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Astrosociology and Human Factors: Antagonistic, Independent, or Convergent?

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[Abstract] Astrosociology has emerged during the last decade to focus on the relationship between outer space and society. The focus here is mostly on the micro level of analysis which involves human social interaction on the personal level. Human factors analyses applied to space-related issues may be broken down into three types, which will receive substantial attention throughout this article. In the past, human factors has dealt with human-technology (or machine) interaction for the most part, but not exclusively so, as will be discussed. Another major part of the discussion involves how the two have related to one another historically and how we should move forward into the future. The questions explored regarding this particular issue focus on how the two can continue to coexist and even become interrelated in the area of space exploration and related topics. For example, what does each area of study have to offer the other? Can human factors scholarship gain additional insights from the extensive and wide-ranging traditions of the social and behavioral sciences? What can the human factors approach offer astrosociology? Is this another way in which we can bridge the divide between the social science community and the space community?

The relationship between astrosociology and human factors requires deliberation. Whether the two areas of study become antagonistic or convergent, or remain largely independent, will have implications for how human interactions in space ecologies become characterized, studied, and understood in the future. The discussions in this article lead to conclusions that, perhaps by their very nature, may cause disagreement and thus engender confrontational reactions by some in the space community. This outcome would prove positive for everyone, as an energetic set of debates on this subject is required for progress to occur in our long-term understanding of interpersonal issues regarding human migration to, and survival in, space ecologies in a variety of very different space environments.

Keywords: astrosociology, human factors, astrosocial phenomena, social interaction, micro level of analysis, space ecology, space environment, social interaction, human-machine interface, human-environment interface, human-human interface

I. Introduction

ASTROSOCIOLOGY and human factors currently coexist yet they remain separate in terms of their literature as well as the interaction between researchers and scholars in the social science and space communities. Given these fundamental forms of separation, it behooves all with an interest in human habitation of spacecraft, settlements, and all manner of other extraterrestrial ecologies to determine whether or not they can benefit from a formalized collaborative interaction. Thus, one fundamental question exists. Are they separate because they are somehow antagonistic to one another, simply independent without any historical reason for interaction, or are they due for a formalized convergence based on the anticipation of the space community's movement toward collaboration with the social sciences?

The fundamental definition of astrosociology involves social, cultural, and behavioral patterns related to outer space.[1] Astrosociology and space-related human factors analysis share many things in common. For example, and perhaps this is the most important connection between the two, both fields involve the human being as an integral part of their approach to issues associated with space exploration and related issues. They both view human beings as an integral part of the overall system along with the technological considerations.

Of course, the field of human factors is much older than astrosociology. However, it is not as old as sociology, anthropology, and psychology. Many of the social or behavioral sciences, and their subdisciplines, are much older

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that human factors applied to space since the space age is much shorter than the inception of these social and behavioral sciences. If one were to argue that astrosociology and human factors should remain separated, as things currently stand, then one must take the untenable position that the entire literatures of the social sciences – and thus astrosociology – have nothing to contribute to the study and understanding of human social interaction beyond what exists within the space community. This particular position is difficult to defend due to the fact that sociology, for example, became a necessary scientific approach to understanding human interaction and social structures on Earth. It began as a philosophical form of reasoning because previous approaches, including biblical scholarship, was found by a great many to be unable to explain the tremendous forms of social change that occurred during revolutions in societies and later the shift to industrialization and capitalism. Therefore, without additional space dedicated to furthering this argument, the assumption is made that the social sciences and astrosociology have much to offer the space community. In this case, they have much to offer in the area of human factors analysis.

This assumption brings to mind another major question: why is astrosociology necessary when human factors already exists? It is because no claim is made here that psychological and psychosocial research did not exist before the advent of astrosociology in 2003. To be fair, research focusing on the human-human interface – discussed in the next section – is normally termed as "psychosocial" (see, for example, Morphew[2]). Nevertheless, its use in isolation from the social sciences fails to stimulate the full participation of the social and behavioral sciences.

The assertion made here is that the near absence of traditional social scientific research, as important as this status quo is, pales in comparison to the general approach taken by NASA – as one important example – in which issues are framed in ways that place the human being as a secondary consideration to the engineering of mechanical systems or the study of space phenomena. Why is this so? There is a barrier around the space community that tends to repel social scientists from studying space issues. For those who persevere, their work is often carried out in isolation from their fellow social scientists. Today, if humans are indeed destined to enter the vast reaches of space in a more dramatic fashion, this research must intensify and become more common among all disciplines far beyond its current scope.

I. Definitions of Ergonomics and Human Factors

Before moving on to discuss the types of human factors interfaces, it is important to provide some attention to the definitions of ergonomics and human factors in a more general sense. Much research occurred before human factors analysis was applied to spacecraft. After human factors does have a terrestrial foundation.

During World War I, airplanes had to be designed to accommodate pilots on a crude but necessary basis. Many different definitions have turned up over the years since the time that ergonomics and human factors "officially" emerged during World War II as a way to improve safety through aircraft design and utilization.[3] During the 1950s, the concepts remained rather simplistic by today's standards. "The focus of human factors (HF) research in the mid-1950s may be capsulized by the Double Fit Principle: Find the best 'fit' of the submariner candidate to the machine and build the machine to 'fit' that person."[4] Human factors and ergonomics expanded its focus as new technologies emerged, such was the case with computers in the 1960s. Through the years, experts have applied ergonomics and human factors research to designing such things as office furniture, commercial and military aircraft, ships, submarines, space capsules, the space shuttle, and space stations.

Ergonomics is the more simplistic concept. It is the applied science of equipment design to interface with human beings in order to enhance human performance.[5] The mitigation of human error is also an important objective. Many link ergonomics to the human-machine interface (in its simplest form), which is the topic of the next discussion. The focus is on the placement of switches, dials, buttons, monitors, and other elements of the equipment so that operators can maximize efficiently and thereby productivity.

The definition of human factors has grown complex due to competing characterizations that express it boundaries in different ways; that is, what is included and excluded as its focus. While it started out with more of an ergonomics focus, it has expanded into an interdisciplinary field. As stated earlier, the general field of ergonomics and human factors started out as purely terrestrial concerns, and then was adapted finally for spacecraft applications.

One definition adopted by the Human Factors and Ergonomics Society from the International Ergonomics Association, for example, pays greatest attention to the optimization of safety and performance without specifically mentioning the multidisciplinary nature of human factors specifically.

> Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance… [E]rgonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities, and limitations of people.[6]

The focus of ergonomics tends to be on the individual rather than human interactions among individuals. Likewise, it does not focus much on environmental elements.

Other definitions spell out its multidisciplinary nature that includes the social and behavioral sciences and they also mention habitability. The latter implies long-term existence in the same environment and thus a long-term use of the same equipment and systems.

> Human Factors is that field which is involved in conducting research regarding human psychological, social, physical, and biological characteristics, maintaining the information obtained from that research, and working to apply that information with respect to the design, operation, or use of products or systems for optimizing human performance, health, safety, and/or habitability.[7]

It is quite clear that the field of human factors has become much more sophisticated over the years to accommodate both changing technologies and increasingly complex environments for human inhabitation.

NASA's definition views "Human Systems Integration…[as] an umbrella term for several areas of "human factors" research that include human performance, technology design, and human-computer interaction."[8] For the most part, this has traditionally meant research and application work involving human-technology (machine) and human-environment interfaces. The human-human interface was not a mainstay in NASA's approach for a long period after its inception, although this has begun to change. It is important to note that NASA has always had an interest in the psychology of spaceflight, which involves individual human psychology but also a bit of social psychology. Additionally, since Mir and International Space Station, and with its participation in programs such as NEEMO[9] and Mars Society's FMARS[10] habitat, NASA has begun to acknowledge the importance of social-scientific research. This represents a good trend for both human factors and for astrosociology.

II. The Three Interfaces of Human Factors Analysis

Human factors is the oldest field that focuses on human beings in space. Most of the rest of the early effort dealt with the engineering of the spacecraft and its technical systems, as well as other related matters. The field of human factors related to space environments includes additional factors not present in most other complex systems on Earth. Nevertheless, terrestrial analogs are extremely important for providing fundamental clues about human behavior in spacecraft and other extraterrestrial habitats due to their many similarities.[11]

As will become clear quite shortly, the term "human factors" as it relates to outer space is applied differently than it is to terrestrial settings. For example, Marilyn Dudley-Flores[12] has separated the field of human factors into three types in large measure to point out that the space community has largely failed to address all of them adequately in the past. They are as follows:

(1) the human-technology interface,
(2) the human-environment interface, and:
(3) the human-human interface.

The human-technology and human-environment interfaces involve the most commonly practiced forms of human factors within NASA based on historical necessities.

> The aspect of astrosociology that perhaps most often come to mind is that of crew interaction, both among crewmembers, and between the crew and Mission Control. The human-human interface is one of several aspects of what is grouped together as "human factors," others being the human-technology interface and the human-environment interface. The latter two have historically received more attention in human spaceflight as being the more immediate and relevant concerns, given that in this venue humans are operating technology in a hostile environment. However, the social interaction of spaceflight has been given short shrift for the nearly half-century of human spaceflight..[13]

In the past, the unbalanced attention to the human-technology and human-environment interfaces made sense because the crews were small and Mission Control thoroughly scripted their activities throughout their stays in space. In fact, up until 2011, the space shuttle program operated in this way and the International Space Station continues this tradition.

Consideration of each of the three dimensions of human factors will demonstrate that each one is different from the others in important ways, especially the human-human interface. The human-technology and human-environment interfaces of human factors analysis are necessary components of both the planning and success of human space missions, of course. However, as we will see, despite being overlooked to a great degree until recently due largely to its focus on human social interaction, the human-human interface has highly significant implications for the ongoing success of missions. It will become even more important as missions become more complex.

A. The Human-Technology Interface

As the name implies, the human-technology interface consists of two components. "The two most critical elements of HFE [human factors and ergonomics] are…the human and technology; without these, there is no

HFE."[14] Before the space programs in the United States and the Soviet Union, the relationship between technology and the human being was the focus of human factors and ergonomics analysis in environments such at the workplace (including the production line), in ocean-going vessels and submarines, and aboard aircraft.

With the advent of scientific management, or Taylorism named after its founder Frederick Taylor,[15] and time-and-motion studies that began in the early 1900s, occupational efficiency became a key objective.[16] The same became the case for the space program decades later, including within NASA right on through the Apollo era and to this day. One example is the time-and-motion analysis of the mission of Apollo 16 that includes analysis of the three lunar excursions.[17] The Space Shuttle missions continued, and International Space Station missions still carry out, the tradition of carefully scripting the workflow of astronauts in order to maximize their productivity. These types of studies are strongly related to ergonomics and human factors analysis focusing on the human-technology interface. However, scientific management is no longer pushed to its full hypothetical extreme, which could result in what Karl Marx called *alienation*, or a loss of control by workers of the production process.[18] Similarly, sociologist Max Weber coined the sociological concept of an *iron cage*, or the increasing rationalization resulting in a technically ordered, high structured, dehumanizing elements most common in modernizing capitalist societies.[19] In bureaucratic organizations, Weber predicted a stifling and unrewarding existence for workers in organizations that became too bureaucratic. Related to these general observations, NASA mission controllers have evolved their oversight duties. They have recognized that they constantly need to assess the psychology of astronauts and the even the social conditions of their workplace to ensure they are not overworking them.

During the Mercury program, it was obvious from the outset that astronauts needed to interface successfully with their instrumentation. Although comfort was not the highest priority, it also made sense to make the controls as accessible as possible. A major objective for employers on Earth was to increase productivity, which included the elimination of human errors. These types of requirements, borrowed from existing terrestrial and aviation human factors analysis, paved the way for the development of a space-based human factors field. Things became much more complicated when the need shifted to constructing spacecraft that carried human beings. Rockets were a huge problem at first, but Mercury capsule design, started in 1958, required the most sophisticated human-technology interfaces ever created at that point in history.

The human-technology dimension seems like the perfect focus for human factors. It is compatible with astrosociology although it will probably remain independent. Why? The answer relates to the fact that this area of study already exists as a longstanding field. Astrosociology should contribute to the concerns of human-technology human factors, and make significant contributions, but combining the two in some way is probably improbable.

B. The Human-Environment Interface

This particular interface involves the relationship between the human being and the spatial setting in which social life takes place. Social interaction requires the presence of two or more people. For a single occupant, in contrast, life aboard the spacecraft involves the relationship between the human being and both the technology and the environment, which is actually no "social" life at all. In such a case, the human-human interface does not exist. Nevertheless, the human being must cope with many of the same environmental elements present when two or more occupants do exist.

The human-environment interface can involve rather simple adjustments to the environment such as changing the lighting or it can involve much more complex considerations. In ecologies that involve weightlessness or reduced gravity, for example, this relationship between the human being and his or her spatial environment may require multifaceted adjustments. Space environments involve conditions that produce additional stress on occupants that do not exist in non-contained environments.

> Some work environments, such as a space station…or Antarctic research station, are "contained": a person cannot leave the work environment because it is the only environment that support life. Forced containment restricts the actions that a person can take to reduce stress, and this restriction introduces stressors of its own. These include: (a) the surrounding hostile environment, (b) a limited supply of life-supporting resources, (c) cramped living spaces and enforced intimacy, (d) the absence of friends and family, (e) few recreational activities, (f) artificial atmosphere, and (g) an inability to leave the contained environment (Blair, 1991[20]).[21]

The human-environment interface is a complex dimension of the isolated and contained space workplace, which involves altered gravity fields, radiation, and other characteristics in unique social settings existing in various types of space environments.

> Through the body, sensorial data and emotional response interact to create symbolic meaning that ultimately impacts the development of new spatial habitats. The creation of such 'places' requires the understanding of the human-environment interface and integration of territories that range the psychological, social, ergonomic, anthropologic, perceptual, anthropomorphic that radiate into interconnected and intra-disciplinary fields.[22]

Once again, the human-environment interface involves social and non-social interactions, though even the latter involves attaching symbolic meaning to the spatial environment's characteristics.

Undoubtedly, then, a multidisciplinary orientation is required to study such issues. This involves the type of collaboration that astrosociology advocates and utilizes in its approach to the study of astrosocial phenomena. Contributions from sociology, anthropology, and psychology, as examples, are required. This is truly an astrosociological approach, and thus it requires a collaborative approach between engineers (and other space community experts) and astrosociologists (along with other social and behavioral scientists). This seems obvious, but such a formal and extensive collaboration has not occurred nearly enough during the history of the space program in the United States.[23]

C. The Human-Human Interface

The human-human dimension of human factors analysis focuses on how human beings interrelate with one another on three levels of analysis: the micro (which involves two or a few individuals), the middle (which deals with the relationship between people and social structures), and the macro level (which focuses on larger social patterns). Astrosocial phenomena define the major focus of astrosociology, and they also involve these same levels of analysis. The human-human interface, along with the other two, constitutes the space ecology – which consists of the combination of the physical environment and the social environment.

It should be of no surprise that the human element is crucial. The factors that contribute to mission success – such as crew heterogeneity, the level of social integration of crewmembers, and conflict generated by cultural and religious differences – have been well documented over the last two decades or so (for example, see Bishop[24]).

The human-human interface is indispensible if more than one person lives in space ecology. Social interaction occurs in a group setting, whether that group is a dyad (a two-person group) or consists of hundreds or thousands of inhabitants within a space ecology. Longer durations make the human-human interface even more important because the occupants of the spacecraft must interact with one another without the possibility of escaping at the exact moment that they deem fit.

While the idea that human factors and astrosociology exist as antagonistic (or incompatible fields) is patently false, so the human-human interface and astrosociology should be viewed as *convergent* in this author's opinion. Specifically, this means that the human-human dimension should in fact incorporate the rich history of social-scientific knowledge applicable to human spaceflight and settlement. Coupled with the research already carried out within the purview of human factors, social science research and theory adapted from analogous areas can significantly add to the level of knowledge. Joint efforts in the future would also increase the knowledge base considerably faster. One of the challenges we face is to attract a much larger contingent of social and behavioral scientists to work with existing members of the space community. Research findings from analogs are extremely important to understand,[25] and they exist within the literatures of social and behavioral disciplines as hidden gems waiting to be mined.

The use of the concept of human-human interface or factors is used by a number of well-regarded researchers. This seems to complicate the issue, however. After all, the human-human dimension is merely a euphemism for social interaction, which falls under the purview of the social and behavioral sciences. It is, in fact, a focal dimension of astrosociology.

Thus, an inquiry requires exploration, one that may surprise those in the space community who work in human factors: Is the human-human interface distinction actually helpful, or is it simply astrosociology (i.e., the study of social interaction in space ecologies)? Further, was the human-human interface created in order to fill a vacuum before 2003 that is now occupied by astrosociology? Such questions are debatable, of course, but now this debate requires serious attention as astrosociology becomes more relevant.

D. Summary of the Three Interfaces of Human Factors and Astrosociology

In summary, the human-technology interface has a history of operating independently of the social and behavioral sciences to a great extent, so it should probably be viewed as compatible although it should be opened up to collaboration beyond the traditional limits of human factors and even space psychology. The human-environment interface focuses on how an individual interacts with his or her spatial environment, as stated, but this also has implications for how people interact with one another in space ecologies. The human-human interface is seemingly undistinguishable from the concept of human social interaction, a mainstay of sociology for over two hundred years.

Thus, the human-technology and human-environment interfaces of human factors potentially are convergent with astrosociology, especially when two or more occupants inhabit a single environment. It is quite easy to see how these two interfaces relate to one another. Moreover, one cannot really view the human-technology interface in

isolation, either, except perhaps to conduct the most focused studies regarding ergonomic issues. The interconnectedness of the three interfaces receives attention in the following subsection.

Social and behavioral scientists – especially psychologists – have already worked within the various areas of space research, including space human factors, for decades now. NASA has had an interest in the human-machine interface since the Mercury program and has slowly begun to address even the human-human interface over the last few years in a more serious way. One can state that no matter how space human factors and astrosociology evolve from this point forward, one must view formal collaboration as the minimum acceptable standard if convergence is not a possibility for any of the interfaces. Independence only relates to the separate discipline boundaries and does *not* signify a rigid separation of human factors and astrosociology. At the other extreme, any sort of conflict or antagonism between the two would create a situation in which both disciplines would suffer. We must avoid such an outcome, as progress in the areas of spaceflight and human space settlement suffer as well.

1. Three Interfaces, One Set of Concerns

One way to view human factors is to do so holistically. Rather than separating it into three interfaces, one may analyze it as a group of human beings living and working in a confined or contained space while interacting simultaneously with the technology, environmental conditions, and other human beings that exist in their ecological environment. While individual researchers may focus on one interface, they must also work with those who focus on the other two interfaces. Additionally, they must also look at the entire picture. They must scrutinize the entire ecological environment in order to avoid the form of reductionism in which the researcher understands artificially created simpler parts without gleaning a clear understanding of how these parts fit into the whole, and more importantly, how they interact with one another.

In a way, then, breaking human factors into the three interfaces of human factors may be more disadvantageous than helpful. At the very least, the researchers within the three interfaces must make their findings available to all those who work in the human factors field, regardless of their interface of focus, and they must interact with others in the other interfaces. In addition, human factors analysts should work with astrosociologists focusing on similar areas, especially concerning the human-human interface.

III. A Changing Social Reality with Humanity's Shift to Longer Durations in Space

It is important to place this discussion in the proper context. To the extent that public and private organizations continue to approach spaceflight in ways that mimic the past, human factors can continue to remain isolated from astrosociology and the other social and behavioral sciences. If, on the other hand, human spaceflight begins to include larger contingents of people for longer durations, then a changing social reality will emerge in which viewing things utilizing older paradigms will not remain adequate.

Astrosociology exists because of the dearth of theory and research devoted to the relationship between humanity and outer space that existed in 2003, and not because of an inevitable increase in humanity's presence in space, even though it was always thought that we should be prepared for that as well. Social and cultural patterns of any sort, including those that disfavor spaceflight and settlement, deserve understanding as well. The main approach of astrosociologists is to study whatever astrosocial conditions develop, whether or not they favor increased human spaceflight, even when the existing paradigm does not shift to something new.

On the other hand, a changing social reality for humankind in space, should it occur, requires a change in the approach taken to address it. For the most part, however, we tend to continue our traditional efforts as if nothing of significance will ever change. "The sociologist Charles Perrow[26] has discussed how resistance to human factors within complex organizations has strong structural and cultural underpinnings and is not overcome easily."[27] As a result, NASA has been slow in implementing human factors on an appropriate scale. The human-human interface, or more appropriately, input from social and behavioral scientists, continues to lag behind the increasingly likelihood of the need for astrosociology.

Of course, no guarantees exist that an organization within a particular nation will increase its presence in space in significant ways. However, it is quite easy to see that there are trends favorable to such an outcome that include China's meeting of aggressive milestones in space, NASA's announcements of traveling to asteroids and Mars, and a higher number private companies entering the space industry in pursuit of becoming players in the space tourism market and other markets in the space industry. These types of trends make it prudent to pursue knowledge that relates to the relationship between space and humanity because societies may shift to a changing social reality that emphasizes space to a much greater degree in a way that leaves too many people unprepared. Such a new reality would affect humans wherever they live and work, whether in space or on Earth.

Once again, if one makes the assumption that the human presence in space will increase at some point in history in terms of greater numbers and longer stays, then we are currently unprepared to deal with the potential ramifications of such social patterns. Past experiences in human spaceflight have laid only a tentative foundation for understanding the future of long-duration spaceflight that we can expect in the future. Even stays aboard space stations represent only a fraction of the time that will be required, so the physical dangers and human interactions involved have presented only minimal indications of what to expect as missions are extended beyond current experience. Unquestionably, the definition of "long-duration" will need to change.'

We have a pretty good sense about the physical dangers. However, we do not yet understand the limits of human endurance under dangerous conditions nor how we will cope with them. Probably more importantly, we do not yet fully understand the full extent of the implications of psychosocial variables involved with living in space ecologies. For example, the study of the cultural and social dimensions of space medicine, incorporated in the subfield of *medical astrosociology*, focus on such issues.[28,29] precisely because of the missing attention paid to this vital subject matter by social and behavioral scientists – as well as the majority of those in the space community. Such subject matters require that we study them just because of the strong possibility of requiring such knowledge someday. The leap of faith required to imagine this potential reality is not really that difficult to take.

IV. The Collaborative Future

Based on the foregoing logic, it is safe to state that the future of understanding humans in space must be forged between astrosociology and human factors analysis. There is no alternative. The two are certainly not antagonistic in terms of their subject matters, and independence would only carry forward the unproductive status quo, so convergence – or at least a strong commitment to collaboration – represents the best future scenario. The time has come to discuss how to implement collaboration on a formal basis.

A. Bridging the Two Major Branches of Science

Whenever one views the same problem or application from perspectives of the physical/natural branch of science and also from that of the social/behavioral branch of science collaboratively, each side may glean bits of knowledge, but it will inevitably result in only a piece of the puzzle.[30] By combining the two, new insights would present themselves that simply may not be possible to perceive from either single perspective. Too often historically, issues related to human factors have been approached separately from scientists from each of the branches of science. Their lack of collaboration has resulted in a slower rate of progress in understanding how human social groups will sort themselves out and which variables prove to be the most important. We simply have no direct observation of such a scenario on a large scale.

In addition to collaboration between the two branches of science, another need exists. Within the space community, and specifically within organizations such as NASA, the human-human interface must become more prominent and more acceptable by the leadership. While it is beginning to occur even now, another trend must develop. These organizations need to start collaborating with astrosociologists, and even employ them, in order to prepare humanity for an increased presence in space should this occur.

Important questions for the future do indeed exist. Is the human-human interface simply another name for astrosociology? Should astrosociology replace the human-human interface? Are there really only two human factors interfaces (i.e., the technology and environment interfaces)? Or contrarily, should astrosociologists simply work within the field of human-factors – and maybe also within astrosociology and collaborate with human factors analysts – so that both branches are bridged? Perhaps the most important thing is collaboration among all of the relevant scientists, regardless of how these fields evolve.

V. Conclusion

In general, astrosociology and human factors cover overlapping subject areas and thus research interests. The human-machine interface is the least connected, in the sense that it has focused on a set of largely engineering and biomechanical concerns, though it still can benefit from astrosociological collaboration, just as astrosociology can benefit from issues related to the human-machine interface. After all, interactions with technology occur in a social environment within the spacecraft or habitat.

The human-environmental interface is similar to the human-human interface in the sense that both require interdisciplinary cooperation among several disciplines and fields. On the other hand, it is less clear that this interface should become part of astrosociology. One may approach the human-environment interface from orientations traditional to the space community – such as those taken by space architects or engineers – or from orientations familiar to social scientists – such as those taken by sociologists or anthropologists. The only thing that

is clear at this point is that neither the "hard" sciences nor the "soft" sciences can provide all of the answers necessary to understand the totality of all issues regarding humankind's survival and prosperity in space ecologies.

This author favors a scenario in which the human-human interface folds under the banner of astrosociology. The attempt to create a subfield of human-human-based human factors analysis serves no practical purpose. Astrosociology was created as a social science field to cover human interaction involving astrosocial phenomena, so the development of a human-human interface serves arguably as nothing more than a redundant effort.

However, even if the two remain completely independent, it is time to take advantage of the compatibilities of the fields of astrosociology and human factors (including all three interfaces) so that synergetic research becomes possible that results in the types of new knowledge unattainable by either field alone. Thus, it may be that a central argument focusing on astrosociology as a successor to human factors is misguided in the sense that the two fields can work together in their separated states.

Regardless of the state of space human factors, the continued development of the field of astrosociology is needed to unite disparate social and behavioral scientists, and bring them together with members of the space community, in order to construct a well-recognized and fully interactive multidisciplinary field. Whether or not the human-human interface and astrosociology merge or not, it is clear that collaboration between the space community and the social science community is required even today so we may prepare ourselves for more ambitious missions in the future. Potentially, they are convergent fields. Independence is acceptable, then, as long as communication between the two becomes normalized and formalized. The social and behavioral sciences have much to offer the space community, but the space community also has much to offer astrosociology. Any thought of antagonism between the two simply mirrors the last fifty plus years, which should be viewed as unacceptable to both sides. Progress occurs most fruitfully if humanity gains all of the knowledge it can about astrosocial phenomena. Isolation has never proven to be the most successful strategy, so we must therefore move in a new enlightened direction in which open communication serves as the fundamental element in the relationship between the fields of human factors and astrosociology.

In closing, this short essay has sought to accomplish two major objectives. First, it seeks to initiate new thinking about some of the important issues that exist involving the relationship between human factors and astrosociology. Second, it seeks to open a growing dialog between those working in astrosociology and those working in human factors so that scientists from the social and behavioral sciences will begin to work with those in the space community more regularly to further humanity's understanding of astrosocial phenomena related to spaceflight and settlement. The goal is to increase the limited collaboration that has existed in the past dramatically.

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