several years on that other sphere? Having been accustomed to Moon weight, they will on return to Earth feel heavier than lead, and their whole sense of self will require profound readjustment.

2. Communication

Much of our terminology may be inappropriate for the lunar experience. In space, we will need a new vocabulary to replace "up and down" and "day and night." Back in 1957, when German space science professor Hermann Oberth wrote his classic *Man Into Space*, he reminded us that we would have to change our ideas about construction, because "other laws prevail in space and there is no reason why the old architectural rules should be followed." By extension and analogy, our language about construction and indeed most other subjects will have to change in a drastically different environment.

Will there be one official language or several in use? If the first crews and settlers are international in makeup, is English to be preferred or should all be fluent in two languages? (If Americans were to undertake a joint mission to Mars with the Soviets, for instance, then both English and Russian would probably be required.)

Certainly, we can expect extensive use of computers and satellites for communication, but what will be the procedures and the pattern of interactions between humans on the Earth and on the Moon, and how will the means of communication affect the cultural expansion?

3. Dress

Culture is also expressed in garments and adornments. We may or may not want uniforms with mission patches, but lunar conditions will dictate certain types of clothing or space suits. They will have to be designed to serve a variety of purposes from protection to comfort. In 1984, for example, the first female to walk in space, cosmonaut Svetlana Savitskaya, commented that her space suit was not elastic enough and that she had to expend too much energy for each movement (Oberg 1981).

Some scientists have described the Moon as an impossible environment for humans, but so was the Earth for the first living things there—they coped by staying in the sea for the first two billion years! Humans will adapt to lunar conditions which require them to wear life support systems when they leave their protective habitats. That necessity will be incorporated into the new culture, and it will alter behavior from that on Earth. Dr. David Criswell, director of the Consortium for Space and Terrestrial Automation and Robotics (C-STAR), believes that astronauts in space suits are like disabled or handicapped persons, and that space planners could learn much from the field of rehabilitative medicine (1988).

Twenty-first century clothing styles on the home planet may be very much influenced by styles that develop for the lunar surface or for interstellar travel. Explorers and scientists in the Antarctic have tended to grow beards and longer hair. We wonder what lunar dwellers will do. Perhaps they'll shave off all their hair to keep from having to tuck it into their space suits every time they don them.

4. Food

The diet and eating procedures of a group of people set it apart from other groups. We are all aware of NASA's pioneering in food technologies and compositions, so that even our own intake here on Earth has been altered by the

astronaut experience. However, because of transportation costs, we will have to cut back on the amount and type of food cargo from Earth and depend on new closed biological systems to provide human sustenance. Hydroponic farming, featuring plants suspended in nets above circulating liquids that provide nutrients, may prove a boon. With traditional foodstuffs at a premium, the new culture may focus on high-quality and high-energy nourishment, thereby affecting the breed of both humans and other animals in space.

Although the lunar cuisine may not be as pleasant as that of the mining camps in the Old West, its preparation, presentation, and eating will surely alter the culture. One certainty is that food packages will not be disposable but rather recyclable. Let us hope habitat planners make up somewhat for the rations and regimen by providing a view of the Earth in the dining and drinking area. Or will there be any views from these modules buried in lunar regolith for protection from radiation?

5. Time Consciousness

The sense of time differs by culture, and yet lunar inhabitants will have to keep in touch with mission control. Will the 24-hour time system prevail on the high frontier? Or will the exact sense of time gradually be replaced by a relative one, like that of traditional farmers who go by sunrise and sunset and seasonal changes?

That particular time sense would of course have a different expression on the lunar surface, where the "day" lasts for 2 weeks and so does the "night." Because the axis of the Moon does not tilt as does the axis of the Earth, the Moon lacks seasons. Will the long periods of darkness and isolation incline the first Moon colonists toward suicide, as NATO has found its soldiers posted in northern countries to be? Will they suffer with manic behavior, as some Swedes do after their annual dark periods? If one needed change, one could move around the Moon from areas of darkness to areas of light. But what will happen to the whole concept of day and year, so much a part of the human heritage?

6. Relationships

Cultures fix human and organizational relationships by age, sex, and degree of kinship, as well as by wealth, power, and wisdom. The first lunar inhabitants are likely to establish relationships on the basis of professionalism or their respective disciplines. They will be scientists and technicians, civilian and military. Theirs will be primarily work or organizational relationships, even if they are of

different nationalities. Because the first colonists will be knowledge workers (that is, people who work with information and ideas), there is likely to be comparative social equality among them. Eventually, the founders will gain special status in the community.

The first element to alter the arrangement will be male-female relations. Eventually, this will lead to the first pregnancy on the lunar surface. As more and more people go to the Moon, there will be legal and illegal liaisons and eventually children will be born on the Moon, and someday on Mars. Dr. Angel Colon of Georgetown University Medical School has already anticipated the situation with his research on space pediatrics.* The point is that space will be a whole new ball game in terms of human relationships and a culture will grow in response to such new realities.

New familial arrangements will emerge (Oberg and Oberg 1986). It remains to be seen whether monogamy, polygamy, or polyandry will become the norm in 21st century space communities. If the first lunar colonists are only males, homosexuality may become prevalent; whereas, if mixed groups are sent, then heterosexuality will be the basis for many relationships. Astronaut Michael Collins (1988) proposes that six married couples be selected for any manned mission to Mars.

Should the makeup of the first crew be purely civilian, then we could expect one lifestyle; whereas, if military people are included, then we would expect another lifestyle including rank and protocol. The issue of such relationships will affect governance, housing assignments, and social life.

Another unique feature of space culture will be human-machine relationships. Automation will dominate not only the transportation system but also the exploration and life support processes (Freitas and Gilbreath 1980, Automation and Robotics Panel 1985). Humans may form new attachments to their helpers, especially as designers program more humanlike capabilities and features into these extensions of ourselves. Inventive applications of artificial intelligence on the Moon may not only facilitate functions in lunar communities but also serve as tests of expert systems, which may then be transferred to Earth. Knowledge engineering will accelerate as a result of space development, and space culture will feature teleknowledge (information developed by technical transmission) and telepresence.

*Personal communication.

7. Values

The need system of the space culture will be unique, and out of it will evolve special priorities to ensure survival and development. In time, these priorities will form the value system of the lunar base. As the colonists move up on the hierarchy of needs, their values will change. The resulting value system will in turn influence the norms or standards of the lunar community—that is, acceptable behavior in that situation. It is these mutual premises that will determine whether the colonists are pleased, annoyed, or embarrassed by the conduct of their fellows. Eventually, this process will produce conventions that are passed along to each new group of lunar settlers, so that the preferred practices of privacy, deference, etiquette, and gift-giving will be established.

For example, it is conceivable that these lunar pioneers may ban all talk of Earth accomplishments, happenings, or experience and focus only on what is done on the Moon or in space. They may learn to value the people on the space station, who supply them, more than remote people on the home planet, even when they represent the government. Because of their unusual view of the cosmos and the light/dark situation on the Moon, they may value artists more highly than technicians, for their capacity to express the pioneers' feelings and longings.

At the 1974 Princeton Conference on Space Colonization, Richard Falk examined "New Options for Self-Government in Space Habitats." He proposed four shared commitments that would enhance space living: (1) to the minimization of violence, (2) to economic well-being for all settlers in the habitat, (3) to a guaranteed level of social and political justice, and (4) to the maintenance and improvement of ecological quality (1977). Falk's premise is that this sort of value consensus before settlement would influence recruitment and selection of space personnel, as well as provide an ethical orientation for their training.

8. Beliefs

People's lives, attitudes, and behavior are motivated by spiritual themes and patterns which may take the form of philosophy, religion, or transcendental convictions. If the population of a lunar community is international, the space culture emerging on the Moon might include beliefs from the Earth's religious traditions—primarily Judaism, Christianity, Islam, Hinduism, Buddhism, and even Confucianism. However, since such belief systems are also reflections of new stages in human development, space dwellers may create their own unique form of

"cosmic consciousness" that raises the human race to a new level of being and perceives the oneness of the human family. For example, suppose a space colony were developed on the basis of a belief in synergy; the members would then be dedicated to creating a synergistic society through cooperation.

9. Mental Processes

The way people think and learn varies by culture because of different emphasis on brain development and education. Space culture, for instance, may offer humanity a rare opportunity to focus on whole, not split, brain development. Obviously, modern communication technology and satellites will have a primary position in information sharing and knowledge development. For education and training, the first lunar colonists will rely on computers and a data bank, as well as on a variety of modern media alternatives. Self-instructional systems will be widely employed, and all in the group will be expected to share their expertise and competencies with each other as circumstances require.

Assuming that a multicultural community develops, a synergy may emerge between Eastern and Western cultural orientations to learning, so that an integration of logic, conceptualization, abstract thinking, and intuition may evolve. We can anticipate a new reasoning process being created in space, especially with wider applications of artificial intelligence. With the removal of many ground-based blinders and binders, the creative process may be unleashed and human potential actualized.

10. Work Habits

One way of analyzing a culture is to examine how the society produces its goods and services and conducts its economic affairs. The work culture in space will be metaindustrial and will feature the use of high technology. In the beginning, the work will be performed outside using cumbersome space suits to provide life support. Or it will be done by robots, operating automatically or under the manual guidance of humans, who may remain in a protected habitat. On the surface of the Moon, for instance, this work may involve the mining, transportation and distribution, and processing of lunar materials.

Human vocational activity will include the operation and repair of communication satellites, the creation of solar power stations, and the conversion of solar power into microwaves for transmission to Earth and subsequent reconversion to electricity. The

first space stations, as well as bases on the Moon, and subsequently on Mars, will involve much construction—using new space materials and designs to build habitats and factories, communication and storage facilities, and other necessary structures.

The early space workers will focus on the transformation of nonterrestrial resources into useful supplies, such as oxygen, water, and cement. The nonterrestrial workers will use zero or low gravity to facilitate their labor, and they will take advantage of the vacuum. All of this work will require extensive use of computers and automation, and the "tin collar worker," or robot, will be a principal ally.

Such unusual work activities will influence the direction of the culture. The roles of knowledge workers and technical workers will probably be enhanced. Since those who get into the first space communities are likely to be highly selected, competence in one's field of expertise and multiskillfulness are norms that will probably emerge. The space culture will reflect these worklife changes in art and artifacts as well as in technology.

The new space enterprises and the culture thus created are a fruitful arena for social science research. Furthermore, these developments will have enormous impact on Earth-based work cultures. Large American corporations, from Fairchild and McDonnell Douglas to General Dynamics and Rockwell, are already gearing up for construction of the $8 billion space station, the staging area for exploration of the rest of the solar system. It may very well develop as a multinational facility for spacefaring peoples—a foretaste of 21st century life and culture.

Space Personnel Deployment System

The movement of large numbers of people from their native country to a foreign one has spurred increasing interest, especially on the part of transnational corporations, in the phenomena of culture shock and reentry shock. When people are rapidly transported from their home culture to a strange environment abroad, they may experience severe disorientation, confusion, and anxiety. Their sense of identity is threatened when they are removed from the comfortable and familiar and thrust into the uncertain and unknown. Such expatriates, particularly overseas managers and technicians who may be away from home for many months or years, go through a transitional experience that may include such phases as growing awareness of differences, rage, introspection, and integration.

Many multinational businesses have relocation services, as well as cross-cultural orientation and training programs, to facilitate acculturation of personnel to the new environment with its changes and challenges. In a previous publication, I have proposed that various aspects of foreign deployment support services be systematized (Harris and Moran 1987). Such an approach could be adapted for Earth people going into space to establish first construction bases and then planned communities. Figure 14 depicts my conception of a space personnel deployment system.

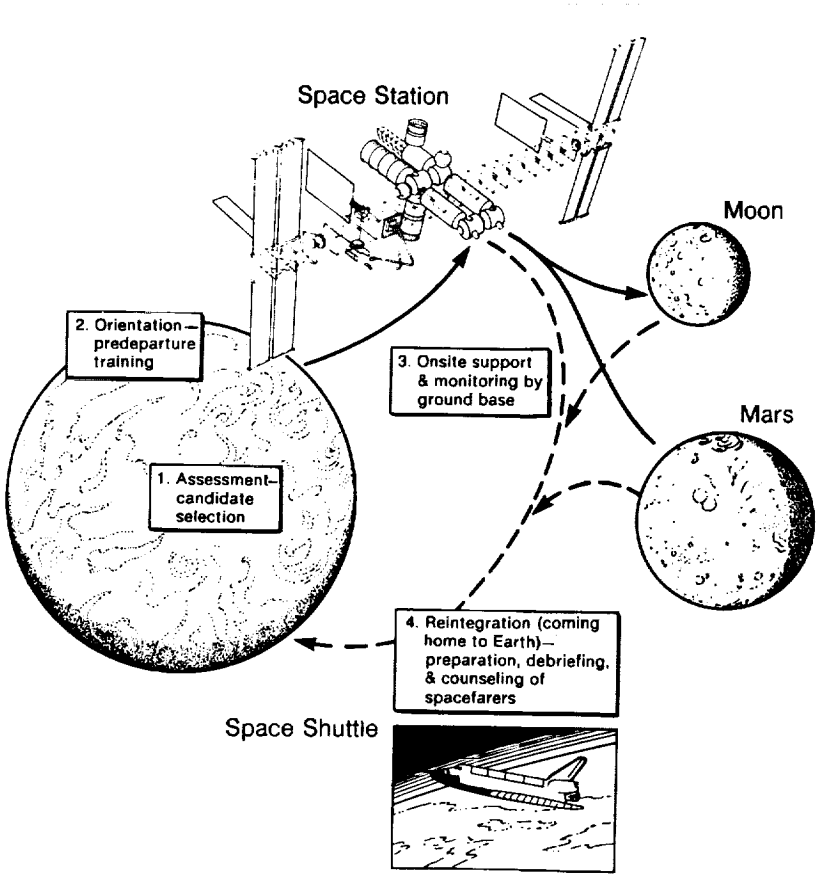

Figure 14

A Space Personnel Deployment System

At the moment, it is unlikely that spacefarers will have to deal with extraterrestrial "foreigners"—but they will have to cope with all the other aspects of adaptation to a new cultural environment. Research by Harrison and Connors (1984) on groups in *exotic environments* is relevant. Their "exotic environments" include polar camps, submarines, offshore oil rigs, space capsules—any isolated and remote living situation. Such experiences can assist in planning life in space stations and settlements.

We can thus prevent or limit the psychological "shock" of isolation, loneliness, and strangeness that humans may experience when living on the high frontier for many months or even years. The following outline of a system for intercultural preparation and evaluation is proposed for further research by NASA. It could avoid or reduce the depression, withdrawal, hostility, paranoia, and other mental health problems that may afflict space travelers, and thus it could contribute to mission success.

1. Assessment

In the next decades of space development, sponsoring organizations should take care in the selection of space settlers, workers, and travelers. Whether the group is a national space agency, an aerospace contractor, a commercial enterprise, a government department, a media company, or a tourist firm, it should be responsible for the spacefarer's well-being, as well as the impact of that person on the space community. Better to screen out potential misfits than to attempt to provide care and rehabilitation in space. The rigorous and defined selection and training used for NASA astronauts may not be the basis for future space deployment; these guidelines would seem advisable as a more diverse space population evolves:

- WHAT—Ascertain the ability of each space candidate to adapt to and deal effectively with the new environment, evaluate both the physiological and the psychological capability of the individual to deal with the difficulties and differences of long space travel and of life in space under constrained conditions, identify proneness to space culture shock and areas for retraining to improve adjustment to space conditions, ascertain needs for skills in human relations and coping.

- WHO—Apply such screening of space travelers and settlers to all who would utilize Government transportation, whether NASA personnel, contract workers, visiting professionals, members of the Armed Forces or Congress, visiting dignitaries from any source, representatives of the media, tourists, or the families who accompany any of these people to a space station or base.

- HOW—Use a variety of means to evaluate suitability for space living, such as psychological interviews, questionnaires, tests, simulations, and group meetings.

- WHY—Seek not only to determine suitability but also to identify those requiring preventive counseling because of their likelihood to experience space culture shock. The aim is to eliminate from space communities, at least in their founding stages, those who would want to return to Earth prematurely, those who would be disruptive influences in a space colony, and those who would simply not be satisfactory for their space assignments. Initially, the cost of transporting people to and from space will demand a careful selection policy and program.

NASA should consider establishing an organizational data bank on human factors to be used in the selection and preparation of spacefarers. Such a data bank might include information from research on personnel living in such exotic environments as submarines or the scientific bases in Antarctica. It might contain information on space habitat conditions and lifestyle, including data on food, medical conditions, responses to weightlessness, and skills required. Eventually, as experience in space living increases, the data bank might include specific cultural information for space stations in orbit, lunar bases, martian bases, and similar locations in space. Space "expatriates" while onsite or upon return to Earth would be asked to contribute insights to this fund of knowledge about life in zero or low gravity. Eventually, such input could be classified by the orbit in which the experience was garnered.

In time, this data bank about space life may become the basis of policy and guidelines for space travel which would be formulated by government agencies, corporations, or other organizational sponsors of people in space. It may someday contribute to practical decisions about such interplanetary matters as laws and insurance, passports and visas, financial compensation and allowances, taxes, security, training, and suitable dress.

In selecting the first space workers for a tour of duty of 12 months or less, practicality may give preference to those healthy and well-balanced persons who (a) have already had astronaut training, (b) come as a happily married couple with complementary competencies, and (c) are committed to long-term living in space.

Undoubtedly, NASA has already assembled a wide range of data about the performance and needs of astronauts in space during the past 25 years. In the next quarter century, we expect that a more heterogeneous population will be going into space. Research should be funded on the dimensions for successful space adaptation. Eventually, a profile, useful for assessment, could be developed of requirements in space for technical competence, resourcefulness, creativity, productivity, adaptability, emotional stability, motivation, risk-taking, interpersonal and communication skills, leadership and growth potential, cultural empathy, and other psychological, as well as physical, attributes.

We should take advantage of this period before the time of mass travel into space to conduct research on and develop means of coping with that alien, sometimes hostile, zero- or reduced-gravity environment. The pioneers who experience space life in the next 25 years can provide insight into the new culture and information on adjusting to it. Their Earth-based sponsors should do everything possible to enhance their well-being and success in space, while learning from them about their experiences aloft.

2. Orientation

The second component in a space deployment system is a combination of self-instruction and training to prepare personnel for life beyond this planet. Oberg (1985) has described the astronauts' training, which offers a basis in this regard. However, with a more diverse population going into space, more generalized training would be needed. The curriculum would depend on the orbit, length of stay, and mission. Some of the training would be designed to develop skills in one's area of expertise, such as space technology or administration. Some of it might be to develop a secondary role to fulfill in the space community, such as food provider or paramedic. All would be expected to complete a basic course in space living that would deal with zero- and low-gravity compensation, life support systems, physical care and exercise, mental health services, and human relations. All would be given orientation to the cultural challenges of

space communities and specific information about the cultures of their fellow crewmembers.

The learning program would include human behavior issues like communication, motivation, team-building and synergy, leadership, conflict management and negotiation, and family relations, both with those in space and with those left behind on Earth. Presumably there would be a need for all to learn something about space safety, the robotic and computer systems to be used at the space station or base, and the basic equipment that everybody would be expected to operate, such as an airlock or a rover. Possibly courses in astronomy, space migration, and space community development and systems, as well as in space recreation and constructive use of leisure time, might be among the innovative learning opportunities.

Instruction might include video case studies, simulations, programmed or computerized learning, and questionnaires. The content would draw heavily on information gathered about life in space by both American and Soviet space scientists. Instructors presenting live or media training should include those with experience in space.

There might be international, national, or regional space academies established by the turn of the century for such educational preparation. (The military academy model might be adapted for these new peace academies.) NASA, for example, might consider a location adjacent to the East-West Center near the University of Hawaii, where ample resources would be available. (Such a Pacific Basin site for an international space university was proposed in 1985 by Tetsuo Kondo, a member of the Japanese Diet, and by U.S. Senator Spark Matsunaga, and in 1986 by people addressing the National Commission on Space.) The faculty of a space academy should range from astrophysicists and astrochemists to behavioral scientists and astronauts. The program objectives would be to prepare spacefarers for effectiveness and excellence in their space cultural experience.

In addition to the example of the NASA training program for members of the U.S. astronaut corps, prototype space orientation programs can also be found in the educational offerings of the U.S. Space Camp and the International Space University founded in 1987.

3. Onsite Support and Monitoring

An effective space deployment system should include a third component of support services and monitoring by Earth-based sponsoring organizations. One dimension of this support

would include all the food, supplies, equipment, facilities, communication, and transport necessary to maintain a community of humans in space. If we designate this as "physical support," the other dimension to be concerned with is "psychological support." That is, a program onsite at a space station or lunar base which will facilitate integration into the host environment and culture.

Upon arrival at the space location, the newcomer should benefit from an acculturation program, which may include being paired off with a seasoned "buddy," receiving indoctrination briefings, and being presented with media programs that will familiarize the person with the local scene, its dangers and its opportunities. Communication links have to be established so individuals can keep in touch with family and friends at home on Earth. New forms of video/audio recordings may be transmitted by satellite which will keep spacefarers informed of events in their families, hometowns, and organizations. To counteract alienation while boosting morale, Earth-based sponsors might have an information exchange with their representatives in space; it could range from organizational news bulletins to shopping services and training updates.

NASA today physically monitors the vital functions and well-being of its astronauts. Dr. James Grier Miller is planning a computer monitoring system for those on a space station. It is conceivable that organizational sponsors of space expatriates might wish to have a "space wellness program." This could be a more comprehensive approach that furthers the mental or holistic health of the space dwellers. It might include needs adjustment surveys, performance data analysis and reporting, and individual or group counseling. As individual and group data is amassed in an organization's computers, insights will be gained with which to improve the whole deployment system. Special attention should be paid to high-performing spacefarers (Harris 1988). Written records and videotapes of such top performers in space can be helpful in preparing others for the challenge of space living.

Such data will influence on-the-job training, design of space habitats and equipment, programming of recreational and other leisure time, work scheduling, procedures for making assignments and scheduling leave, and devising salary and benefit plans, especially for more hazardous service.

In the startup stages of a space operation, only emergencymedical assistance may be available to space dwellers. But, as the human space community grows and we move beyond frontier living conditions, more extensive physical and psychological assistance should be made available to spacefarers who need it. Problems may arise from the disruption of an individual's circadian rhythm, the effects of the gravity-free environment, the stress of lack of privacy, and the effects of lengthy space stays. There are many human factors related to space living that will have to be addressed by those responsible for deploying people in space, not the least of which is how to develop a viable sense of community with relevant psychological, social, political, and economic ideas.

A whole new infrastructure needs to be built on Earth to support space-based activities properly, including regional bases on this planet that are directly linked to a particular space enterprise. Similarly, an infrastructure has to be created at the space facility where humans will dwell, one that will deal with the needs and aspirations, weaknesses and failings of the species.

4. Reintegration

Until now human missions in space have been counted in minutes, days, weeks, and months. Present planning for the space station by NASA, for instance, calls for six to eight people working a 90-day shift. Current research indicates that humans can stay in space without unacceptable physical deterioration for up to 12 months before being rotated. Obviously, if human space migration is to take place, we must move beyond these constraints. Some have proposed that the first space settlers should be volunteers who commit to space either permanently or for a long time. They argue that the first colonists to the New World came to stay, not to be rotated back to Europe. Others point to the length of sheer travel time for interplanetary missions, such as 2-1/2 years to Mars and back, and discourage any plans for too-quick rotation of space colonists. Visionaries speculate that the human body will eventually adapt to the differences in space life, that a new gene pool and even a new breed may evolve over generations.

Starting with the construction crews and astronauts on the first

NASA space station, we can assume that guidelines will be set for safe lengths of stay. In the initial stages of space base development, we can expect regular reentry of space workers to the Earth's environment. If we are to avoid "reentry shock," the process of preparing people for that transition should begin on the high frontier. Perhaps astronauts who have been to the Moon and back would make the best consultants for designing such programs. Space people will have to readjust both physically and psychologically to the home planet. Their sponsoring organizations should have a plan for facilitating their reintegration into Earth's lifestyle and tempo. Reentry counseling may range from reassignment to occupational activities on this planet to preparations for return to the high frontier. Some will experience "you-can't-go-home-again" syndrome, while others will complain of a variety of traumas and crises upon their return and may even require outplacement from space services or assistance with a divorce. The interplanetary experience may prove to be more profound than cross-cultural experiences here on Earth.

To close the space deployment loop, we should gather and analyze information from returning expatriates. Data gathered through questionnaires, interviews, or group meetings should be computerized. This data should be analyzed to improve the future recruitment, selection, and training of spacefarers and to improve the quality of life in space communities.

San Diego State University professor Arthur Ellis has begun to examine the role of social work in the space age.* As large space colonies are planned, he believes that the human services field can contribute to establishing policies, services, and ethics that will protect and enhance society's human resources in space. Ellis envisions the application of social work methodology to the stress and depression experienced when individuals are separated from their families by space missions or when they must endure long periods together in a space community. The hazards of being human in an alien environment may demand that some form of space psychotherapy be available both on the high frontier and on return to Spaceship Earth.

Conclusion

The human race is in transition from an Earth-based to a space-based culture, and the process of this "passover" may take centuries.

*Personal communication.

> We *Homo sapiens* are by nature wanderers, the inheritors of an exploring and colonizing bent that is deep . . . in our evolutionary past. . . . Whereas technology gives us the capacity to leave Earth, it is the explorer's bent, embedded deep in our biocultural nature, that is leading us to the stars.
>
> (Finney and Jones 1985)

Anthropologist Finney and astrophysicist Jones remind us that it is the species called "wise"—*Homo sapiens*—which evolved biologically and adapted culturally so as to populate and make a home of this planet. These same inclinations and capacities propel humanity into the solar system and may be the catalyst for interstellar migrations. Finney and Jones speculate on an explosive speciation of intelligent life as far as technology, or the limits placed by any competing life forms originating elsewhere, will allow.

The humanization of space, in any event, implies the extension of Earth cultures, both national and organizational, into the universe. It means creating not just new space technologies, methods of transportation, and habitats but a wholly new lifestyle and way of thinking that evolves appropriate societal and economic structures, legal and political systems, art and recreation, as well as suitable life support. Early in the next century our extraterrestrial pioneers may produce the first space-born generation that is not psychologically dependent upon Earth. In time, these high frontier dwellers may raise a different type of human.

The "creeping" begins with the Shuttle that takes us 300 miles or so to a space station, a platform for assembling the world's best scientists and engineers in low Earth orbit. The "walking" begins when we can regularly, economically, and safely extend our presence 23 000 miles above the Earth's surface to geosynchronous Earth orbit. There or at bases on the Moon and Mars we will mature and step into the universe and a new state of being.

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