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Human space exploration

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The next major step in human space exploration, going beyond LEO, will not be possible without multinational cooperation, say experts. The international space station program, despite its twists and turns, proved what countries can accomplish together and could serve as a model for a joint exploration effort. Over a dozen space agencies from around the world have begun discussions on coordinating long-range plans for such missions, which are likely to proceed in the future—with or without U.S. leadership.

NASA's plans for sending expeditionary crews

beyond LEO were sidetracked when President Barack Obama reset America's space agenda in April 2010, curtailing the Constellation program, which was to be an energetic plan of putting people back on the Moon, sending crews to Mars and beyond. Preparations for a human return to the Moon were halted outright. Top priority went instead to developing capabilities that would allow astronauts to visit near-Earth asteroids, orbit Mars, and ultimately make landfall on the Martian surface.

It has become increasingly apparent both to the U.S. and many other spacefaring nations that realizing any vision of sustainable space exploration beyond LEO will require greater global cooperation.

The success of the ISS project—hailed as one of the most advanced engineering achievements to date—underscores what is possible when spacefaring nations collaborate to pursue a shared strategy.

Looming large, however, is the cash-strapped condition of nations. The process of piecing together a long-term global space partnership is fraught with other challenges as well, from uncertainties regarding technical competence, to questions of interdependence and leadership acumen, to lack of political willpower.

Nonbinding international coordination

This month the Global Space Exploration Conference, organized by the International

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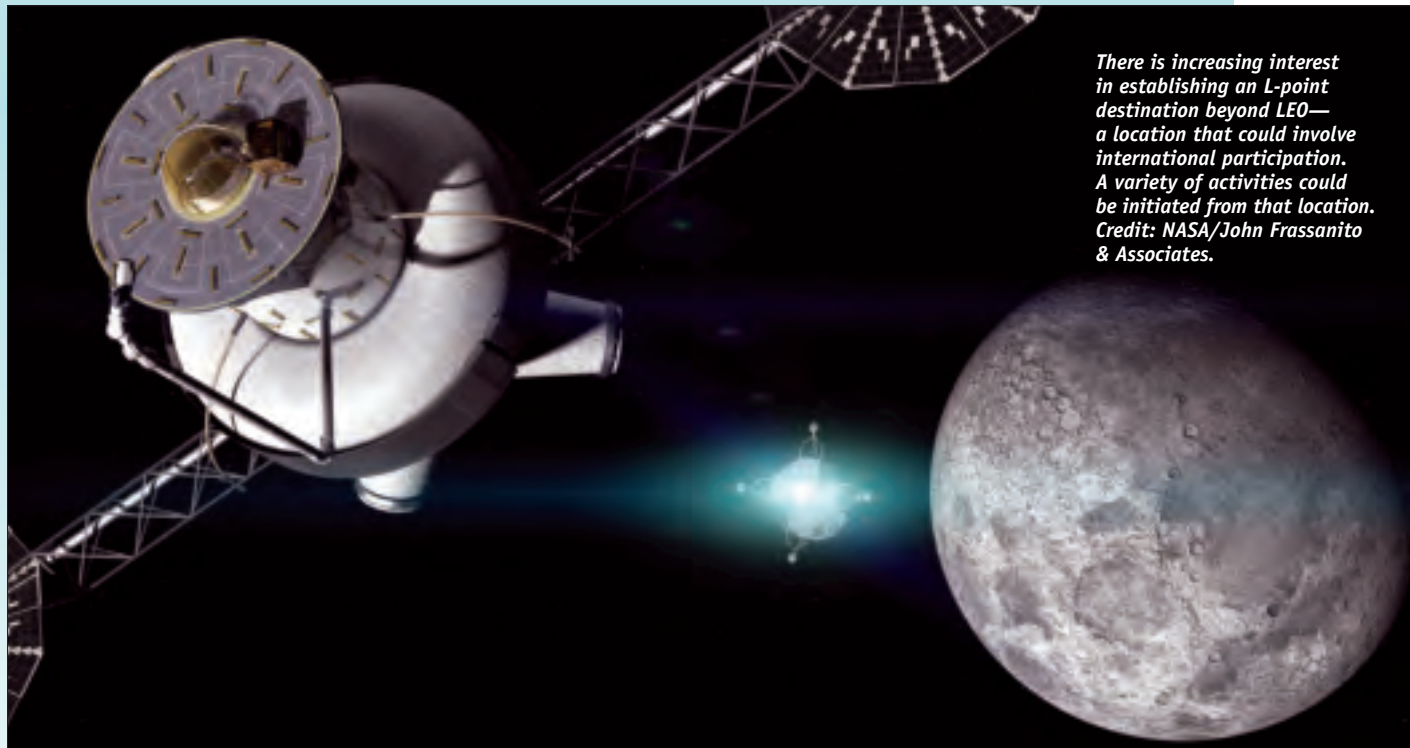
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Astronautical Federation and the AIAA, is serving as an international forum for discussions by major stakeholders in this arena—senior administrators and space exploration managers from the major space agencies, industry, governments, academia, and non-governmental organizations.

Sure to be a major topic at the conference is a recent publication by the International Space Exploration Coordination Group (ISECG), a voluntary, nonbinding international coordination forum.

ISECG has its roots in 14 space agencies whose members sat down together in 2006 to take a hard look at global interests in space exploration. The group seeks to enable a flow of information between agencies regarding interests, objectives, and plans in space exploration. The goal is to fortify both individual exploration programs and the collective effort.

Last year ISECG released the Global Exploration Roadmap, or GLEX for short. A long-range exploration strategy, it begins



There is increasing interest in establishing an L-point destination beyond LEO—a location that could involve international participation. A variety of activities could be initiated from that location. Credit: NASA/John Frassanito & Associates.

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by Leonard David
Contributing writer

ISECG participants

ASI—Italy

CNES—France

CNSA—China

CSA—Canada

CSIRO—Australia

DLR—Germany

ESA—Europe

ISRO—India

JAXA—Japan

KARI—Republic of Korea

NASA—United States

NSAU—Ukraine

Roscosmos—Russia

UKSA—United Kingdom

with the ISS and expands human presence in the solar system, leading ultimately to human missions to explore the surface of Mars. The roadmap flows from this strategy and identifies two potential pathways, Asteroid Next and Moon Next.

Each pathway is a notional mission scenario covering a 25-year period and presents a ‘logical sequence’ of robotic and human missions. Both were deemed realistic approaches that could address common high-level exploration goals developed by the participating agencies, recognizing that the groups’ preferences regarding the pathways may vary.

The document notes that “there is much work to be done before the risks associated with such missions can be reduced to an acceptable level and the required technologies are matured to enable a sustainable approach.”

The next iteration of the roadmap is expected later this year, with agencies hoping to elaborate on strategies laid out in the earlier document. There is also an eagerness to recognize additional opportunities for near-term partnerships that contribute to shaping sojourns beyond LEO.

ISS: A key factor

“We think about a coalition or partnership for exploration beyond low Earth orbit,” says Kathy Laurini, senior advisor, exploration and space operations, at NASA. She is the agency’s representative to ISECG, based in The Netherlands.

“There’s no question it’ll start with the strong partnership that’s formed by the ISS agencies. But there are a lot of other agencies out there that are emerging and have a lot of capabilities. It would be nice to bring them in,” Laurini tells *Aerospace America*.

The ISS is a key ingredient, a platform to showcase research and technology and

to enable innovation, she says, as well as to promote commercial cargo and crew operations. “So to the extent that ISS can drive those innovations, and make it cheaper for us to get to space, it helps governments really look beyond low Earth orbit.”

Deliberations in the ISECG arrive at a bottom line, says Laurini. “Going beyond LEO is the next step; it’s a question of when. Right now we’re doing cooperative work so that when budgets free up there are plans that are technically feasible, programmatically implementable...but have been developed collaboratively.”

Laurini says NASA cannot control the critical path of partner nations for moving beyond LEO. “It’s just too expensive. It is going to take all of us and several agencies on the critical path. So just finding the right roles for those agencies, that are consistent with their capabilities and their long-term goals...is a challenge.” But in the field of human spaceflight, “NASA is the glue. Agencies look to us for that role, frankly.”

The September 2011 first iteration of ISECG’s document presents a roadmap to Mars “mainly because there’s a big question about the next destination,” Laurini explains. “The fact is we don’t really need to decide right now. The idea is to be iterative over time, to serve as a tool to help align policies and plans. The ISECG is charting a way forward, one that is a collaborative vision and respects the fact you only get money if there’s a benefit to your stakeholders. Doing that and finding the common ground...that is always a challenge.”

The implications of humankind moving beyond LEO are global, says Laurini. “If you’re going to do it, you should do it internationally. There’s no better time than now to start the planning.”

Open-ended process

Bernhard Hufenbach heads the Exploration Architecture Office in the Directorate of Human Spaceflight at the European Space Research and Technology Center (ESTEC)—the technical heart of ESA in Noordwijk, Netherlands. “Global cooperation for future space exploration is not only a necessity, due to the resources required for implementing sustained exploration, but also a common goal as stated in the Global Exploration Strategy, considering derived broader socioeconomic benefits,” he says.

International partners in any future exploration must learn how to manage interdependency, notes Hufenbach. An impor-

High-level representatives from 41 countries, including the 29 ESA and EU states, took part in a recent international conference on space exploration in Lucca, Italy. Credit: Andrea Rossi, ESA.



tant enabler for this in an international program, he says, is a clearly defined governance scheme and overall cooperation framework.

The model applied for the ISS program can serve “as a good reference,” Hufenbach believes, one that has helped to forge a strong partnership and to mitigate the consequences of various crises that arose during the project.

But there are differences between the two programs, Hufenbach stresses.

“Exploration is an open-ended process, composed of multiple missions to different destinations with potentially varying partners, driven by a very long-term vision,” he says. Today, the boundaries of a particular ‘international program’ in this process are not defined. The governance scheme and cooperation framework for exploration must address long-term strategic planning, as well as the implementation of incremental steps through dedicated programs. “It needs to be flexible and easily adaptable to cope with change of partners and mission scenarios,” he concludes.

“There is a question mark over whether the ISS model is the right one to adopt,” says Ian Pryke, a senior fellow at George Mason University’s Center for Aerospace Policy Research. “Whether you take an ISS model or whether you’ve got to evolve some different model remains to be seen.”

One hurdle overcome in the ISS program, Pryke recalls, was worrying about having station partners on the critical path. Fast forward to today: As long as the station is there, he contends, “you’ve got a number of space agencies that are locked into working together. And they are doing it on a daily basis. That creates a positive background for whatever you do in the future.”

Pryke notes that the ISECG has been careful to put the emphasis on coordination rather than cooperation. “Today, it’s very hard to talk about modes of cooperation when you don’t know exactly what you would be cooperating on,” he says.

Leadership vacuum?

A question raised by Max Grimard of EADS Astrium in France is: Will the U.S. remain the real leader of human space exploration? His assessment is that human space exploration is at a turning point, and should find its direction during the coming decade.

Grimard presented his personal view at the 2011 International Astronautical Congress in Cape Town, South Africa: “Today,



The ISS is an exemplar of lessons learned for orchestrating any global program of human travel beyond LEO. Credit: NASA.

U.S. exploration plans are sucked down into political battles, Europe and Japan are nearly nowhere, Russian plans are hazy, China’s ambitions are clear and implemented, and new actors such as India are raising their profile.”

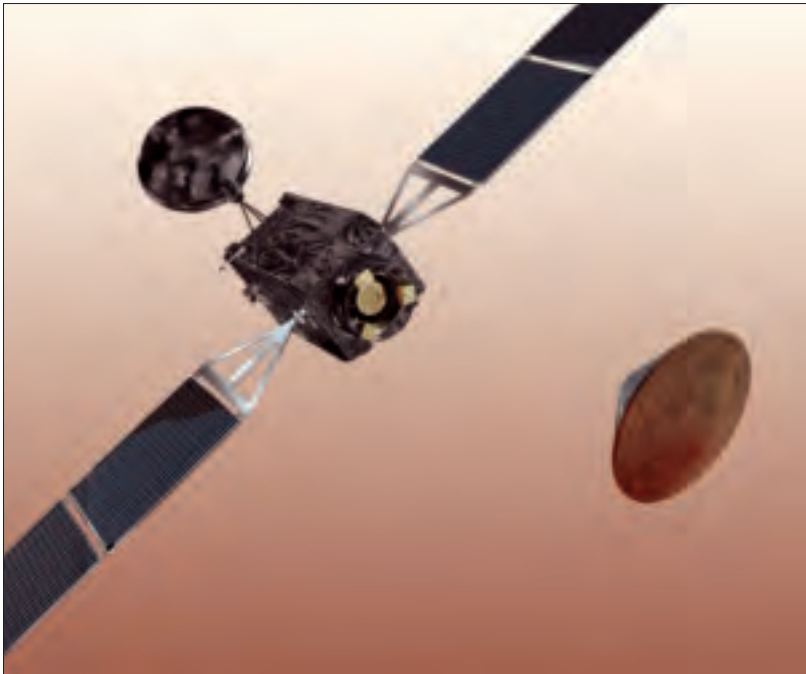
Given that appraisal and the uncertainties of the current environment, his next question is straightforward: Who will be the leaders of human space exploration 10-15 years from now?

Grimard believes four key factors are driving the dynamics of human space exploration: the general budget situation, human space exploration within a country’s political agenda, budget competition for resources, and political stability during long-term exploration ventures.

There is a strong consensus that the next big step for human space exploration, such as NEOs or Mars, will necessitate huge infrastructures that are not affordable by any one country, Grimard says. Even planting new footprints on the Moon will need international cooperation.

“Three of the ‘historical’ spacefaring countries—the U.S., Europe, Japan—have lost political momentum for human space exploration. They are facing very strong economic constraints and have more urgent priorities,” he says. Although the U.S. still has the largest civil space budget, the pressure of the debt crisis will deepen this loss of momentum, he believes. “Human space exploration is continuing more on ‘DNA obligation’ than on clear strategic objectives.”

Grimard forecasts that the U.S. will have difficulty generating an international initiative that embraces trusting partners. That is a paradox, he observes, in that the nation remains the most powerful and



The ExoMars descent lander (above) would deliver the rover (below) to a specific location using an inflatable braking device or parachute system. Using conventional solar arrays to generate electricity, the rover will be able to travel a few kilometers over the rocky orange-red surface of Mars.



highest spending country for human space exploration, “but it can hardly appear as a leader, due to its evasiveness.”

Considering the situation, Grimard advises that the booster of new initiatives in human space exploration could more likely be China rather than the U.S. in the coming decade—but not as a catalyst of an international effort. There is a high probability, he says, that China will pursue national ambitions ‘à la Apollo’ while the block of space station partners carry on human spaceflight in the framework of ISS and spend money trying to start a long-term initiative, without entering full-scale development.

If so, Grimard argues, this might lead to a global loss of momentum for meeting the ultimate objective: expanding the frontier of human space exploration toward the NEOs or Mars. That is, nobody is steering international partners in the structure of a worldwide endeavor. “The milestone for humans, to go outside the Earth-Moon system, might shift very far in the future,” he concludes.

Grace and goodwill

Dispatching an expedition to Mars has long been a drawing card, as the ISECG document demonstrates. Still, getting a lasting pledge between NASA and ESA to pull together the robotic ExoMars mission turned sour earlier this year.

ESA, in cooperation with NASA, had pieced together the ExoMars program to investigate the Martian environment and demonstrate new technologies paving the

way for a future Mars sample return mission in the 2020s. But NASA’s 2013 budget spelled out the disappointing news: The agency pulled out of a 2016 ExoMars mission and signaled a no-go on a follow-on 2018 mission. Meanwhile, ESA officials have begun looking at Russian support.

“The recent situation with Mars exploration demonstrates that even having an international cooperation agreement is no guarantee of success,” says Marcia Smith, president of Space and Technology Policy Group. Smith is also founder and editor of the informative SpacePolicyOnline.com.

“Perhaps the most regrettable aspect of the revised Mars plans is that we are renegeing on that 2009 agreement with ESA. After all, we are awash in Mars probes—already there, on their way, and to be launched—so I personally am not that concerned about possibly missing a Mars opportunity. But we did sign an agreement with ESA and now have to back off because of budget realities,” says Smith.

With so many unpredictable factors, Smith says she does not know of a solution. “I credit our international partners around the globe for being so flexible in working with us despite the twists and turns” in the station program, for example, and in use of the shuttle for ISS operations as promised.

“So, yes, international cooperation is critical, and I hope that our partners continue to show the grace and goodwill that they have in the past as our plans constantly shift,” says Smith.

Lack of coherence

“The upcoming GLEX conference is an important part of creating a broader international consensus on human explorations beyond low Earth orbit,” says Scott Pace, director of the Space Policy Institute at George Washington University’s Elliott School of International Affairs in Washington, D.C. “The United States will not be engaging in exploration without international partners, so realistic plans need to be developed in consultation with prospective partners.”

Pace’s survey article on this subject was published in the *Harvard International Review*. Organizing a broad international approach to space exploration and space security will not be easy, says the article, not least because of the errors and confusion in recent U.S. space policy statements, strategies, and programs.

Pace notes also that the U.S. has dimin-

ished its global influence by omitting the Moon as a focus for near-term human space exploration efforts, and by failing to cooperate with Europe on the next stage of robotic missions to Mars.

Moreover, there is a lack of general coherence regarding civil space exploration in the Obama administration's 2010 National Space Policy. It directed the NASA administrator to set "far-reaching exploration milestones"—specifically, by 2025, to begin missions beyond the Moon, including flying humans to an asteroid.

As later technical work has shown, says Pace, there are few scientifically attractive, technically feasible asteroids that can be reached on this schedule. Even worse, the international space community, which had been focusing its expectations on the Moon as the next U.S. target of exploration, "felt blindsided," he notes.

Asian countries like Japan, India, China, and South Korea had seen the Moon as a challenging but feasible destination for robotic systems, and a practical focus for human space exploration, Pace continues. The choice of an asteroid mission was, perhaps mistakenly, taken as an indication that the U.S. was not interested in broad international cooperation but would focus instead on partnerships with the most capable players—Russia, and perhaps European countries. As a result, spacefaring nations are increasingly making their own plans, separately from the U.S., he writes.

Pace explains that Asian space agencies have shown an interest in lunar missions as the logical next step beyond LEO. These missions are viewed as "ambitious but achievable" and hence more practical than trips to Mars or more distant locales. He believes that a program of multilateral exploration of the Moon would also be a symbolic and practical means of building a framework for peaceful space cooperation, in concert with dual-use discussions of space transparency and confidence-building measures, known in diplomatic shorthand as TCBMs.

Conditions for cooperation

John Logsdon, professor emeritus of political science and international affairs at the Space Policy Institute, agrees that a space exploration program can take place only through multilateral cooperation. "No country is going to do this on its own, as the U.S. did during Apollo," he says,

Logsdon adds, however, that the de-

sire for a program of human exploration "is not shared by everybody in the world." Convincing governments to invest public resources in a long-term, expensive proposition "is far from a slam dunk," he says.

First, when you start listing the conditions for cooperation, one is that the project must make a meaningful contribution (a provision that a number of countries can now meet). Another is financial necessity; but "the tricky one is political will," he says.

"The heads of space agencies can talk themselves blue in the face about how to do this...but until they can convince, both collectively and individually, their political



The Moon is seen as one of the likeliest targets of the Aurora program, a European long-term plan for the robotic and human exploration of the solar system. Credits: ESA - AOES Medialab.

and budget masters to commit to this kind of enterprise, it's not going to amount to anything," says Logsdon. "Cooperation is a political *and* budgetary act," he emphasizes, "and space agencies by themselves cannot make this happen."

Logsdon is among those who view ISS as a success story. The project shows that difficulties can be overcome and partnerships can work, he says. Nonetheless, the station program "hasn't all been sweetness and light. But the benefits of working together are so substantial," he says, "that they allow a partnership to persist over troubled times. No marriage is without its rough spots...nor is any large-scale cooperative project."

The joint U.S./USSR Apollo Soyuz Test Project was a key first step in international human spaceflight. This 1975 mission brought together in Earth orbit U.S. astronauts Thomas Stafford, Vance Brand, and Donald K. Slayton and Soviet cosmonauts Aleksey Leonov and Valeriy Kubasov. Slayton and Leonov pose together in the Soyuz orbital module during the docking mission.



The ISS is there. It works. And it works in a way that creates interdependence, most of all between the U.S., Russia, and Canada, Logsdon observes. “Japan and Europe are very much aware that they are less-than-equal partners,” he notes. “That’s because if their modules went away tomorrow, the station could still function. That puts them in a weaker bargaining position...and [is] why those countries say in fu-

ture cooperation they want interdependence, not one-way dependence.”

And what about China? “It takes two to tango...and I know that’s a cliché,” Logsdon responds. “A partnership takes willing partners. It’s not clear that China, at its current stage of space development, gives high priority to collaboration in human spaceflight.” He suggests that Chinese cooperation is almost a separate issue, in view of the burgeoning cooperation among current ISS partners and emerging space-capable states. “Also, people don’t talk a lot about this, but what are Russia’s desires for the next several decades? I think that’s an important element of this too.”

In the broader scheme of things, says Logsdon, orchestrating a sign-on-the-dotted-line global space adventure is a fragile exercise. “I’m not sure you can sneak up on this and wake up one day saying, ‘oh my heavens, we’re committed to sending people to Mars.’ There have to be specific point decisions to undertake voyages of exploration. The fundamental question is, are there enough governments interested in doing this to create a critical mass?” ▲




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