

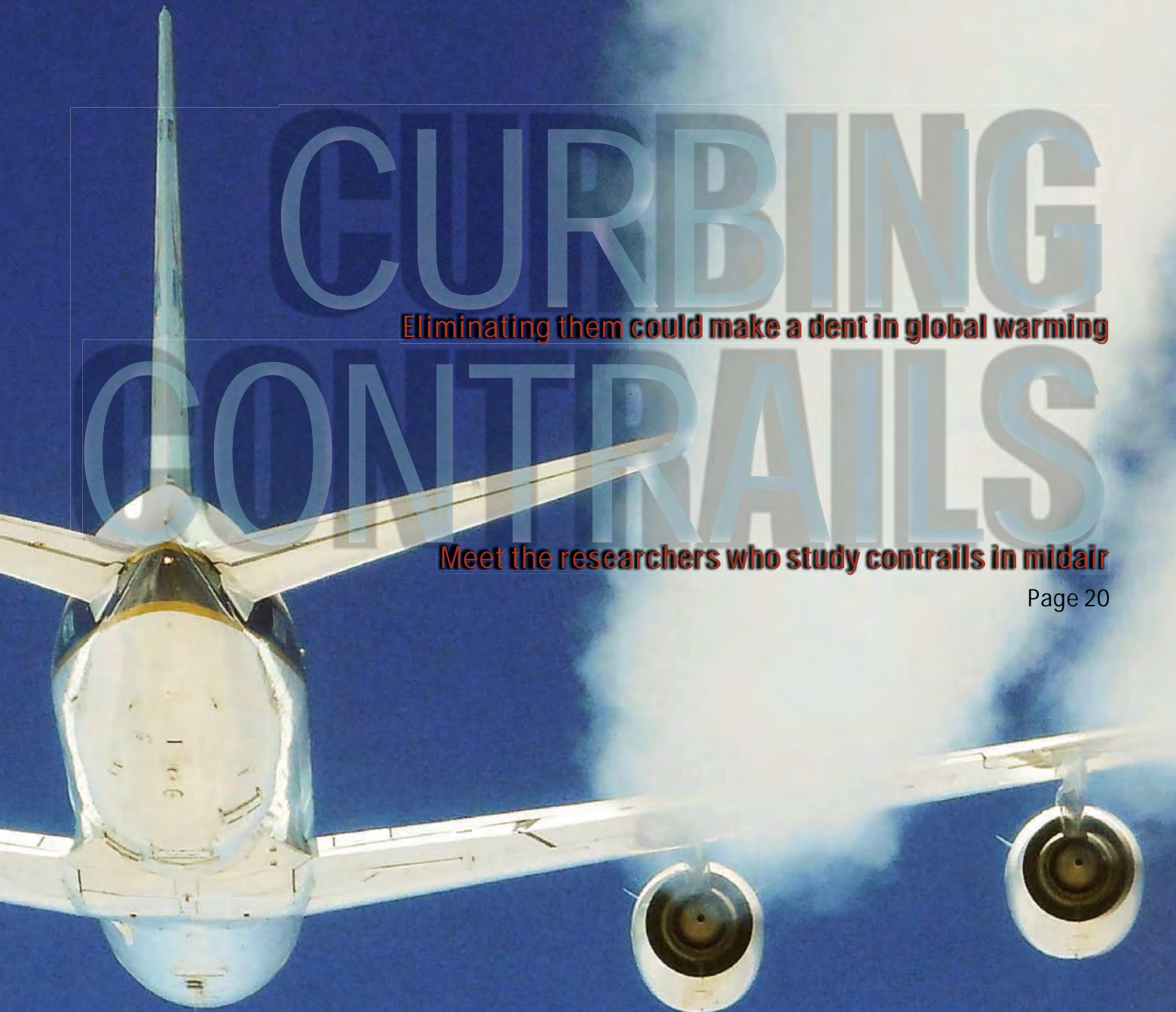
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International cooperation was all the rage after the fall of the Soviet Union and establishment of the International Space Station program in the 1990s. If humans were to colonize space for science and commerce, they would do so together as a multinational team. When Anatoly Zak traveled from the U.S. to the International Astronautics Congress in Jerusalem in October, he found a loss of consensus on the future of human space flight.



When top space leaders from the U.S., Russia, China and Europe gathered at the International Astronautics Congress in Jerusalem in October, there was no missing their mismatched and uncoordinated strategies in human space flight agendas. In a nutshell: NASA sounded eager to go to Mars; the European Space Agency discussed building an international “Moon Village”; China talked about building an Earth-orbiting space station of its own; and Russia discussed preparations for a lunar mission and for separating its modules from the International Space Station after 2024 to create its own station.

ANALYSIS

The new standard seems to be to defy the cliché that no country can succeed in space exploration without partners and that joint missions in space should improve relations on Earth. After two decades of cooperating on the ISS, there are signs that its collaborators are drifting apart on a sea of political turmoil.

“The challenge is right now, engineering-wise, we are willing to be dependent upon each other, but then our governments are not necessarily willing to,” William Gerstenmaier, NASA’s associate ad-



collaboration

RISK

administrator for human exploration, told me in a phone interview after each of us returned from IAC.

Advocates of international collaboration are worried, and my analysis of the discussions, many of which were behind closed doors, is that they should be. The end of life for the ISS is on the horizon, and it could take years to develop a comprehensive international program to succeed it with anything as ambitious. The space-faring nations don't have much time to bridge their differences and sacrifice

their desire for fully independent space capabilities for the sake of a larger cooperative program.

NASA, which boasts the world's largest space budget, released a new doctrine right on the eve of the IAC. Called "Journey to Mars," it declared that the U.S. is "closer to sending humans to Mars than at any point in NASA's history."

The ambitious manifesto, however, provided no budget numbers or timeline for the journey. Robert Zubrin, founder of The Mars Society, went on his Facebook

The International Space Station is slated to be shut down in 2024, and its original partner countries are drifting apart to pursue separate visions for space exploration.

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page and declared, "NASA announces its current plan for not going to Mars."

NASA begs to differ, pointing out that the main audience for the document might be among partner agencies rather than at home.

"The purpose of this document is not to get down to details of missions or specific hardware but talk more philosophically about how it is all linked," Gerstenmaier told me. He acknowledged that it "is not satisfying to my engineers, because it doesn't have enough specifics," but "politicians don't like it" for the same reason.

Still, he said, "it does provide [a] framework where other countries can start seeing how they want to play together."

For Gerstenmaier, the leading space agencies aren't diverging as much as it might appear: "I don't see them necessarily out of tune, we just recognize we run at different paces," he explained. "We get portrayed as going solely to Mars, but we are not going immediately. We are going to this proving-ground region [near the moon]."

piecemeal agreements with other space agencies.

Currently, NASA is anxious to learn what Russia finds when it sends robotic landers to the polar regions of the moon, as it plans to do before the end of the decade to probe for water ice.

"We would like to know: Are there resources on the moon that can be used for in-situ utilization to get propellant maybe for a Mars-class mission?" Gerstenmaier asked.

Under one scenario, U.S. astronauts and Russian cosmonauts might eventually take an Orion capsule into orbit around the moon and while in orbit remotely steer Russian rovers across the lunar surface. From lunar orbit, the crew could have an advantage over ground controllers back at home due to lower latency of communications. The same technology could be much more critical during the exploration of Mars, Gerstenmaier stressed.

During IAC's opening ceremony, Roscosmos chief Igor Komarov pledged to continue the Russian participation in the ISS until 2024 and to discuss the future of the human space flight program with its partners during the upcoming year. In parallel with continuing ISS operations, Roscosmos drafted a plan to mount a lunar expedition by the end of the 2020s to complement its plan to have its own space station ready by 2024 to continue Russian presence in orbit.

"I think one way or another, there will be a next-generation station in the low Earth orbit, for the very simple reason that a great deal of work and experiments for the exploration of deep space would be simpler and cheaper to be conducted there than let's say on the moon," Komarov told me in a sideline interview at IAC. "However, we think that the next goal [for the human space flight] will be the moon, not Mars. And we are talking about not just planting the flag and leaving, but organizing a long-term work, which would enable us to learn how to build settlements on other planets. I think the majority of our partners agree with us. We have no doubt that Mars would (eventually) become the key goal of the program, but our current strategy is to do it step by step. The moon is inevitable on that path and it is the most effective destination for resolving many of



Johann-Dietrich Woerner, chief of the European Space Agency, stirred excitement at the 2015 International Astronautics Congress with a proposal to build an international lunar base called the Moon Village.

In Gerstenmaier's view, those plans to send missions into lunar orbit or Lagrangian points, collectively known as cislunar space, are well aligned with the efforts of other agencies, such as ESA and Roscosmos. He points to the European decision to provide the service module for one and possibly two upcoming missions of NASA's Orion spacecraft as a model for future



ESA/Foster + Partners

The European Space Agency's vision for an international Moon Village includes using 3D printing to help build habitat structures out of lunar soil.

our current challenges...”

Vladimir Solntsev, the head of RKK Energia, Russia's manned spacecraft contractor, echoed Komarov, his new boss after a reform that made Energia a division of Roscosmos State Corp. Solntsev detailed the Russian space strategy during an IAC presentation he made via a translator, saying that entirely new technologies would be needed for a Mars mission, including closed-loop life-support systems, new propulsion systems and radiation protection. In an apparent reference to NASA's strategy, he opposed the concept of a Martian base on “economic” reasons.

My sense is that the real reason for Russia's anti-Mars stance is not the difficult engineering but the worsening economic situation in the country, which forced the space budget sharply downward beginning in 2015 after more than a decade of solid growth.

The lunar part of the Russian space agenda is finding more traction in Europe than its proposal to undock from the ISS in 2024 to create a new space station. The

Russian proposal created some angst in Europe among advocates of international collaboration, but the newly appointed chief of the European Space Agency, Johann-Dietrich Woerner, restored some excitement when he proposed construction of a “Moon Village” — a loosely regulated international lunar base, combining human-tended and robotic components.

Woerner told me that his very public move was prompted by a less-than-successful attempt in late 2014 to initiate discussion of this idea with ESA's partners outside Europe — an apparent reference to NASA and Roscosmos. Woerner managed to generate some press, but he has yet to enlist support at the top of the space establishment.

“I had several meetings with Igor Komarov, from Roscosmos, about the subject, I had a meeting with [NASA Chief] Charlie Bolden, with the Japanese space chief Mr. Okumura, so we have all these interactions now and it is important to get them together,” Woerner said.

Woerner wants space agencies to fo-

cus on areas of particular interest to avoid redundant spending. For example, ESA could provide various experiments and equipment, while Russia would probably be interested in transportation systems, he suggested.

Formulating an international plan doesn't have to be done immediately, but it can't wait long: "We have different opinions, we can put them together and, therefore, I hope that the proposal to start it is not too late, but there is an easy sentence: The earlier the better...but better late than never."

Russia is building the Luna-Glob robotic lander to send to one of the lunar poles to search for water ice. NPO Lavochkin, which is headquartered near Moscow, is the main manufacturer of the spacecraft.



NPO Lavochkin

In Woerner's view, implementation of lunar plans could start as soon as two or three years from now with smaller missions such as the Russian unmanned lunar lander, for which ESA pledged to supply scientific instruments and sophisticated landing equipment.

These relatively small missions could be funded on a one-time basis and eventually be folded into a larger international program: "If we want to do something like ISS, which I don't think [ISS is on the horizon] but maybe, then we need the full picture first and this will take some more time." He seemed less than enthusiastic about a Russian or Chinese space station.

"I don't like that we will have several space stations at the end of the day, because [human space flight] has to be an international activity. So, we will discuss with our partners and I will be very blunt with my opinion."

Woerner acknowledged that there is no money in the current ESA budget for aggressive human space flight, but he said that he has seen enthusiasm for it across Europe, and he hints that small increases for the program could eventually materialize.

The toughest country to convince to join an international human space flight endeavor might be China. At the IAC, Xu Dazhe, the head of the National Space Administration, promised that the first modules of a Chinese space station would be launched in 2018. China says other countries are invited to participate, but the Chinese space station is being developed with no coordination with any foreign partner.

Why hasn't Chinese participation in the ISS ever materialized? The station partnership is based on full disclosure of technical information about space hardware and on mutual access by all parties to each other's space centers. The Chinese military, which largely runs the country's space program, likely finds that unacceptable.

The chief designer of China's manned space program, Jianping Zhou, says that after the assembly of its station is completed in 2022, it would become the destination for the Chinese astronauts for the following decade. Zhou told reporters that China has no intention of sending humans to the moon or Mars in the foreseeable future.

There are political problems, too. At the opening of the IAC, NASA's Bolden criticized his Chinese counterparts for what he said was their failure to make space cooperation "fully transparent and mutually beneficial." Bolden added: "If we are not collaborating with everybody, we find ourselves on the outside looking in."

No doubt, it would take a major political breakthrough to bring China and its unquestionable space potential into the joint space effort.

Without a broad international agreement signed by the heads of states, advocates of international collaboration rightly fear that the planning and conversation over what to do after the ISS will come to naught.

NASA officials hope ISS could serve as

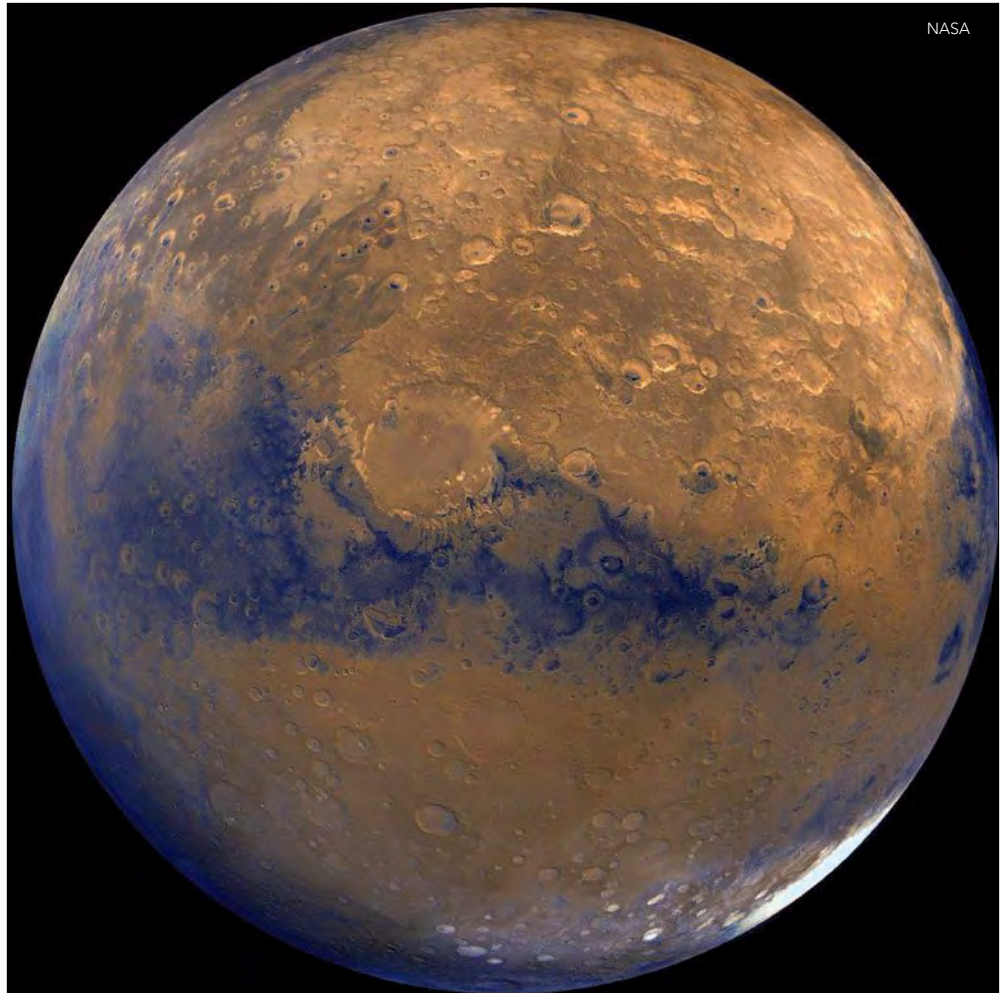
a springboard for such collaboration, both in terms of the legal structure of an agreement and as a strategy for addressing the engineering challenges. In fact, in Gerstenmaier's view, the current agreements would allow further collaboration:

"What's amazing to me is that if you look at the ISS intergovernmental agreements, IGAs, they are flexible enough [for cooperation beyond the ISS]. The authors put the word 'exploration' in there, so I think I can even use some of the ISS IGAs for exploration activities," Gerstenmaier said. "Now, how far we can push that and when do we then need a separate intergovernmental agreement I don't know..."

The original legal framework for the space station enabled the partners to bring Russia into the project. It also enabled the ESA and NASA to barter a European-built service module for the Orion spacecraft in exchange for NASA's support of a European role in the ISS.

Time is of the essence.

"The next couple of years [will be] pretty important if you really want to have a joint program," Gerstenmaier said. "The way I think of it, at the end of the 2020s our goal is to leave the Earth-moon system. So, if you get really serious about that, we really have to nail down our habitation systems, hardware performance and all those things. These things seem like they are a long way away, but I don't think they are so far away. We gotta start now thinking about how we want to cooperate. I think, what you are seeing now, each individual country start to flesh out what their humans' exploration plans are. And now the trick will be to take their individual plans and look for common areas where we can combine and operate efficiently, and kind of start to build maybe at first a loosely integrated plan in the next couple of years and then kind of cement that in place."



Unlike Russia and China, the U.S. is targeting Mars, not the moon, for human space exploration. Skeptics, including Robert Zubrin, founder of The Mars Society, question the feasibility of NASA's current plan.

But there is another factor that requires a quick action.

"My concern is the station has a finite life and this is another urgency: We need this exploration program at least conceptually agreed to, so we can start moving in this direction before the station becomes like Mir, where it is so costly to just keep it in orbit. I know that point is coming and that requires work now," Gerstenmaier said. "I think we have a maximum of three years" to define a long-term strategy and reach a cooperative agreement.



Anatoly Zak is the publisher of *RussianSpaceWeb.com* and the author of "Russia in Space: The Past Explained, the Future Explored."