BIOJURIDICS AND ASTROLAW: AN UPDATED APPLICATION TO SOCIAL AND LEGAL THEORY

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Abstract

Astrolaw is the body of law that governs human relations in space and the principles of social order flowing from the unique natural requirement of human space existence. The jurisprudence that relates to the biological foundation of human values is known as "biojuridics." As humans prepare to venture beyond Earth orbit and live far from Earth for prolonged periods, important questions arise such as: do the fundamental biological changes that occur in humans living in space for prolonged periods lead to changes in behavior and value judgements which can cause changes in the perceptions of these individuals in what they believe to be proper laws and institutions for themselves? If occupancy of space habitats with an artificial life support system and an alien frame of reference produces significant physiological and psychological changes, would conscious and behavioral consequences be expected? From the 21 year history of long-term space station habitation, insight has been gained into the many questions surrounding the changes in the human physiological/ psychological system. The purpose of this paper is to explore the possible biomedical and psychological foundations of Astrolaw and discuss the validity of their application to social and legal theory in light of the information gained since this topic had been seriously presented in 1975 by Robinson in his book, "Living in Outer Space"[1], as well as in subsequent publications.[2,3]

".....jurists and scientists must learn each other's disciplines and in so doing, learn their own for the first time."

George Robinson,
Living in Outer Space, 1975

Introduction

Prior to space station flights (Skylab, Salyut, and Mir), our knowledge had been deficient concerning physiological/ psychological consequences of long-duration flight and whether space flight can actually produce direct effects on individual and societal patterns of behavior. A general consensus exists today that the basic biomedical consequences seem to be within the spectrum of human survivability and that intellectual capacity and problem-solving ability do not change in space. However, important questions remain which include: are the observed physiological/ psychological consequences of living in space consistent with underlying legal values? How can they be mediated by environmental, aesthetic, architectural, medical, psychosociological, and legal intervention and innovation? With the expanded body of space flight knowledge and experience, the frontier of space and the changes it brings to social and legal theory must be approached with an updated understanding of what the impacts are on humans as a result of living in space, both in the near term and for missions/settlements envisioned for the future.

"Living in Outer Space" Revisited

With the US/International "Freedom" space station on the horizon, the continuation of the Russian "Mir" space station series, and the possibility of bolder missions ahead (e.g. Moon and Mars), shouldn't we revisit some of the initial thoughts on the biological foundations of astrolaw presented by Robinson in his book "Living in Outer Space?" In his book, Robinson's central thesis rests on the premise that law must recognize its biological underpinnings -- that justice, and not simply law, depends more upon the biological nature of the human being than upon abstract concepts. In his book, Robinson asks the reader to consider the inevitable future and to recognize the need to determine the true nature of humans in outer space as well as the need to protect the unique requirements of spacekind. The premises of this book are behavioral patterns and temperament have biological foundations,[1] and such biological foundations should be integral components (along with architectural engineering and a guiding philosophy of space community objectives) of the interdisciplinary approach to establishing space habitat legal regimes.[2]

Robinson also asks the reader to assume for a moment that the biochemical, bioelectrical, neurophysiological, endocrinological, and psychological characteristics of a space station society or an extraterrestrial community produce individuals with markedly different value-forming processes from those on Earth, that over long periods of time participants evolve who are measurably distinct from Homo Sapiens. Robinson believed that we are at the point of creating a new, parallel species and a physiologically alien culture to exist separately and distinctly in an extraterrestrial environment. Although physiologically different individuals might be produced through multiple generations inhabiting an extraterrestrial colony, this

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concept will not be discussed here and shall be limited to behavioral and physiological aspects only in the context of upcoming long-term space occupancy and relatively near term astrolaw applications.

Since the writing of "Living in Space" in the mid-1970s, humans have continued with 17 additional years of long-duration space station flights culminating with a flight of 366 days aboard the Russian space station Mir. Much has been learned about the behavioral and physiological changes that appear fundamental to space exposure. The following briefly highlights some of the key findings and discusses them in relation to astrolaw.

Space Flight Effects

In zero-G a time course of physiological effects occurs. The physiological baseline of the 1-G norm begins to shift after orbital insertion. The adaptation process begins early and reaches the next physiological baseline or zero-G norm. The body adapts appropriately to a lighter load imposed upon it and physical countermeasures (exercise) have helped retain physical capacity and strength for return to Earth.[4] If artificial-g is to be added for future advanced missions, then the physiological changes seen in zero-g (bone changes, muscle atrophy, headward fluid shift, reduction of fluid volume, etc.) should not occur but behavioral effects of space flight could persist and are of fundamental importance in our discussion here. In other words, the closed space environment as a "psychological pacer" may be at the root of certain undesirable behavioral effects noted in previous space flights. This is contrary to the notion that behavior in space is the result of or greatly influenced by physiological changes due to space flight.

In addition to the timecourse identified for various physiological changes occurring in space, a time course is also being studied (although more observation is needed) for human capability and productivity in space. For example, the Russian experience has noted that cosmonauts exhibit forms of fatigue peaking at 4-6 months into a flight.[5] This is why working flights have been limited to this duration and experimental flights of longer duration are few in number and are done solely to test human limits. Diaries of cosmonauts (for example, Lebedev's 211-day flight diary published in the US) have added greater insight into the thoughts of those living for prolonged periods in a confined area with a hostile environment outside.[6] Fatigue, sleep problems, apathy, impatience, have been identified as factors that can influence a cosmonaut's response to a given situation. Indeed, psychological indications of distress and fatigue are routinely monitored by various means (facial expression via video, voice patterns, and responses to questionnaires) by psychological specialists during Russian long-duration flights.[7]

What has been observed in the past 21 years of space station activity is that problems of crew compatibility, communication with ground and among themselves, do exist. This has been noted in US Skylab flights (turning off communication to ground) and some Russian Salyut and Mir flights.[8,9,10,11] This may be the result of an entire array of factors which, if properly identified, can be modified to enhance astronaut work capacity and general well-being. What problems may occur could simply be due to oversight of mission planners and designers, of critical environmental, psychological, and motivational needs of space travelers and that if these are not provided, a "reasonable human being" may show symptoms of discontent or forms of natural rebellion.

In many cases the Russians have found that motivational problems resulted due to lack of meaningful work activities. Indeed, deprivation of stimuli and consequent boredom are an enemy for long duration space flight. In this regard, one school of thought is that the apparent hightened behavioral responses (which may or may not represent "perceptual changes") noted in some astronauts and cosmonauts may be an indication that the overall "environment" needs improvement.[12] If unchecked, repeated occurrences may prove significant even in the near term. Their underlying causes are crucial to the understanding of how to provide an optimal living/working space environment for crew members and the expanded awareness astrolawyers may need to have of possible problems related to confined environments such as may be encountered in a long-duration space voyage or permanent space settlement.

Thus, an open question exists whether the "behavioral changes" noted in some past space flights might actually be warranted, expected, and representative of a normal response to the given situation. Therefore, careful consideration must be given to the possibility that some observed responses may not be unique to space or related at all to physiological changes due to weightlessness but may actually be fundamental responses to closed environments (which can even be found on Earth: ships, submarines, cave studies, polar regions) which characteristically lack the natural variety of stimulation and conveniences.[13] Countermeasures to provide a psychologically and physically healthy working/living environment may become a necessary requirement for long-duration voyages. Perhaps, in the final analysis, not to provide an appropriate spectrum of critical countermeasures would be considered "unethical."

Another observation which may complicate matters or make it difficult to form general conclusions about behavior in space is that humans are highly individualized perceptually, and even on Earth, exhibit varying sensitivities and coping strategies for dealing with stressors. Their reactions to the inconveniences, annoyances, or perceived danger of space may be the same type of response they would exhibit in an analogous situation on Earth. There are also individuals with higher tolerances to stressors or more successful coping strategies. In other words, when launching an astronaut into space, even though highly selected, we are launching an *individual* along with his/her personality traits and unique psychological makeup.[14,15]

In order to accommodate both the dramatic and subtle variations in value forming processes and behavior patterns of space travelers and inhabitants, there may

eventually be a socio-legal framework specifically designed to establish norms of formal relationships among space inhabitants, space travellers, and interacting Earth dwellers. Detailed studies should be done of communications patterns, social dominance, utilization of space within the habitat, meal behavior, energy expenditure, mood fluctuations, territoriality, personality typing, and crew selection/compatibility. What also should be examined is the proper legal framework for operational relationships involving space communities of relatively long duration. Here, the professional, psychological, and cultural makeup of the participants will vary substantially.

There is a critical need to rely more on self-evaluation of crew members in a space habitat environment. Corrective procedures should evolve from flight participants and not from support personnel located on Earth's surface. Based on past experience, there is a clear behavioral indication that space inhabitants should be permitted at least some autonomy in formulating a legal philosophy and regime among themselves and between the space community and non-space inhabitants. The stringency exemplified in the Mercury, Gemini, Apollo, Skylab, and Shuttle "Mission Rules" will have to become more flexible for future long-duration space existence, or the rules and guidelines will face constant violation by space participants.

Especially for interplanetary voyages and initial extraterrestrial expeditions and settlements, conflict and disputes of any nature can take on a very serious tone because of the potential for endangering the safety of the crew and jeopardizing the success of a mission. Events which would normally seem insignificant on Earth may become more significant in space and, in certain instances, human tolerance may be greatly reduced resulting in minor annoyances being felt more acutely.[16] Disputes should be resolved in the simplest and most rapid manner to allow for safe and effective mission completion.[17] Indeed, the profession of law may change and expand markedly when applied to human space flight. Glazer has stated that lawyers practicing in space will take on a capacity of brokers for peace because there is no margin for error in the space environment.[18] Astrolaw would be used to resolve conflicts as rapidly and effectively as possible.

Physiological Changes in Space and Complications in Medical Practice

Although physiological changes do not appear to markedly influence behavioral responses in space, these changes may pose a serious and complex problem for both the medical and legal areas. Many studies have been devoted to describing the physiological changes and medical problems involved in the pursuit of advanced missions, but identifying the legal aspects of medical practice in space in the context of increasing mission complexity and risk to human life have not been adequately addressed. Administration of health care to astronauts and other flight personnel are of great importance--so are the issues of liability, responsibility and damage relating to medical practice in space.

Whereas the approach to medical treatment on Earth may be sufficient for treating patients on Earth, many approaches are proving to be insufficient for treating patients in space and call for the development of new procedures and policies. In addition, policies established for medical practice in Earth orbit may prove inappropriate for treating patients on the Moon or on long-term planetary missions where remoteness and loss of real-time contact with Earth may require different policies based on these different circumstances. Treatment of patients in Earth orbit or on the Moon has the advantage of close contact with Earth and its established medical advisory structure. Deep space missions, on the other hand, may experience a substantial communications time delay or even loss of contact entirely. Physicians may see themselves faced with making critical medical decisions in the absence of ground advice, especially if minutes are critical which could save a patient's life. From Mars, for example, transmission to Earth and back to the ship may, in certain circumstances, take up to an hour.

In space the medical treatment protocol may not be the same as used on Earth since there are differences between physiological "norms" on Earth and in weightless space flight (as discussed earlier in this paper). The physiological "norm" for artificial gravity of 1-G, as might be applied to a Mars mission transit, may be quite similar to Earth "norm" and will not be discussed here. As already noted the human physiological baseline, the one-g "norm" shifts after orbital insertion, gradually reaches the zero-G "norm." However, return to Earth is accompanied by a second physiological shift that results in readaptation to the one-G environment.[4] These fluctuations in physiological norms do pose a concern regarding the timing of an illness or injury event as it might be complicated by these physiological shifts. Medically difficult scenarios could be encountered during the treatment of illness or injury in the early phase after launch and immediately postlanding. Of concern as well is the zero-G adapted state which has demonstrated an altered drug absorption, hematological changes, decreased fluid volume, etc. The body is clearly different. What is the appropriate dosage of a drug in zero-G? How will the effects of the drug be changed? What are the appropriate therapeutic procedures for a given medical problem? How different is zero-G therapy from conventional one-G therapy?

The therapeutic procedures used in weightlessness, and also in the fractional gravities on the Moon and Mars, will most likely depend on the time of occurrence of an injury or illness and the individual's level of adaptation to the given environment at a given moment. The procedures should be well known and established for a given scenario, although this may be complicated by the multifactorial nature of the situation and individual physiological makeup of each astronaut.

Another concern is that if crew injury or illness were severe enough in space, the patient may not be able to tolerate reentry G-force (regardless of whether the patient is zero-G, fractional-G, or one-G adapted). Medical criteria must be determined for committing the patient to

reentry and landing without endangering his or her condition.[19]

A fundamental precept of any legal system is that a person who causes personal injury, property damage, or death should be required to provide compensation to the victim. In view of the possibility that astronauts might suffer personal injury or even death resulting from medical treatment, the development of a broad consensus on criteria and procedures governing liability is required. The subject is extremely complex, yet it is of practical importance in connection with activity in space being carried out in the future.

Conclusion

As more humans venture into space in the coming years, theories of astrolaw will be tested. Space stations have provided a wealth of information and can serve as real-time laboratories for testing these theories in the future. The progressive technology and improved ability to live in space for extended periods will necessitate a new jurisprudence to be developed and practiced in space by trained astrolawyers who will regard space as a distinct and possibly transforming environment. It is quite possible that physiology, medicine, psychology, and sociology will become tools of jurisprudence in the future and the study of biojuridics become essential.

References

1. Robinson, G.S. Living in Outer Space (Public Affairs Press, Washington, D.C., 1975).

2. Glenn, J.C. and Robinson, G.S. Space Trek (Stackpole Books, Harrisburg, PA, 1978).

3. Robinson, G.S. and White, H. M. Jr. Envoys of Mankind (Smithsonian Institution Press, Washington, D.C., 1986).

4. Nicogossian, A.E. Space Physiology and Medicine, (2nd. ed, A.E. Nicogossian, C.L. Huntoon, and S.L. Pool. Lea and Febiger, Philadelphia, PA, 1989).

5. Moscow Domestic Service in Russian (1200 GMT, 5 March, 1989).

6. Lebedev, V. Diary of a Cosmonaut: 211 Days in Space (Gloss, College Station, 1988).

7. Gazenko, O.G. Kosmicheskaya Biologiya i Meditsina (Nauka Press, Moscow, 1987).

8. Committee on Commerce, Science, and Transportation: US Senate. Soviet Space Programs: 1981-87 (Washington, D.C., 1988).

9. Clark, P. The Soviet Manned Space Program (Orion Books, New York, 1988).

10. Cooper, H.S. F., Jr. A House in Space (Bantam Books, 1976).

11. "One Year in Space." Literaturnaya Gazeta (January 4, 1989).

13. Kanas, N. Psychosocial Factors Affecting Simulated and Actual Space Missions. 56 Aviat. Space Environ. Med. 806-11 (1985).

14. "Cosmonaut Likens Space Flight to Honeymoon." Chicago Sun-Times (August 8, 1979).

15. Nicholas, J.M. Interpersonal and Group Behavior Skills Training for Crews on Space Station. 60 Aviat. Space, Environ. Med. 603-608 (1989).

16. Vinogradov, M.V., Varlamov, V.A., and Zybkovets, D.Ya. Methodological Approaches to Predicting Psychological Disadaptation in Human Beings in Extreme Conditions. Problems in Diagnosis and Control of the State of Human Operators -- Abstracts of Scientific Papers of an All-Union Conference (Moscow, 1984).

17. March, S.F. Dispute Resolution in Space. 7(1) The Hastings International and Comparative Law Review 211-237 (1983).

18. The New Frontier for Legal Profession--Astrolaw. San Francisco Examiner (January 31, 1984).

19. Nicogossian, A.E. and Garshnek, V. Consideration for Solar system Exploration: A System to Mars. Aerospace Science (Nihon University Press, Tokyo, 1988).