Isolation in Historical Cases and the Implications for a Mars Mission

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"Houston we have a problem." After several minutes racing through empty space at a speed approaching that of light, the message reaches mission control. It is seven decades after those fateful words were first spoken during the Apollo 13 mission, and the unspeakable has happened upon the spaceship Wanderer. A crewmember has had a nervous breakdown, critically injuring a crewmate and damaging valuable navigation equipment. The product of 40 years and billions of dollars of research is drifting crippled in space, along with the fates of three men and three women. Over the past months support staff on earth had watched relations erode, tempers flare and sanity slip away as the pressures of spending day after day cut off from the rest of the world and in the closest of quarters with the same five comrades. Fantasy yes, but the effects of long term isolation on the human mind are a serious consideration for long term space flight, and must be addressed before any long term mission could be attempted. Assuming that all other technical hurdles to a mars mission could be cleared, the fact remains that a small group of men and women must spend a long period of time together in the most trying of conditions. There is no place to hide on a small spacecraft, and the slightest of disagreements could very possibly escalate into a life-threatening crisis. Isolation is an inescapable element of long term space flight that must be dealt with during a manned mission to Mars, but by applying what we have learned from prior human adventures and studies, the negative effects can be minimized.

The problem of isolation is aggravated by the many physical constraints on a manned flight to Mars. No matter what technological innovations are made between now and launch date, some difficulties just cannot be avoided. The most troublesome problem is that there is no real way to shorten the duration of the mission. It is impossible to get

the amount of fuel out of the earth's gravitational field that would be necessary for a quick flight to mars, so travel must be planned to take advantage of the movement of the planets. The Mar's Reference Mission, NASA's unofficial plan for any travel to Mars estimates two transit legs of between 130 and 180 days, and a 600 day stay on the surface (NASA, I8). Travel times any shorter are not feasible given current technology. This brings the minimum stay in space to 2.5 to 2.75 years, an eternity compared to a Soviet Cosmonaut's 14-month stay aboard space station Mir; the longest human space flight to date.

Again due to fuel constraints, the size of any space ship going to Mars would be limited. Gear and supplies would dominate this already small living space. Living conditions are cramped enough on the space shuttle whose missions are around two weeks long. Just the food and water necessary to sustain the crew on the four to six month journey out would occupy a huge amount of space. Scientific instruments, equipment for living on mars, fuel and other necessities would reduce crew space to the bare minimum. Cramped crew quarters would make personal time nonexistent and contact with crewmates unavoidable. Space constraints would also cut down on the opportunities for exercise available, limiting the crew's ability to work out their stress.

Communication times would increase the further the crew got from earth, and signals would take from 20 to 30 to as long as 40 minutes to go from mars to earth and back. (Brimley, WWW). Slow communications preclude the possibility of real time interaction with family and friends back home, and make psychological evaluation by physicians on earth quite difficult. Two and a half years is a long time to only carry on conversation with a few people. And a few people it would be. Science fiction has

created great visions of crews of 100 people or more traveling together through space in a miniature civilization. We are ages away from the technology and resources to support a crew large enough to prevent loneliness and group conflict, and even if the technology were to exist, there is not the public and government interest and support necessary to fund such a mission. Solutions to the problem of isolation will not come from science breakthroughs but from the careful study and satisfaction of human needs.

Fortunately there is a wealth of knowledge on the subject of human solitude. Mankind has a drive to explore that equals our need for company and socialization. Men have trekked to the frozen poles, set sail for months upon unknown seas and dove miles below the surface of the ocean in cramped submarines, most often alone or in small groups similar to the ones that would crew a space mission to Mars. The way they reacted to long periods of isolation from the rest of the world, often under the harshest conditions on earth, is invaluable to the planning of an extended Mars trip. The famous polar explorer Admiral Richard Byrd, who had himself spent a solitary winter in a small cabin close to the South Pole, described living conditions at Little America, the Antarctic scientific research station in the late twenties. "Argument clung to us always. They started innocently, gathered increasing strength and became so fraught with passion as to threaten to bring down the roof. They seemed to have no end. Pertinacious minds, reluctant to concede defeat would trot them forth like horses under raps, and start them off again" (Byrd, 210). A crew on their way to Mars could expect similar friction; only under much more cramped conditions, with fewer crewmates. The polar scientists found that diversions such as card games and boxing matches were necessary for sanity, but that they had to be careful not to take these competitions too seriously. Byrd decided that a

combination of routine schedules and duties with occasional unique events such as movie screenings worked best for maintaining morale and sanity. However the researchers did have the advantage of relatively large quarters that would not be available aboard a spaceship. In his winter alone at 80 degrees south Byrd was confined to a small cabin and storage tunnel and felt the effects of isolation combined with carbon monoxide poisoning. He tried to cover up his eroding mental stability, but through radio communications his support team was able to realize his mental state and send a rescue mission (Neider, 386). In space there is no chance for a bail out, no safety net in place to save a crew that becomes mentally unstable.

There is much that can be learned from long stays at the frozen poles, solo sailing voyages and other such long duration expeditions. When small groups are put to the test in close confines, the inherent difficulties of all male groups becomes obvious time and time again. When out of touch with women, men tended to neglect their appearance and put a hardened shell on their feelings. While some reservation can be useful in preventing minor conflicts, burying problems away is no way to deal with them, and leads to more serious conflict down the road. Thor Heyerdahl, the great Norwegian adventurer of Kon Tiki expedition fame, floated several oceans on primitive rafts to prove his native migration theories. After many months on a tiny raft with six to ten men he claimed that "the most insidious danger on any expedition where men have to rub shoulders for weeks is a mental sickness which might be called 'expedition fever' – a psychological condition which makes even the most peaceful person irritable, angry, furious, absolutely desperate, because his perceptive capacity gradually shrinks until he

sees only his companions faults, while their good qualities are no longer recorded in his gray matter" (Heyerdahl, 213).

On one 18 man polar expedition, a daily self-morale rating proved to be a useful tool; when one man recorded a string of low ratings, his comrades would cheer him up with extra attention, or a communication with home. These efforts almost always brought an increase in morale. Psychological evaluation proved to be a double-edged sword however. Extensive tests requiring written responses and picture analyzation angered the men, and their annoyed answers were of no use to psychoanalysts. Also some of the tests designed to monitor group interaction had the effect of driving wedges between crewmates, and aggravating minor incidents. No matter their demeanor, every member of the group was found to have problems with others at one time or another, and the acceptance of this reality did much to smooth matters (Neider, 425–35).

Of utmost importance to the success of any expedition were the qualities of the leader. Given a charismatic, fair and respected leader, men would pull together and overcome minor differences, instead of letting small problems snowball into crises. A study done on shipwrecked navy sailors showed the importance of a strong and binding presence. "The most important single influence is that of the leader, whether he be the master of the sunken ship, or merely a leading hand or senior rating. Broadly speaking, those lifeboats rafts or floats which contain commissioned officers are happier, better conducted, more comfortable and actually show the highest survival rate…If on the other hand there is no one who can naturally assume the role of chargehand, a sense of hopelessness, querulous depression or apathy may set in…" (Critchley, 72). A good leader did not lead with an iron rule, or give excessive direction, but it was important to

have a clear authority. Smaller subgroups with their own individual leaders were tried, to no avail, as they tended to pit one group against the other (Neider, 427). The most outstanding example of the benefits of good leadership was Ernest Shackleton. In 1915 Shackleton set sail in command of the ship Endurance with a crew of 27 men with the goal of traversing Antarctica from west to east. The ship became lodged in unmoving ice flows and was destroyed. Shackleton and crew set off on an epic overland journey to safety. His men were able to endure horrifying conditions, for months on end, and didn't give in. This was to a large extent due to Shackleton's strength, confidence, interpersonal skills and willingness to put his men before himself, never skirting from any chore or danger, rather leading by example.

In a long-term space travel, one would have to strike a careful balance between loneliness and personal space. Obviously too much contact with other crewmembers would lead to trouble, but at the same time humans are social creatures and would suffer from a lack of personal interaction as well. While crewmembers would have all too much contact with each other, they would be by far and large separated from family and friends on earth. The psychological effects of leaving one's home planet behind are unknown as there has never been a case of separation from one's home of this severity. One can only imagine the separation anxiety that could set in after being away from Earth for close to three years. Studies show that loneliness can decrease ease of concentration by up to 28% (Weiner, 50), concentration that is of utmost importance in the many difficult technical aspects of a Mars voyage. The effects of loneliness often increase when combined with other problems, such as those that would most likely be encountered by long term space travelers. One interesting thing to note was that young men were

significantly less affected by loneliness than older men whereas age had little effect on the women's state of emotional well-being. (Weiner, 29). Both men and women experienced much higher rates of heart disease when lonely (Lynch, 240), which gives an indication of the general health dangers of such a mission. However people who came to their isolation willingly, such as explorers, fared much better mentally than people forced into isolation, such as prisoners and castaways (Weiner, 58), a positive sign for space exploration. Admiral Byrd observed that "those who survive with a measure of happiness are those who can live profoundly off their intellectual resources" (Weiner, 64). A well-chosen crew would have to be able to turn inside themselves for stimulation on the long journey to and from Mars.

An extended voyage to the harsh environment of mars would need to be exceedingly well planned, and not just in the mechanics of getting out and back. A manned space mission is only as good as its men, and they would have to be the best. The crew would have to be selected based on their psychological profiles as much as their technical proficiency, and then trained together until they functioned as one. An Antarctic isolation period such as the one outlined in Kim Stanley Robinson's Red Mars would be ideal for challenging the group to work together, and highlighting any potential weak areas. They would need to be put through ordeals at least as challenging as the months of space flight before them, better for relationships to fall apart here on earth than in the confines of a ship in deep space. Crew size is a balance between technical, political and psychological constraints, but a crew of seven is seen to be the best compromise. A crew much smaller has more group dynamic issues, while the logistics of launching and supporting a larger crew outweigh any advantage. Larger crews also tend

to form factions that can come to oppose each other (Holland). The crew should be middle aged, young enough to be in good shape, but old enough to have experience in a wide array of interpersonal situations. An ideal crew would be made of married couples (Holland) who work well together, and would have all the advantages of a mixed sex crew, with none of the sexual tensions. Among the crew there must be a well-defined chain of command with a carefully selected leader who can direct his men and women without creating more problems. The mission leader must be able to tolerate small squabbles and arguments, not trying too hard to enforce peace between the crewmembers. During the failed Shackleton expedition most of the crew waited behind in a tiny hut while six men took to the sea to go for help. Among those who stayed behind there was "an astounding absence of serious antagonisms, considering the conditions under which they were attempting to exist. Possibly it was because they were in a state of almost perpetual minor friction. Arguments rambled on the whole day through, and they served to let off a great deal of steam which might otherwise have built up" (Lansing, 204). The ability to vent over minor issues is key to avoiding larger conflicts.

Living quarter design must be done with the utmost care to offer any sense of comfort and privacy possible. The US Navy's SEALAB 2, a submerged living container, is an excellent analogous environment and has provided good insights into living space design. It was found that "most friction arises when the individual feels that he is imposed upon by the group, and so the design of undersea habitat should provide an opportunity for privacy when it is required" (Hussein 46). Separate isolated sleeping/reading chambers could be used to this effect. Cabin space should be maximized by sending multiple unmanned landers ahead with supplies and gear that

would not be required until landing on Mars. Fuel could also be stockpiled in earth orbit ahead of time to increase the amount of rocket payload that could be used for comfort items. In addition to privacy and space, ease of use must be addressed as well. The findings of the SEALAB 2 experiments indicated that "a design method where the number and complexity of the systems and components is deliberately limited" should be adopted (Hussein, 38). Simpler designs and interfaces are more pleasing to the eye and are less stressful to use. Exercise equipment should be incorporated into shuttle design, with regular workout programs required to stimulate release of mind leveling endorphins, as well as muscle maintenance. Exercise bikes could even be wired to generate electricity to supplement solar and nuclear sources, further justifying their added weight.

During the mission a routine schedule should be developed. In the late 19th century Captain Joshua Slocum completed the first solo sailing circumnavigation of the earth, and during his voyage he found that "The loneliness of my state wore off when the gale was high and I found much work to do. When fine weather returned, then came the sense of solitude, which I could not shake off."(Slocum, 50). However a balance needs to be struck between hard work and idleness because an excessively demanding schedule would create too much stress, and lead to conflicts between crewmates. This would be an excellent opportunity to practice emergency and landing procedures, as well as scientific studies.

Regular communications would be of utmost importance in maintaining a connection to the home planet, so astronauts wouldn't feel so isolated. Even though face to face real time communication would be impossible, daily video messages could go a long way towards relieving homesickness. Along with this would go an extremely

thorough psychological monitoring system, so a crack team of physicians back on earth could monitor very closely the behaviors of the travelers. This would have to be done in such a way as to avoid annoying the crews. Electronic monitoring systems would be invaluable in providing as much information about the men's mental state without bothersome tests to fill out all the time. This has been tried before on SEALEB 2, with good success. Electroencephalogram and electrocardiogram tests were carried out and it was found that "There are reliable links between certain responses of the body to stress and observable personality traits, and a degree of displacement and recoverability of character. Blood pressure, heart rate and respiration rates also give some indication of reaction to stress" (Hussain, 44). Physicians monitoring vital information could detect and address mood stress issues before they got out of hand. All the crew should be extensively trained in psychology, and there should be one of them designated the crew medical officer, to whom problems could be brought.

While isolation would be a big factor in any manned mission to Mars, with careful psychoanalysis and the lessons learned from centuries of exploring oceans, the poles and earth's orbit its effects could be minimalized. Spending 36 months away from family, friends and even the planet you were born on would take a huge toll on anyone, but the rewards of exploring a new planet would be astounding. During SEALAB "The knowledge that they were part of a project with unlimited potential and great significance doubtless had a significant impact on most if not all of the men" (Miller, 156). Men and women are capable of great things when they have much to gain. Mankind has never learned anything by staying at home, by shying from a challenge.

SOURCES CITED

NASA, The Mars Reference Mission

Brimley, Dr. Ground Segment Communications Architecture. Available at http://www.geocities.com/CapeCanaveral/Galaxy/7191/4_3_1.html (27 May 2002)

Byrd, Richard Evelyn. *Little America*. New York: G.P. Putnam's sons, 1930

Neider, Charles, ed *Antarctica: Firsthand Accounts of Exploration and Endurance*. New York: Cooper Square Press, 1972

Heyerdahl, Thor. *Kon-Tiki Man*. San Francisco: Chronicle Books, 1990

Critchley, Macdonald. *Shipwreck Survivors: a Medical Study.* London: J & A Churchill, 1943

Weiner, Irving B, ed. *Loneliness: a Sourcebook of Current Theory, Research and Therapy.* New York: John Wiley and Sons, 1982

Holland, Dr Al. NASA Chief Psychologist. Conversation on 5/16/02

Lansing, Alfred. *Shackleton's Incredible voyage.* New York: Carroll and Graf Publishers, Inc, 1959

Hussain, Farooq. *Living Underwater.* New York: Praeger, 1970

Slocum, Joshua. *Sailing Alone Around the World*. London: Rupert Hart Davis, 1948

Miller, James W, Ph.D. *Man's Extension into the Sea: the Measurement of Human Performance.* Washington, D.C.: Marine Technology Society, 1966