Handbook of Science and Technology Convergence
DOI 10.1007/978-3-319-04033-2_79-1

Astrosociology (Social Science of Space Exploration)

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Abstract

Discussions concerning science and technology convergence too often ignore the social sciences. This is not the case here, as the focus is on a relatively newly emerging and increasingly relevant social science field. Astrosociology is an interdisciplinary and multidisciplinary field that promotes and represents convergence of the physical/natural sciences and the social/behavioral sciences on all matters pertaining to humanity's interests and activities in space and the consequences of these activities for people on Earth. While political science and economics have sustained a strong interest in space, interest on the part of anthropology, sociology, and several fields of psychology has been low. Also, with the exception of selected space science research areas including astrobiology, the search for extraterrestrial intelligence, and the protection of the Earth from asteroids and comets, the receptivity of physical and natural scientists to inputs from the social and behavioral sciences has been low. Increasing synergy between the "hard" and "soft" sciences requires increasing interest within both the social and behavioral sciences and encouraging receptivity on the part of physical sciences. This chapter emphasizes the need for convergence, the barriers to convergence, and potential approaches to reduce these barriers. Achievement of unprecedented levels of collaborative synergy is possible with increased levels of sustained convergences. This is possible by increasing social science literacy among the public and "hard scientists" and developing win-win research projects that accommodate varied interests and goals. SETI, astrobiology, and planetary defense serve as specific examples of successful convergence efforts, though they involve social scientists in relatively small numbers. These examples demonstrate both the limited successes and the largely untapped potential of the social sciences to contribute to space education and research.

Introduction

Since the dawn of the space age in 1957, contributions from social scientists have not kept pace with hard scientific and technological developments. Economics and political science have made ongoing contributions, but research and application from other fields including anthropology, sociology, and many areas of psychology have been somewhat sporadic and intermittent. Much of the good work was accomplished in the past by individuals alone, and among several social scientists for specific projects and publications, so no coherent collaborative effort remains intact long enough to move the theoretical and empirical work forward on a sustained basis. No body of literature can reach adequate development and recognition unless interdisciplinary and multidisciplinary efforts become formalized and sustainable.

Each field within social science has benefitted from pioneers. In anthropology, Ben Finney has had a long-term interest in space-related matters including reducing the divide between the physical and social sciences (Finney 1992). Along with physicist Eric M. Jones, he forever united space exploration and settlement with the search for extraterrestrial intelligence (SETI) in their coedited volume *Interstellar Migration and the Human Experience* (1984). More recently, we find seminal work by Jack Stuster (1996,

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DOI 10.1007/978-3-319-04033-2_79-1

2004, 2005). Recently, anthropologists have begun studying "new space" activities on the part of visionaries, entrepreneurs, and others to increase private enterprise in space (Valentine 2012).

In sociology, B. J. Bluth (1983) made significant early contributions to understanding psychosocial adaptation to spaceflight, and though many of her writings were never published, her achievements are summarized in Connors et al. (1985). Extensive writings by William Sims Bainbridge (1991) also come to mind, as does the work of Alvin Rudoff (1996) and Diane Vaughan (1996). One of Rudoff's questions – where is sociology? – still rings loudly in our ears. Pass (2004c) has termed space as sociology's forsaken frontier.

In psychology, while hard-core research at the human-machine interface has been continuous, NASA's interest in personality, social, and organizational psychology gained traction only after astronauts reported difficulties on extended duration missions on the Russian space station Mir (Harrison and Fiedler 2011a, b). NASA cut "soft" psychology from the space program before the Mercury flights ended. However, in anticipation of post-Apollo flights, psychiatrist Nick Kanas and psychologist William E. Fedderson (1971) outlined psychological and social issues at the individual, group, and intergroup levels. This provided a model for many researchers who followed, and Kanas went on to a long and distinguished career involving collaboration with Russians. Robert Helmreich (1983) is among the leaders who sought to reinstate neglected areas of psychology into the US space program, and psychiatrist Patricia A. Santy (1994) and the interdisciplinary team of Connors et al. (1985) later joined him. In 2001, Harrison (2001) wrote a book called *Spacefaring: The Human Dimension* that made a clear and concise argument for the need for social science involvement.

There were other pioneers, but the number of social scientists involved in space-related matters was, and remains, small. Thus, the promise that social science holds for illuminating and guiding our entry into space is still largely unfulfilled. The problems are twofold.

First is the issue of igniting interests within the social sciences. This is difficult because it is not among the traditional research areas nor is it, particularly at this moment, a hot research topic. With occasional exceptions, academic publications do not appear in mainstream journals; indeed, they may appear in journals such as *The Journal of Rockets and Spacecraft*, *The Journal of the British Interplanetary Society*, *Acta Astronautica*, and *Theology and Science* that are unknown to social scientists. It is difficult to generate involvement in a research area that has a meager and difficult-to-find literature base and does not have the support of top leaders of the field. It may be difficult, too, because, traditionally, some of the most promising space-related topics have a science fiction ring.

Second, there is the problem of engaging interest and receptivity on the part of the "hard" scientists and engineers (and their administrators). For many – not all – hard scientists, past personal experience, standard practice, and intuition suffice. Input from the social sciences is unwelcome if it costs extra money, delays a launch, or somehow interferes with management prerogatives. As for envisioning our future in space, anthropologists and sociologists were bypassed in favor of Utopian visions promulgated by rocket men such as Konstantin Tsiolkovsky, Hermann Oberth, and Wernher von Braun. Oftentimes, these inspirational visions have strong religious and ideological themes mixed with assumed advances in technology (Harrison 2007, 2013, 2014; Launius 2012). People often fail to recognize that space exploration and settlement is more than a strictly scientific activity, largely because the human dimension of space receives too little attention.

Definition, Scope, and Relevance of Astrosociology

Astrosociology represents an effort to (1) increase interest among social scientists, (2) boost receptivity to social science inputs on the part of physical (and natural) scientists, and (3) thereby expand the level of

DOI 10.1007/978-3-319-04033-2_79-1

synergy produced by all the many participants in the ongoing drama of humankind's entry into space working together. Astrosociology focuses on the relationship between space and society/humankind (Hearsey 2011). Astrosociology is the scientific study of *astrosocial phenomena*: the social, cultural, and behavioral patterns related to outer space (Pass 2009).

While it may be tempting to assume that astrosociology applies only to humans living in space, and thus consider it an unneeded field that is still well before its time, it is already applicable to those on Earth, as it has been for decades. Astrosocial phenomena will loom in importance in terrestrial societies as human activities in space exert more subtle and blatant influence on individuals, groups, organizations, and societies. Thus, rather than a premature effort, astrosociology is planting its roots at the beginning of a long and potentially hazardous beginning of forays beyond the Earth (Pass 2004a). Moreover, we know very little about the effects of astrosocial phenomena, even in terrestrial societies.

By moving beyond a few scattered efforts, we can, to consolidate gains, achieve new insights and make collaboration among traditionally different disciplines an accepted and hopefully routine part of all space-related efforts and social science transitions. Convergences among the various social science, physical science, and natural science disciplines and fields are vital for fostering future advancements in space and understanding resulting effects on Earth, including a spacefaring future (Pass 2004b; Pass and Harrison 2007). We have much to draw upon. These include drawing on sound theory and research, preparing for unintended consequences of well-meaning ventures, and urging the alignment of technological and cultural change. For example, the development of space societies requires an approach similar to urban planning in order to maximize the livability factor within the isolated human ecosystem.

Even the acceptable uses of technologies – or what sociologists call *material culture*, coined by sociologist Ogburn (1922) – possess positive and negative social and cultural characteristics. For example, what are the acceptable uses of nuclear power? What are the unacceptable applications? Not everyone agrees that this type of power source is acceptable when launching spacecraft from terrestrial spaceports. Decisions about how best to use potentially harmful scientific discoveries and technological viewpoints require ethical decision-making and that requires study by social scientists. Such efforts require long-term commitments. In the absence of interdisciplinary education and research, the gap between technology and culture could grow catastrophically large.

In our assessment, researchers in the physical and natural sciences show a greater degree of sustained collaboration than do their peers in relevant areas of social science. We see major collaborative efforts in biotechnology, nanotechnology, artificial intelligence, robotics, and future energy technologies, just to name a few. Nothing like this exists within the social sciences to an extent that is even close to the taken-for-granted realities enjoyed within the physical and natural sciences. Without a much greater impact by social scientists, the potential for space migration and the salvation of humans on Earth remain less certain. However, increased involvement on the part of the social sciences and improved collaboration with the physical sciences is not enough. We need a shared, holistic understanding of space exploration, settlement, and related areas. The future of space education and research must identify and exploit areas of compatibility that can result in convergence with the physical and natural sciences wherever possible. This can result in new forms of synergy beyond what is possible among the physical and natural sciences alone, providing new insights, methodologies, and new directions in research and education.

STEM

STEM stands for the "hard" sciences, technology, engineering, and mathematics. This acronym identifies the major focus of NASA and the core curricula of a growing number of new programs in academia. The "S" in STEM has historically favored the physical and natural sciences, as if the social sciences

DOI 10.1007/978-3-319-04033-2_79-1

represented something fundamentally different, something somehow unscientific or at least less scientific than the "hard" sciences. Even the label "soft sciences" implies that the scientific method, rigorous theory building, and unbiased empirical investigation are less applicable to human behavior or, worse, that human behavior is not subject to scientific laws. This is a purposefully constructed overstatement of the average position of natural and physical scientists in order to illustrate the point that the concept of science is too often exclusive of social science when it comes to space issues. Yet this status quo involving the exclusion of the social sciences includes its own built-in limitations.

Originally advocated by the Rhode Island School of Design (2014), STEAM is an effort to add the arts to the STEM agenda. There is nothing wrong with this approach per se, but it does not go far enough because it leaves out the social and behavioral sciences as well as the humanities. The arts can contribute to space research, such as making a habitat livable rather than just survivable through the construction of appealing artistic works and comfortable architectural surroundings. However, the social sciences can offer much more than the arts alone.

To be fair, projects that involve collaboration between scientists from both branches of science have occurred in the past including work on committees and projects, publications, and other forms of research efforts. However, it is also fair to point out once again that these interdisciplinary efforts have tended to be short-lived rather than the persistent efforts that can ensure long-term advancements. This is problematic, as it generally results in small developments. While short-lived efforts can bring about new ideas, discoveries, technologies, and scientific applications, typical interdisciplinary efforts end too soon, and thus the synergy that may have developed dissipates too quickly. The promise of ongoing convergences lies in formal, long-term multidisciplinary campaigns, with continuing efforts to create new interactions among scientists within each branch of science and those between the two branches. In the area of space education and research, the dearth of research on astrosocial phenomena means that much more collaborative work is required that can benefit humankind in both known and unknown ways.

Thus, temporary cooperation cannot continue if humankind truly seeks to live permanently in extraterrestrial ecosystems, for example. The physical environment characterized by contributions from the STEM subjects is a necessary element of survival and even potential prosperity, but it is not a sufficient condition. Human beings, who must live within the confines of those space ecosystems, must have both physical *and social* environments that support survival (Pass 2011). One cannot foretell the exact convergences that arise when the two branches interact formally and sustainably, yet one can reasonably expect that new breakthroughs increase chances of survival. Planning from the early stages of any program or trend will benefit humankind most profoundly when all types of scientists and scholars work together toward a common goal on a continual basis.

Successes

Developments in astrobiology, SETI, and planetary defense illustrate that highly collaborative research is possible. Here, we find collaboration among social scientists and humanists and between these fields and physical and natural scientists. Although relatively few social scientists are involved, the success of this collaboration gives rise to hopes for similar successes in space exploration and settlement and other achievements pertaining to humankind and space on a much more widespread basis.

Astrobiology studies the origin, distribution, and future of life in the universe and hence touches upon great questions of human existence, long considered the province of philosophy and theology (Blumberg 2011; Dick and Strick 2005). Where did we come from? Are we alone in the universe? What will become of us? NASA's astrobiology program, as set forth in the NASA Astrobiology Roadmap, combines physical, biological, and social sciences and recognizes enormous implications for society (Des Marais

DOI 10.1007/978-3-319-04033-2_79-1

et al. 2008). As such, astrobiology provides fertile grounds for astrosociology. Central topics include the origins and evolution of life, the search for life and its precursors beyond the Earth, environmental ethics, establishing ourselves as a multi-planet species, and protecting ourselves from global catastrophes and extinction-level events.

Because of astrobiology's far reaching implications for humanity, NASA's Astrobiology Roadmap spurred a parallel effort now known as the "societal roadmap" (Race et al. 2012). Based on workshops drawing participants from a wide range of disciplines, the societal roadmap identifies five areas for exploration. These are:

1. The range and complexity of societal issues related to how life begins and evolves
2. Astrobiology's implications for the significance and meaning of life
3. Relationships of humans to life and environments on Earth
4. The potential relationships of humans with other worlds and types of life
5. Life's future on Earth and beyond

The societal roadmap underscores the importance of anticipating new discoveries, including how people with different worldviews are likely to react to them (Race et al. 2012). What might be done to communicate new findings to diverse audiences? Will the public accept or reject these new discoveries, and, if accepted, how will they incorporate them into existing cultural and subcultural narratives? What impact might they have on space entrepreneurs and industrialists? What kinds of social change might we expect? How is it possible to turn new findings into building blocks for understanding discoveries that are yet to come? The societal roadmap provides a useful resource for researchers at the juncture of astrosociology and astrobiology.

SETI, the scientific search for extraterrestrial intelligence outside of our solar system, began in 1960 when theoretical calculations and advances in technology prompted Frank Drake to initiate a radio telescope search in 1961 (Drake 2011). Search strategies seek indicators such as a focused radio beam, a pinpoint of light, or an artifact, which are indisputable products of nonhuman technology. Among SETI researchers, the astrosociological component is known as "the cultural aspects of SETI" or CASETI. John Billingham provided much of the leadership here. He was an aviation and space physician who, after his shift to SETI, became a strong advocate of interdisciplinary research (Billingham 1998; Billingham et al. 1999; Harrison 2013). Billingham was fond of saying that we need to apply all of the "gray matter" that we can to SETI, and he hoped that by attracting to SETI, the top scholars in various disciplines, others within the discipline, would follow suit.

As defined by Billingham (1998, p. 711), CASETI includes "all thinking about ETI [extraterrestrial intelligence] going back to the classical era, the immediate [consequences] of detection, and indeed the science and engineering of SETI as set in the context of human activity." Within a year of Drake's first search, the National Science Foundation sponsored an interdisciplinary workshop at the National Radio Astronomy Observatory, and within the first 10 years, SETI had recruited scholars from anthropology, archeology, linguistics, history, and sociology to join the conversation. Based on workshops held at NASA – Ames Research Center in the 1970s – a comprehensive report on SETI included commentary on religion, societal responses, and the kinds of studies that might be done in preparation for contact (Morrison et al. 1976). By the 1990s, CASETI had become a regular part of annual International Astronomical Federation conferences and were featured in special issues of the peer-reviewed journal *Acta Astronautica*, but very little seems to have made it into premiere social science journals. Over the years, the cultural aspects of SETI have been the focus of many conferences and have surfaced in new venues, including regional sociology meetings and national anthropology conventions. There is a relatively abundant and growing interdisciplinary literature including overviews (Harrison 1997, 2007;

DOI 10.1007/978-3-319-04033-2_79-1

Michael 2014; Michaud 2008; Tough 2000) as well as more specialized fare (Traphagan 2014; Weintraub 2014), though convincing more social scientists to participate remains a critical challenge (Harrison 2011a). The SETI Institutes' Douglas A. Vakoch has edited several truly multidisciplinary books (Vakoch 2011, 2013a, b, 2014; Vakoch and Harrison 2011). The significance of studying SETI (and astrobiology) utilizing scientists and scholars from both major branches of science becomes clear when one considers the implications of detecting extraterrestrial life in any form and how such a discovery could alter societies and their cultures in ways not totally predictable based on today's incomplete data (Harrison 2011b).

Astronomers, planetary scientists, and other physical scientists involved in the protection of the Earth from asteroids and comets (planetary defense) have shown remarkable interest in contributions from social scientists including them at planetary defense meetings held on an intermittent basis. This acceptance is evident in the International Academy of Astronautics Cosmic Study Group's report on *Dealing with the Threat to Earth posed by Asteroids and Comets* edited by Ivan Bekey (2009). Here, we find chapters on organizing for the task, behavioral factors and planetary defense, and policy implications. The science agenda includes identifying potentially hazardous near-Earth objects, calculating and recalculating orbits to estimate when (and to a lesser degree, where) they will strike, and inventing and deploying devices to deflect or destroy the object. The societal agenda includes promoting international planning, performing risk assessments that take subjective assessments and emotions into account, and preparing for warnings and evacuations, an initial emergency response, and long-term recovery efforts (Race et al. 2012).

It is not entirely clear why astrobiology, SETI, and planetary defense embraced social science from the start while the early space program was resistant to involving social science. Quite possibly, cold war politics and the goal of beating Russia to the Moon worked against social science. The space program was highly organized and controlled, the time schedule was tight, and anything that portrayed NASA or the astronauts in an unfavorable light were, from an administrative point of view, threats. Social science research had the potential of revealing a flawed organization or preventing serious imperfections in the astronauts. From the start, astrobiology, SETI, and planetary defense became as international efforts. Whereas the great Moon race was a win-lose contest between American and Soviet ways of life, astrobiology, SETI, and planetary defense offer a superordinate goal, on the whole, a win-win activity. NASA is highly involved in astrobiology and planetary defense (not SETI), but is not hegemonic and welcomes international participants. Perhaps this open approach reduces the potential damage that could have resulted from the broad-based consultation and interdisciplinary activity. In any event, successful astrosociological research requires taking the vested interests of organizations and participants into account.

Areas of Future Astrosociological Education and Research Efforts

Astrosociology has gone through a number of growing pains, though it has managed to move forward. Most of the first 10 years of development focused on introducing the field to the space and social science communities and on making the case for its relevance and thus necessity. In 2008, the incorporation of the nonprofit organization known as the Astrosociology Research Institute, or ARI, in California became a reality. Its mission remains the development of astrosociology as an academic field, though on a much more formal basis. Furthermore, over the last 3 years or so, the transition to the pursuit of educational and research-oriented actions has accelerated.

Astrobiology includes a strong educational component that bodes well for the future aimed at scientists and technicians, social scientists, humanists, and the public. This is intended to build solidarity across interest groups, increase interdisciplinary and multidisciplinary activities, and smooth the course of our progress in space by minimizing unpleasant surprises or "unintended consequences" (most of which can

DOI 10.1007/978-3-319-04033-2_79-1

be foreseen and dealt with if the right skill mix is involved). Thus far, this educational component includes:

1. Implementing efforts to incorporate astrosociology into existing social science and humanity programs and disciplines, as well as those that integrate the field into STEM programs
2. Providing information, resources, and new developments via the ARI website
3. The *Astrosociological Insights* newsletter
4. Publishing the new free online peer-reviewed *Journal of Astrosociology* (JOA) scheduled for introduction in early 2015

Rigorous theory building and credible research efforts must characterize the future of astrosociology's development. Original astrosociological research remains the last area that still needs considerable development, which will become a high priority starting in 2015. One of the goals is to build a permanent astrosociology community so that interdisciplinary science can continue as space increasingly affects humans who remain on Earth and those who decide to migrate beyond. This research community, we hope, will be self-sustaining long after the Institute passes from the scene, if that should occur.

The social sciences and sociology, in particular, have accumulated more than 200 years of empirical findings, a great many of which are relevant to the relationship between space and society. Borrowing existing theoretical concepts and reviewing relevant research findings represents a good start. Moreover, new astrosociological research could add much to the STEM approach, again to achieve a more holistic understanding of how astrosocial phenomena integrate with terrestrial social forces and how it affects social conditions and influences social change. Astrosociology can serve as an impetus for a new paradigm that unites all the social science and STEM disciplines in new ways so that all scientists interested in space research can collaborate to accelerate progress in several dimensions of social life.

The human dimension affects spaceflight, settlement, resource exploitation, and other related matters whether the humans involved are in space or on the surface of the planet Earth. Even those not directly involved benefit. Even those who openly criticize space programs as wastes of human effort and funding enjoy space program applications as they voice their objections often over calls from the cell phones while avoiding severe climate conditions that they learned about from their weather apps based on data analyzed from overhead satellites. Astrosocial phenomena are pervasive in our cultures, subcultures, societies, and everyday lives, and we need to recognize them as such.

Conclusion

We have illustrated some of the historical difficulties inherent in getting unlike-minded scientists to cooperate so that scientific and technological convergences are more likely to occur. We also provided several examples regarding the tremendous potential successes that convergence activities can bring about if all types of sciences from both branches of science participate. The future of space exploration cannot reach its greatest potential if social science participation and acceptance remain at their current levels.

Technological and scientific progress as the future unfolds depends on convergences among fields and disciplines, especially those that have rarely cooperated in the past. Natural and physical sciences have made tremendous breakthroughs on their own, and perhaps even greater ones through interdisciplinary efforts within the traditional "hard" branch of science that focuses on space. Moreover, societal leaders, ethics experts, and social scientists have decided or at least influenced how new scientific and technological advances were to be used. However, the level of focus on how astrosocial phenomena affect individuals, their social groups, cultures, societies, and the international community has remained

DOI 10.1007/978-3-319-04033-2_79-1

surprisingly inadequate. The creation of the field of astrosociology addresses this inattention so that a formalized effort focuses on this void (Pass 2006) and on this astrosociological frontier that social scientists have scarcely investigated.

The status quo reveals relatively very little input from social scientists regarding space-related matters. Nevertheless, the future of space education and research depends on increased convergences. It will prove increasingly valuable as humankind moves farther away from the planet Earth. What most people – including all brands of scientists and scholars – too often fail to take seriously is the fact that outer space already affects societies and the lives of their citizens on a daily basis, and this influence will only grow stronger over time if science and technology continues to advance at even a moderate pace. Societies will continue to benefit in yet unforeseeable ways as long as space remains relatively important among policymakers, universities, and corporate leaders, not to mention the public.

The timescale of this advancement, should it continue, will depend largely on the level of resistance to new scientific and technological breakthroughs on a number of different fronts. Some resistance will occur even against announcements to pursue particular courses of research that appear to benefit humankind and society, and thus future social movements may develop aimed at disrupting others' plans. Cultural lag is a common structure feature of any society, which occurs when inevitable technological change in the (physical) material culture outpaces nonmaterial culture (ideas) causing resistance (Ogburn 1922), as various subcultures possess conflicting agendas and priorities. To be sure, a large segment of the population possesses various levels of distain for space exploration and especially new technological advances. This give-and-take dynamic process is part of a convergence-divergence process (Roco and Bainbridge 2013). Nevertheless, it remains possible to transcend what humankind currently considers as "normal" progress, as history has shown.

What can convergences accomplish in the area of outer space education and research? The general theme of this chapter, then, focused on two distinct types of convergence strategies. First, cooperative ventures among social scientists within the single branch of social science fields and disciplines require much greater action. As a starting point, however, a much larger proportion of social scientists must take space issues more seriously and pursue astrosociological education and research. Convergences within the social sciences can yield heretofore unattainable outcomes, to be sure, but they will still be limited. It is probable that this type of formalized interdisciplinary pattern must reach a certain threshold for the second type to become prevalent. Indeed, informal pilot programs and ventures will probably be required to move this trend forward.

The second type of convergence becomes possible by moving beyond the fields and disciplines within either of the two branches of science. When adding the social sciences to the traditional approaches dominated by the STEM subjects and thus introducing astrosocial phenomena to the equation, social and cultural forces become much more prominent and central to the scientific investigations carried out. Traditional approaches to space education and research, and those focusing on astrosocial phenomena, when purposely tied together, can offer new insights into both (1) how humans can better live with each other in confined extraterrestrial ecosystems and (2) how humans on Earth can take better advantage of terrestrial environments and resources.. The latter type of scenario most immediately benefits humankind, though over time, both benefit human beings wherever they happen to reside.

The future is wide open, and new convergence strategies can accelerate humankind's progress in science and technology beyond what is possible by either branch of science alone. A higher level of collaborative synergy is possible. New forms of collaborative synergies involving all sorts of combinations of scientific fields and disciplines centering on outer space issues have begun, to be sure, but they remain in their infancy and still lack enough input from the social sciences to result in truly unanticipated developments. Indeed, the design of the field of astrosociology resulted as an attempt to bring the social sciences into the space age. However, one of the more important targeted outcomes

DOI 10.1007/978-3-319-04033-2_79-1

focuses on providing a rallying point for convergence-based advancements to become possible and more mainstream. With this in mind, it is safe to state that humankind is just beginning to take advantage of scientific and technological convergences that may well transform the world, with important contributions focusing on astrosocial phenomena firmly established as a new dimension of space education and research.

However, it cannot be overstated that this is only possible if scientists purposely work toward new convergences within their own branch of science and, more importantly, work toward convergences with those in the other branch. As such, natural and physical scientists should read this chapter, and perhaps surprisingly to many not familiar with astrosociology, social scientists should to do so as well. Otherwise, the human dimension of space will continue to fall under the radar of the space community, resulting in inevitable one-dimensional analyses, thus slowing progress in space exploration as well as resulting in poor management of the Earth's resources and its environment. Once again, it must become clear to all that astrosocial phenomena affect human beings, their societies, and their cultures, wherever they may be, even within the confines of the Earth's atmosphere and magnetic field.

Acknowledgements

This chapter is dedicated to my co-author and dear friend Al Harrison who passed away shortly after finishing his contributions to these chapter contents. He was both as a kind person and a major contributor to space education and research from a social scientific perspective. As our first Advisor, Dr. Harrison was a great supporter of astrosociology and the Astrosociology Research Institute (ARI). In fact, he was a pioneering researcher in astrosociology long before it was established! His input greatly improved the quality of this chapter.

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