

**CREW SELECTION FOR LONG DISTANCE VOYAGES:
LESSONS FOR MARS MISSIONS FROM POLAR EXPEDITIONS AND THE
SPACE PROGRAM**

Wayne Bowen, Ph.D^{*}
and
Randall Wight, Ph.D^{**}

INTRODUCTION

This paper examines the historical record of expeditions to the polar regions, as well as the experience of the US and, to a lesser extent, Soviet/Russian space programs, to answer the question: what factors, beyond technical skills and education, should go into the crew selection for long space missions, especially the eventual trip to Mars? What decisions went into the selection of crews for the discovery of the North and South Pole? How did NASA decide who had the "Right Stuff" for shuttle missions? What did the Soviet Union consider when selecting the crews of Mir? Is it possible to develop a model of crew selection criteria for long-distance voyages that will increase the probability of success, and does the historical record support this model?

Through interdisciplinary research using government documents, memoirs, biographies, secondary works, and statistical sources, this study examined the psychology of crew dynamics on these voyages, analogous to future missions to Mars, focusing especially on the selection of leaders and personal compatibility on extended treks into isolated and hostile environment, such as the Arctic, Antarctic and near-earth orbit. We also looked at the historical record of groups which wintered over in the Antarctic, especially during the early years of modern expeditions, which will provide us additional evidence to answer questions about long-term residence of humans in isolated conditions, such as on Mars and other interplanetary bodies.

Our initial hypothesis leads us to conclude that, aside from necessary technical training, focused on the particular challenges of the environment of the missions, the most essential considerations for crew selection are personal compatibility, long-term unit training, a clear command structure, and the necessity of drawing crews from a common cultural background. These findings may have serious consequences for the expected internationalization of the first expeditions to Mars, and clearly merit additional research, especially in the areas of gender issues and the relationship between pilots and scientists.

* Assistant Professor of History, Ouachita Baptist University

** Dean of Interdisciplinary Studies and Professor of Psychology, Ouachita Baptist University

Sometime early in the new millennium, a small crew will begin the voyage to Mars. Since in all likelihood their vessel will be paid for by US, European, and perhaps Japanese taxpayers, it makes sense to develop criteria which governments can use to select the best astronauts. Just as nearly all the early voyages of earth exploration were funded by kings and princes, it seems likely that the early missions to Mars will also rely on taxpayers. To ensure that these taxpayers get the most for their money, NASA must consider crew selection and behavioral criteria as much as it does payload weights and landing sites.

LESSONS FROM POLAR MISSIONS

As manned space flight continues to become almost routine and efforts proceed to plan a Mars mission, recent accounts of the difficulties experienced by astronauts and cosmonauts aboard Russia's aging Mir space station remind us that long-duration space flight present challenges to human behavior and performance not preciously encountered on short-duration missions. All of these challenges, however, are by no means unique to space flight. Nearly 400 years ago, Henry Hudson encountered similar challenges while exploring the Arctic in search of a Northwest passage. The ill-fated expeditions of John Franklin in the Arctic and Robert Scott in the Antarctic foreshadowed the Apollo I and Challenger disasters.

Although not a novel premise, human behavior and performance in Polar Regions and in outer space share many fundamental similarities. Polar expeditions and research stations have been viewed as analogues of long-duration space missions (Harrison, Clearwater, & McKay, 1991). Fundamental similarities regarding human behavior in extreme environments include the observation that humans can endure almost anything; behavioral problems will inevitably occur in extreme conditions; trivial issues will be exaggerated; relations between headquarters and remote-site personnel will become strained; and, the larger the group, the greater the tendency to form subgroups (Stuster, 1996).

Notable dissimilarities exist between space flight and analogue polar environments. Bone demineralization, muscle atrophy, and radiation loading mark space travel as physiologically unique. Researchers likewise report that anxiety levels among polar crews peak during the first and third quarter of their missions whereas anxiety levels among space crews peak during the first and second quarter of the mission (Kansas, Weiss, & Marmar, 1996). Space-polar expedition comparisons are useful but require care.

Despite the due caution necessary in making comparisons across exploratory domains, polar experience provides helpful clues regarding factors influencing crew selection. Recently, University of California at San Francisco psychiatrist Nick Kansas (1998) offered a psychosocial taxonomy of factors influencing long-term international space missions. Specific dimensions within this taxonomy derived in part from polar experience include gender issues, work issues, and leadership.

Gender is central to crew selection. Crew heterogeneity was not initially an issue in planning space travel: Males from similar backgrounds and countries comprised crews during the early days. The political and economic realities of a manned flight to Mars, however, suggest that homogeneous crews are a thing of the past. Antarctic missions report female crew members as being particularly sensitive to interpersonal dynamics (Kahn & Leon, 1994). Gender stereotyping, however, is still an issue. The Soviet-American Bering Bridge expedition, for example, reported culture-based chauvinism toward the female crewmembers (Leon, Kanfer, Hoffman, & Dupre, 1994). No one wants a repeat of the apron-and-meal-preparation expectations that awaited a female cosmonaut upon arriving for her Salyut 7 mission (Lebedev, 1988). The optimal opportunities for sexual behavior in isolated, enduring crews is at present an unknown awaiting future research.

Labor is central to any endeavor in an extreme environment. In observing polar experience, researchers have gained insight into the relationship among work, motivation, and behavior. For example, during long winters in Antarctica, scientists experience fewer psychological problems than non-scientists (Gunderson, 1968). The motivation among scientists to collect data and produce reports seems to provide focus in the polar isolation that others lack. Finney (1991) reports conflicts between polar scientists and non-scientists that erupted into open hostilities and the destruction of data. Careful crew selection should target people capable of working with and respecting the various roles and individuals required to accomplish Mars mission objectives.

Polar endeavors point to two central, necessary leadership roles. Task, or instrumental, leadership focuses on accomplishing work goals and addressing operational needs. Supportive, or expressive, leadership focuses on accomplishing morale goals and addressing emotional needs. Although the same person may embody both leadership functions, different people may embody one or the other role. The importance of these roles emerges at different times within a mission sequence. Antarctic teams illustrate that in the early stages of a mission, establishing an operations base requires task-oriented leaders with clear lines of authority. As time and isolation become more obvious, the situation requires support-oriented leaders who provide and foster emotion well-being within a social arrangement that respects and values all members of the team (Gunderson & Nelson, 1963; Nelson, 1964). Observations from the Bering Bridge expedition also suggest that group cohesiveness and the decision-making quality is explicitly related to the ability of supportive leader's ability to promote team morale (Leon, 1991; Leon, Kanfer, Hoffman, & Dupre, 1994).

In light of these polar experiences, we would offer three broad suggestions in selecting crews for the any mission to Mars. A mission to Mars and on Mars will consume the lion's share of any given individual's life span. The hardships and close quarters of a Martian expedition call for close attention to intra-crew relations. Researchers (e.g., Myers & Diener, 1995) have demonstrated that people are healthier, are happier and live longer if they have satisfying close relationships. Gottman and his colleagues have argued that the "four horsemen of the apocalypse"—contempt, criticism, defensiveness, and stonewalling—contribute to the endings of most close relationships

and have evidence that dyads who report relational satisfaction learn ways to raise issues and de-escalate negativity in their interactions— particularly on the male’s part (e.g., Gottman, Coan, Carrere, & Swanson, 1998). Harvey and Omarzu, (1997) suggest that understanding close relationships requires understanding what they call “minding the close relationship.” In order for individuals in a committed position to maintain a close, working relationship, they must have a never-ending reciprocal behavioral pattern in which each person tries to know the other and to allow the other to know him or her. In addition, attributions about another’s traits, motives, and behavior must be fair and positive. Relating individuals must accept and respect what they discover about each other. Polar experiences suggest these concerns have not always been incorporated into team building. For a Mars mission to succeed, the crew will need the efficacy and comfort available within close, working relationships.

Creating close relationships requires creating friendships. Although the direction of influence remains unknown, well being and friendship share a strong positive correlation (e.g., Rutter & Garnezy, 1983). Not only do adult relationships foster sharing, resource exchange, and emotional support, but well-formed friendships also facilitate problem solving and promote conflict resolution (Hartup & Stevens, 1999). Friendships also compensate for missing relationships. Emotional support and assistance among friends are among the most important protections against loneliness (Dykstra, 1995). The isolation and confinement inherent in any expedition to Mars pleads for not only for the cultivation of lasting friendships among crew members before lift-off but also for on-board environments that provide opportunity for further friendship development among the crew.

Creating friendships requires the exchange of acceptance and status. We would adamantly disagree with Stuster’s (1996) recent suggestion that psychometric evaluations are less than efficacious in selecting crew for space flight. Robert Hogan (1983) suggests that people are predisposed to evaluate others in terms of the degree to which they will be assets to their social group. As polar experiences so clearly indicate, a failure among crew members to acquire insight into their own and their colleagues responses to environmental challenges and to one another could spell not only disaster but misery for the Martian mission. Whether in the course of human evolution or the course of human exploration of the solar system, how individuals assess personal differences in motives, values, and preferences; in disruptive tendencies that emerge under pressure; and in interpersonal strengths and competencies has implications for a group’s adaptive success. Space flight to Mars will be no exception.

LESSONS FROM SPACE MISSIONS

Although the US government did not create NASA until 1958, the preliminary considerations for astronaut selection began as early as 1956, with government doctors and scientists looking for, as several involved in the process remarked, “supermen”, in the end NASA had to settle for “super normal men” (Shankle 144). The profiles of the thirty astronauts finally selected in 1959, 1962 and 1963 were remarkably similar. All were pilots, mostly from the military services, with degrees in engineering or science.

All were physically superior specimens, and passed grueling tests of endurance and stress. Nearly all were task-oriented or instrumental leaders, used to focusing on missions and performance. As far as NASA's medical team could determine, they were free of every pathology and neurosis then categorized or identified by modern psychology. As author Tom Wolfe described them, they did have "The Right Stuff." For all of their achievements, including orbiting Earth, landing on the Moon, and saving the crippled Apollo 13, few of these types of astronauts would likely be good choices for a Mars mission. The qualities of highly trained and fit test pilots would not be nearly so indispensable with the new technologies and challenges of today. Even NASA has adopted its selection criteria since choosing Armstrong, Glenn and Lovell.

The Space Shuttle program adopted new considerations in selecting crews during the late 1970s, approaching in some ways what a Mars mission would require. With the beginnings of selections for shuttle crews, two major factors made this new program innovative. For the first time, not all astronauts had to be pilots. Mission specialists and payload specialists, unlike astronaut pilots, did not have to have any flight time before they went into space. Another significant change was that NASA agreed to begin accepting female astronaut candidates. The changing political climate in the US, as well as certain technological developments, most notably private toilets in space, made this decision a necessary one for the previously all male, all white, all pilot astronaut program (Santy).

Amazingly, NASA had very little data to work with as it began to accept applications from women and from non-pilot candidates. Despite its excruciating candidate selection process, the agency had never followed up on its psychological testing of astronauts, and so even in the 1980s had no idea of what had been successful evaluative tools, and what had not. As late as the 1985, NASA made no effort to measure the effectiveness of its psychiatric evaluations or evaluators, and had no requirements that its medical staff keep records of their recommendations or test results. Despite this lack of data, in 1978 NASA decided to radically scale back in its psychiatric evaluation of candidates, eliminating all standardized tests and comprehensive examination in favor of two clinical interviews. NASA now does a better job, but still focuses almost exclusively on the educational and technical backgrounds of potential astronauts. (Santy)

While Soviet space scientists took psychological factors far more seriously than NASA, they colored their perspectives with ideological and cultural prejudices, especially relating to gender. The Mir space station also made a valuable contribution, by demonstrating that most of the psychological problems relating to spacefarers occur after they return, a factor which much be incorporated with more seriousness into the programs of NASA, the ESA and other space agencies. While it may not be true that after living in space, "you can't go home again," but we should realize that, especially after and extended time off of this planet, returning astronauts and cosmonauts are never quite the same as when they left: psychologically as well as physiologically.

Robert Zubrin, the founder of the Mars Society, has argued that the crew for the first mission to the Red Planet should be made up of four "renaissance men and women

... cross-trained in several disciplines,” but essentially “two field scientists and two mechanics. A bio-geo-chemist and a geologist will complement a pilot who is also a competent field engineer. The last crewmember, a jack-of-all-trades, is primarily a flight engineer, but can also provide common forms of medical treatment and understands the broad means and objectives of the scientific investigations. This person backs up all the specialists in their functions, and provides one more – he or she will be the mission commander” (Zubrin 7-8).

Based on payload requirements and needed skill sets for his projected Mars Direct scenario, Zubrin’s numbers are realistic and appropriate. With only four crewmembers, selection becomes even more of an essential task in ensuring the success of the first missions to Mars. Profiling and selecting the first crews must be done carefully, but that does not mean that we need to observe potential Martian explorers for twenty years before certifying them as sane and compatible with their fellow travelers. While it may be heresy to disagree with him, on this issue we strongly disagree with Zubrin when he says that “the human psyche will not be the weak link in the chain on a piloted mission to Mars” (Zubrin 129). It might be, if those responsible do not look at this as a serious matter.

In addition to the other points made in this paper, we would just add in closing that, if the history of analogous missions provide any lessons, NASA, the ESA, and whomever is involved in making the final cut for Mars missions must decide, early rather than late, that human factors are as important as technical challenges. When humanity goes to Mars, it should send not just a crew of highly trained scientists and flight engineers, but a group of friends compatible with each other, and capable of enduring each other’s company for over two years in confined circumstances. If this small crew succeeds, and avoid killing each other, then they can make room on Mars for the rest of us. If they fail, and experience a preventable clash which destroys or cripples a mission, it may be this generation’s Apollo 13 mission, delaying for decades again our journey off of this small planet.

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