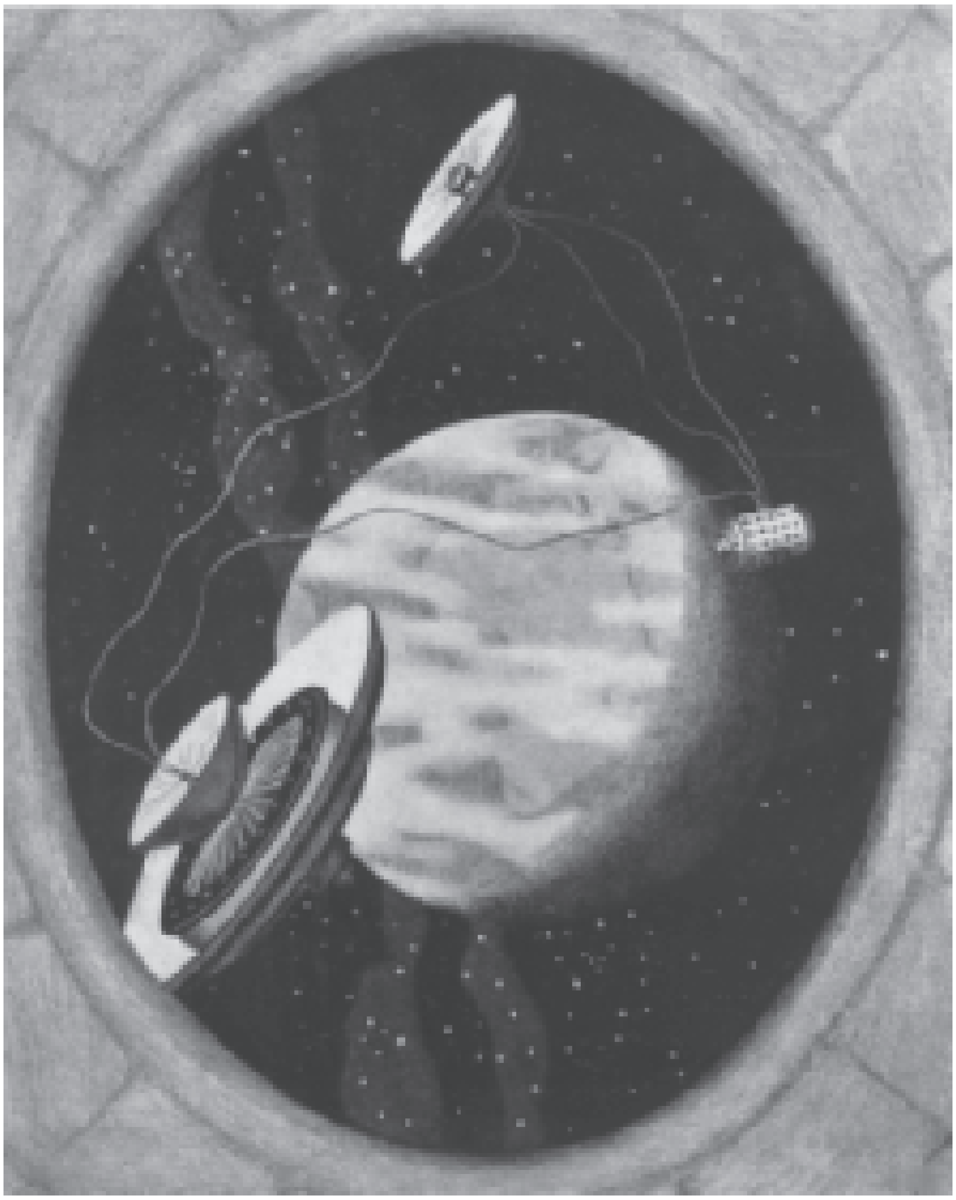
Have We Exhausted What We Can Do with the International Space Station?

by Roger D. Launius

The International Space Station (ISS) was a long time in the coming. From virtually the beginning of the twentieth century, those interested in the human exploration of space have viewed as central to that endeavor the building of a massive Earth-orbital space station that would serve as the jumping off point to the Moon and the planets. Always, space exploration enthusiasts believed, a permanently-occupied space station was a necessary outpost in the new frontier of space. But having achieved the reality of a space station, are we at the point where we have exhausted our commitment to the space station into the future?

The Columbia Accident Investigation Board (CAIB) concluded in 2003 that the Space Shuttle should be retired in 2010—later extended to 2011—and President George W. Bush declared in 2004 that the International Space Station should also be retired in 2020. Ending both of those programs would also end the long envisioned infrastructure for getting humans off this planet and enabling them to go elsewhere in the solar system. Many people believed that the 2020 retirement date for ISS would be extended, perhaps by as much as a decade, to get some serious utilization of its capabilities. Now, with a National Academies study of human spaceflight underway there is renewed interest in ending the ISS program, with the intention of taking the annual funding dedicated to that effort and re-vectoring it toward the Space Launch System (SLS) and the development of deep space human capabilities.

Whether or not ISS is retired in 2020, any discussion of doing so should be informed with an understanding of the historical evolution of a space station. Why did NASA and its international partners spend almost twenty years designing and building ISS, and why have these same nations kept

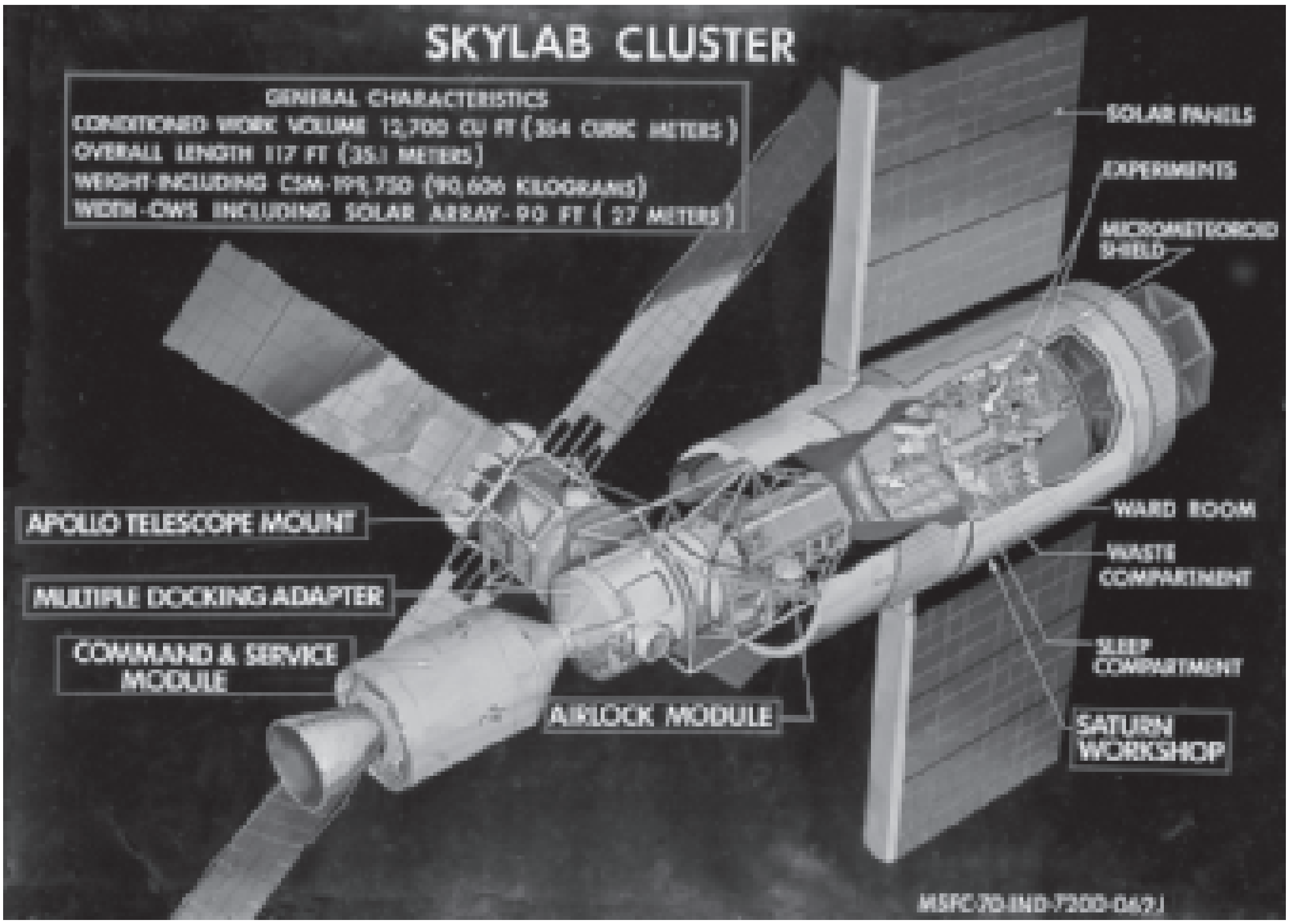


Hermann Noordung (1892-1929) wrote Das Problem der Befahrung des Weltraums (Berlin: Richard Carl Schmidt and Co., 1929), one of the classic early works about spaceflight. Its author, whose real name was Hermann Potoĉnik, was an obscure engineer in the Austrian army who, inspired by the work of Hermann Oberth, prepared the first detailed technical designs of a space station. Here we see Noordung's depiction of the complete space station with its three units, seen through the door of a space ship. In the distance is the Earth, some 26,000 miles away. In Noordung's 1929 illustration the station hovers in geosynchronous orbit on the meridian of Berlin, approximately above the southern tip of Cameroon (Source: NASA) a crew aboard the station since 2000? There had to have been a purpose or several of them; only an investigation of the historical story yield insights in this arena.

There is a long record of dreams about a space station, from the musings Russian schoolteacher Konstantin E. Tsiolkovskiy through Austrian engineer Hermann Noordung to the salesmanship of German émigré Wernher von Braun and beyond. Everyone seemingly accepted the vision of a space station facilitating the human exploration of the cosmos. Accordingly, studies of space station configurations had been an important part of NASA planning in the 1960s and the *Skylab* of the 1970s was the tangible result of these conceptions.

NASA scientists and engineers emphasized a space station because it met the needs of the agency for an orbital laboratory, observatory, industrial plant, launching platform, and drydock. The station, however, was forced first to the bottom of the priority heap in 1961 with the Kennedy decision to land an American on the Moon by the end of the decade. With that mandate, there was no time to develop a space station in spite of the fact that virtually everyone in NASA recognized its use for exploration beyond Earth orbit. It remained near the top of all Apollo follow-on programs even as the Moon landing became a reality in the latter 1960s, but took several unusual turns before emerging as the principal project of the agency at the end of the twentieth century.

Of course NASA built a relatively small orbital workshop, *Skylab*, that could be tended by astronauts and operated in 1973 and 1974. During the three missions to *Skylab*, a total of nine astronauts occupied the workshop for a total of 171 days and 13 hours. In *Skylab*, both the total hours in space and the total hours spent in performance of EVA under microgravity conditions exceeded the combined totals of all of the world's space flights up to that time. NASA was also delighted with the scientific knowledge gained about long-duration space flight during the *Skylab* program despite the workshop's early and reoccurring mechanical difficulties. It was foremost the site of nearly 300 scientific and technical experiments. It would be, NASA officials hoped, the precursor of a real space



This illustration shows general characteristics of the Skylab with callouts of its major components. In an early effort to extend the use of Apollo for further applications, NASA established the Apollo Applications Program (AAP) in August of 1965. (Source: NASA Photo No. MSFC-0101537) station. Eventually, on July 11, 1979 *Skylab* reentered the Earth's atmosphere and disintegrated. It was an inauspicious ending to the first American space station, not one that its originators had envisioned, but it had opened some doors of understanding and had whetted the appetite for a full-fledged space station.

Meantime, NASA pursued the Space Shuttle program, an effort viewed as necessary to reduce the cost and complexity of space access. This winged, reusable vehicle had long been viewed as merely a logistical craft to travel between Earth and the space station but would now become a program in its own right. High hopes abounded for the Space Shuttle following that first launch of *Columbia* on April 12, 1981, but the program failed to achieve its goal of routine, cost-efficient access to space.

With *Skylab* gone from the scene after 1979, and the coming on line of the Space Shuttle as a system in 1981, NASA returned to its quest for a real space station as a site of orbital research and a jumping off point to the planets. In a measure of political acumen not seen often previously, NASA administrator James M. Beggs persuaded President Ronald Reagan, against the wishes of many presidential advisors, to endorse the building of a permanently-occupied space station. In a "Kennedyesque" moment in 1984, Reagan declared that "America has always been greatest when we dared to be great. We can reach for greatness again. We can follow our dreams to distant stars, living and working in space for peaceful, economic, and scientific gain. Tonight I am directing NASA to develop a permanently manned space station and to do it within a decade."

Space Station Freedom concepts early hit on two major designs. The first of these was the "dual keel" design. The second major design for Space Station Freedom was the "power tower" concept depicted here. Ultimately selected as the reference configuration by NASA in 1985, the power tower mounted solar arrays at the top of the trusses and modules and most experiments at the bottom. (Source: NASA Photo No. 85-HC-244)

In 1985 the space agency came forward with designs for an $8 billion dual-keel space station configuration, to which were attached a large solar power plant and several modules for microgravity experimentation, life science, technical activities, and habitation. This station also had the capacity for significant expansion through the addition of other modules.

From the outset, both the Reagan administration and NASA intended Space Station *Freedom*, as it was then called, to be an international program. NASA leaders negotiated international agreements among thirteen nations to take part in the Space Station *Freedom* program. Japan, Canada, and the nations pooling their resources in the European Space Agency (ESA) agreed in the spring of 1985 to participate. Canada, for instance, decided to build a remote servicing system. Building on its Spacelab experience, ESA agreed to build an attached pressurized science module and an astronaut-tended free-flyer. Japan's contribution was the development and commercial use of an experiment module for materials processing, life sciences, and technological development. These separate components, with their "plug-in" capacity, eased somewhat the overall management (and congressional) concerns about unwanted technology transfer.

Almost from the outset, the Space Station *Freedom* program was controversial. Most of the debate centered on its costs versus its benefits. One NASA official remembered that "I reached the scream level at about $9 billion," referring to how much U.S. politicians appeared willing to spend on the station. As a result, NASA designed the project to fit an $8 billion research and development funding profile. For many reasons, some of them associated with tough Washington politics, within five years the projected costs had more than tripled and the station had become too expensive to fund fully in an environment in which the national debt had exploded in the 1980s.

NASA pared away at the station budget, in the process eliminating functions that some of its constituencies wanted. This led to a rebellion among some former supporters. For instance, the space science community began complaining that the space station configuration under development did not provide sufficient experimental opportunity. Thomas M. Donahue, an atmospheric scientist from the University of Michigan and chair of the National Academy of Sciences' Space Science Board, commented in the mid-1980s that his group "sees no scientific need for this space station during the next twenty years." He also suggested that "if the decision to build a space station is political and social, we have no problem with that" alluding to the thousands of jobs associated with it. "But don't call it a scientific program."

Redesigns of Space Station *Freedom* followed in 1990, 1991, 1992, and 1993. Each time the project got smaller, less capable of accomplishing the broad projects originally envisioned for it, less costly, and more controversial. As costs were reduced, capabilities also had to diminish, and increasingly political leaders who had once supported the program questioned its viability. That Congress did not terminate the program was in part because of the desperate economic situation in the aerospace industry—a result of an overall recession and of military demobilization after the collapse of the Soviet Union and the end of the Cold War—and the fact that by 1992 the project had spawned an estimated 75,000 jobs in thirty-nine states, most of which were key states such as California, Alabama, Texas, and Maryland.

Politicians were hesitant to kill the station outright because of these jobs, but neither were they willing to fund it at the level required to make it a truly viable program. Barbara Mikulski (D-MD), chair of the Senate Appropriations subcommittee that handled NASA's budget, summarized this position, "I truly believe that in space station *Freedom* we are going to generate jobs today and jobs tomorrow—jobs today in terms of the actual manufacturing of space station Freedom, but jobs tomorrow because of what we will learn."

In the post-Cold War era, furthermore, NASA found a new ally for the space station program in Russia. In the spring and summer of 1992 the two nations began negotiations to undertake cooperative human spaceflight efforts. This was remarkable because of the more than forty years the two nations had been locked in a desperate Cold War in which the world came to the brink of annihilation through nuclear confrontation on more than one occasion. To seal those negotiations, on October 6, 1992, NASA administrator Daniel S. Goldin and Russian Space Agency director Yuri Koptev signed two cooperative agreements in Moscow regarding human spaceflight. Later agreements brought Russia into the international consortium building the space station. Accordingly, just as the Cold War was the driving force behind expansive budgets for space exploration in the 1960s and continued to influence expenditures in the 1970s and 1980s, its end was a critical component in the search for a new space policy for both the United States and Russia in the 1990s.

Couple that with a redesign of the space station resulting from the new administration of President William J. Clinton in 1993, and the space station took on both a new look and mission, cementing international relations between the world's two Cold War superpowers. John M. Logsdon, the godfather of the space policy community in Washington, noted of the events of the 1990s that it was remarkable that the space station program had survived the political turns of the decade. In the past, he commented, it had enjoyed weak support, both internationally and domestically. He noted:

> Even with all its difficulties and compromises, the space station partnership still stands as the most likely model for future human activities in space. The complex multilateral mechanisms for managing station operations and utilization will become a *de facto* world space agency for human space flight operations, and planning for future missions beyond Earth orbit are most likely to occur within the political framework of the station partnership.

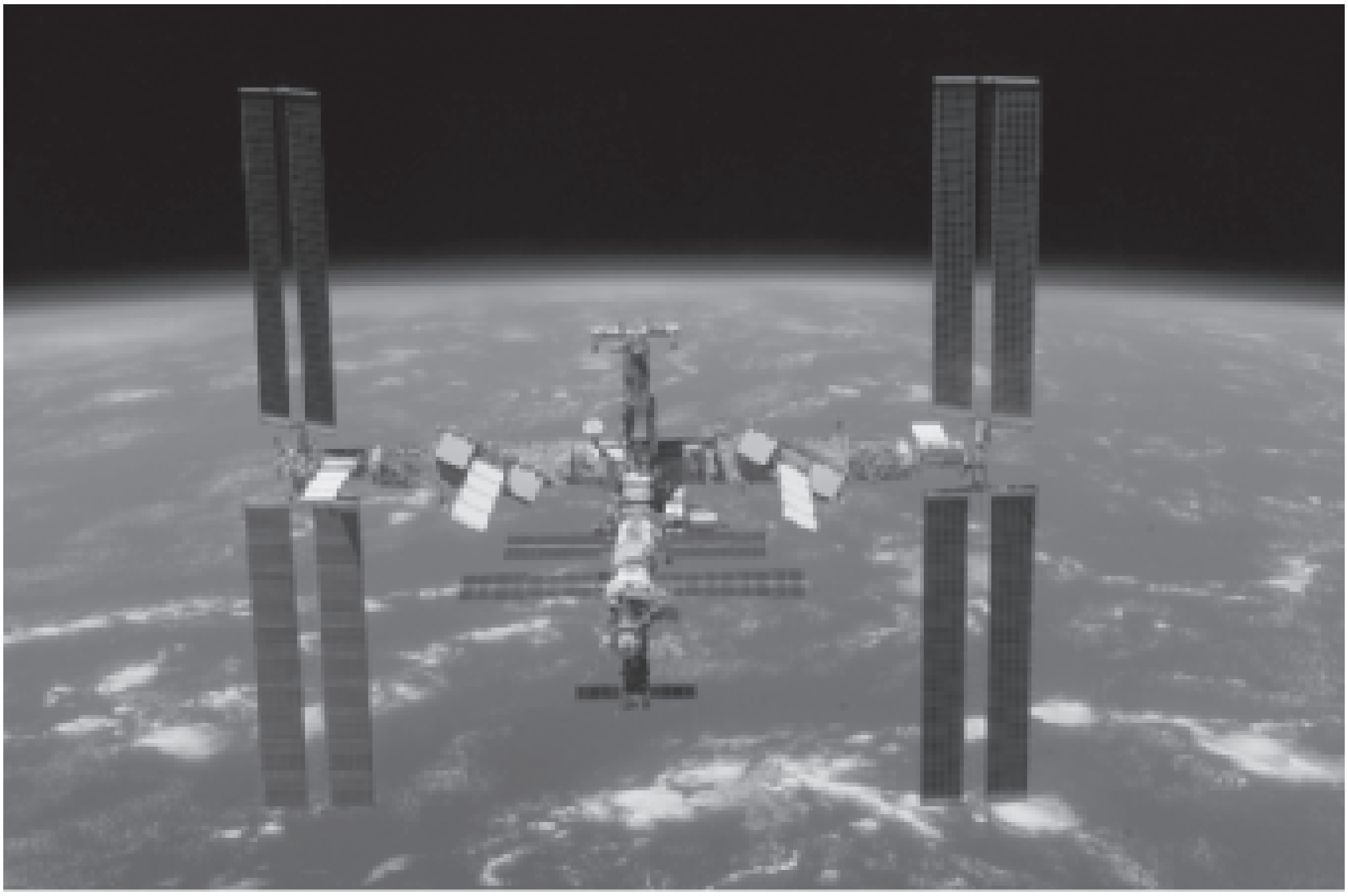
As the first two station modules, *Zarya* and *Unity*, were launched and joined together in orbit in late 1998 several other components were nearing completion at factories around the world. Orbital assembly of the now christened International Space Station (ISS) began a new era of hands-on work in space, involving more spacewalks than ever before and a new generation of space robotics. The Space Shuttle and two types of Russian launch vehicles undertook no fewer than 46 missions to assemble the station.

On October 31, 2000, a momentous occasion arrived when the first crew to occupy the International Space Station inaugurated a new era in space history. When American astronaut Bill Shepherd and Russian cosmonauts Yuri Gidzenko and Sergei Krikalev lifted off in a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan en route to their new home aboard the ISS, it represented the last day in which there were no human beings in space. Shepherd served as commander of Expedition One, the first of several crews to live aboard the space station for periods of about four months.

Even so, much discussion about ISS has devolved into a debate over its purpose. Space stations, which have so dominated thinking about human space exploration throughout the twentieth century, had always been envisioned as launching points for any mission to the Moon or Mars. Using the space station as a base camp, according to this thought process, humanity would be able to return to the Moon and establish a permanent human presence there. Using the space station as a waypoint above the gravity well, it would no longer be quite so hard to go elsewhere in the Solar System. But it quickly became apparent that ISS, with its 51 degree inclination because of the need to accommodate Russian launches and its downsized capabilities, would have limited usefulness for that purpose.

At the same time, the expectation that ISS would become a centerpiece of research in orbit, what some have referred to as an "NIH in space," held certain attraction at least for a time. Who knew what manner of bio-technical discoveries might spring from research conducted there? Others have emphasized the station's significance as a laboratory for the physical sciences, with materials processing in microgravity the chief research effort. Still others suggested that human factors research might gain a leap forward because of the work on ISS, simply because data about changes to the bodies of astronauts engaging in long duration spaceflight would expand the base of scientific knowledge. Finally, some contended that ISS offered a platform for greater scientific understanding of the universe, especially about the origins and evolution of the Sun and the planets of this solar system. Those four scientific endeavors—bio-tech research, materials science, human factors, and space science—represented a panoply of scientific opportunities ballyhooed by advocates of the ISS.

The expectation of path-breaking research on-orbit continues to abound. In 2001 Representative Ralph M. Hall (then Democrat-Texas), speaking at the American Astronautical Society's Goddard Memorial Symposium, commented that while elements of ISS had been launched and crews placed aboard, he questioned NASA's resolve to utilize this new capability. He challenged NASA, "After all of the taxpayer dollars that have been invested in the Space Station, we will need to ensure that we wind up with the world-class research facility that we have been promised." As an aside to his prepared remarks, Hall added that NASA had better find a way to use the ISS effectively. He said that some astounding scientific discovery should be forthcoming—he specifically mentioned a cure for cancer—or the program could rapidly lose



View of the International Space Station (ISS) backdropped by the blackness of space and Earth's horizon. The ISS is moving away from the Space Shuttle Atlantis during STS-117. Arlantis and Expedition 15 crews concluded about eight days of cooperative work onboard the shuttle and station, and the two spacecraft undocked on June 19, 2007. Astronaut Lee Archambault, STS-117 pilot, was at the controls for the departure and fly-around, which gave Atlantis' crew a look at the station's new expanded configuration. (Source: NASA Photo No. S117-E-08045)

Astronaut Susan J. Helms, Expedition Two flight engineer in 2001, works at the Human Research Facility's (HRF) Ultrasound Flat Screen Display and Keyboard Module in the Destiny/U.S. Laboratory. (Source: NASA Photo No. ISS002-6699)

political support.

At a fundamental level, notwithstanding Ralph Hall's quixotic call for curing cancer, the spaceflight community cannot abandon serious efforts to utilize ISS. It plays into the hands of those who advocate a zeroing out of the human spaceflight effort in the United States. As the *New York Times* editorialized on November 25, 2001: "in truth, it has never been clear just what science needs to be done on a permanently manned platform in space as opposed to an unmanned platform or an earthbound facility." If humanity uses the space station neither as a base camp to go elsewhere nor as a facility for research, just what then is its purpose?

There has been no resolution to the issue of purpose in the ISS program. While humanity may take pride in establishing a permanent presence in space—the seeming task of space stations from the beginning of the twentieth century—if those stations do not serve as a means to facilitate something beyond one must question why they should be continued in the twenty-first century. Alex Roland, an historian from Duke University, has likened both the human presence on ISS and on the Space Shuttle as akin to flag-pole sitting. While he recognizes that a case could be made for it, Roland did not see it as a particularly compelling one. It ranges from the pragmatic to the mystical, from the fact that humans going elsewhere can respond creatively to unforeseen problems to the ethereal vantage point of a new place from which to view the universe. "The Space Station is simply a world-class flag pole," Roland commented in 2008. "Being there is an end in itself."

In answer to the question—"Have We Exhausted what We Can Do with the International Space Station?"—the answer is both yes and no. Perhaps the space station's time both came and went during the twentieth century. At present many observers are not finding its use compelling, at least not compelling enough to continue it beyond 2010. The dream of a permanent presence in space, made sustainable by a vehicle providing routine access at an affordable price drove space exploration advocates since at least the beginning of the twentieth century. All of the spacefaring nations of the world accepted that paradigm as the *raison d'etre* of its programs in the latter twentieth century. It drove the United States to lead an international consortium of nations to build ISS to achieve a permanent presence in space. Only through the achievement of these goals, space advocates have insisted, will a vigorous vision of space exploration that includes people venturing into the unknown be ultimately realized. This scenario makes eminent sense if one is interested in developing an expansive space exploration effort, one that would lead to the permanent colonization of humans on other worlds. It makes little sense if there is no consensus on this as an agenda for human activities in space.

At the same time, this vision has not often been consistent with many of the elements of political reality in the United States. Numerous questions abound in the early twenty-first century concerning the need for vigorous exploration of the solar system and the desirability of going to other worlds. Whatever direction for the future, when historians of 100 years hence analyze the space program of 2000 they will remark on the truly astounding international effort that made it a reality and the close cooperation of the U.S., Russia, and the other international partners that made the program a success. The ISS's lasting legacy is the manner in which it taught nations to work together to accomplish complex, high-technology efforts. Will the ISS become a blip on the chronology of international tension and strife or an exemplar of the future?

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SPACE TIMES is a magazine, as opposed to a technical journal, and articles are written in active voice with a clear explanation of technical concepts. The tone leans more toward conversational rather than formal. Articles are written for a well-educated audience that has a great interest in space topics but may not necessarily be familiar with your specific topic.

Virtually any topic involving space science, technology, exploration, law, or policy may be covered. Issues relevant to the civil, commercial, and military and intelligence space sectors alike are also welcomed.

Feature articles (600-3,500 words), op-eds (500-1,500 words), and book reviews (600 words or less) are accepted. Exceptions are handled on a case-by-case basis.

Articles must be submitted in Microsoft Word format, Times New Roman font, 10.5 pt. Other formatting is handled by the production manager during the editing process.

Submission of photos or other visual support is strongly encouraged but is not required. If graphics are submitted, the images must be provided in JPG format in high resolution of at least 300 dpi (CMYK for color and grayscale for black and white). PDFs may also be accepted, depending on the item. Caption(s) and source(s) of the image(s) must be provided.

Visuals may not be embedded in the final submitted article but must be provided separately. However, a copy of the article with the visuals embedded should be provided for layout purposes. Proof of permission from the owner of any photos or other visuals, or contact information for the owner if permission has not been secured prior to submission of an article, should be provided.

Articles must include: (1) a title; (2) a one to two sentence summary of the article for index purposes (optional); (3) if applicable, subheadings providing separation between major sections of the article; (4) a one to two sentence byline/author biography which will appear at the end of the article; and (5) the current mailing address of the author(s). Five complimentary copies of the issue in which the article appears will be mailed to each author. A PDF of the article will be emailed upon request only to the primary author. The full magazine is also available in PDF at www.astronautical.org.

The standard submission deadline is the 15th of the month prior to the issue date (i.e., December 15 for the January/February issue). Please submit articles or inquiries to dthompson@astronautical.org, or contact Diane Thompson at the AAS office at 703-866-0020.