

“We should be careful to get out of an experience only the wisdom that is in it—and stop there; lest we be like the cat that sits down on a hot stove-lid. She will never sit on a hot stove-lid again—and that is well; but also she will never sit down on a cold one anymore.”

Mark Twain

“You will find that the truth is often unpopular and the contest between agreeable fancy and disagreeable fact is unequal. For, in the vernacular, we Americans are suckers for good news.”

Adlai Stevenson, commencement speech at Michigan State, June 8, 1958

## Chapter 19

### Future Orbits

Even after dealing with the Russians for 10 years, NASA managed to show just how little it had learned and just how badly it could still blunder. In March 2001, the agency picked a fight with Russia that never should have been fought, a fight that could never be won. And when NASA inevitably lost the bitter confrontation, the result was anger and dismay on all sides.

The question was whether millionaire “space tourist” Dennis Tito would be allowed on board when he arrived at the International Space Station as part of the Russian crew of a replacement Soyuz bail-out spacecraft. One Soyuz always remains attached to the ISS for emergency evacuation of the expedition crew, and since each Soyuz lasts only six to seven months, it needs to be replaced periodically. The Russians had always made it clear that they alone had the authority to choose the crew of the Soyuz, and they had made sure that all of the international documents contained the appropriate wording.

NASA knew that there would always be two Russian crew members; who they were was immaterial. The third seat, it knew, would probably be sold to a visitor from another partner in the space project. Russia had been getting \$15 million or more for the third seat on visits to Mir in the 1990s, and since there was still little usable research equipment on the ISS to make a scientific visit worthwhile, nobody had been willing to meet Russia’s price. Then Tito, who had bought a ticket on a flight to Mir before it was terminated, offered to pay for a trip to the ISS. The Russians signed a deal.

Cries of outrage arose from space program officials in different nations (some of whom had hoped that their own astronauts could have had the seat at a lower price). Tito’s presence would interfere with crew activities, it was claimed. He would be dangerous because he would not be fully trained. And he would use the resources that space shuttles had brought to the ISS at great expense.

In public, NASA administrator Dan Goldin proclaimed that “safety is our number one objective,” and that that was the reason why Tito couldn’t go. The Russians hung tough, since without Tito’s money, they couldn’t afford the launch rocket. Without the rocket, the mission would have to be canceled, and the ISS would then have to be evacuated. It didn’t help that NASA chose to prohibit Tito’s launch during the week that Mir died, a week of mourning for

the loss of the country's space independence and its subjugation to American leadership. NASA couldn't have chosen a worse time, and a surge of Russian nationalism began to build in support of Tito and his flight.

William Readdy, a former astronaut who was serving on Goldin's staff in Washington, explained why space flight was still too dangerous for nonprofessionals. On national television, he cited the February 1997 fire aboard Mir and the June 1997 collision with a Progress freighter. These were examples of situations in which the skills of merely amateur astronauts would prove inadequate.

But these examples would have proved just the opposite, if the full stories had been disclosed. Readdy was perhaps counting on the fact that his audience would not be fully informed about the events that he was using in his argument. Or perhaps he hadn't thought through all the implications himself.

When the fire occurred, one Soyuz crew had been in the process of replacing another, and there were six men aboard, including one passenger, a German scientist. He did exactly what he was supposed to do: He put on an oxygen mask and stayed out of the way. Dennis Tito would have been able to do the same, and his presence would not have added to the hazard.

Readdy said that the collision had occurred "during a routine Progress docking." This was an inaccurate description of the event; it actually occurred during a very unusual test. But more to the point, the docking would never have been scheduled during a crew handover, when a passenger was on board, because during that period, there aren't any docking ports open. On the schedule of future ISS dockings, looking ahead five years or more, there isn't a single Progress docking of any kind scheduled during the time when two Soyuzes are docked to the station. Such a collision would therefore be impossible with a 'non-professional' visitor aboard ISS.

Looking at NASA's claim in the light of all the details of the incidents, there is nothing to support the agency's argument. The accidents show that the presence of a visitor added nothing to the hazards, even in the worst-case situations.

On the issue of flying inadequately trained space travelers, Readdy was asked to defend NASA's history of flying its own passengers on shuttle missions—for example, the two congressmen in 1985–1986. The first had been Jake Garn, the Republican senator from Utah. Readdy assured the TV audience that Garn had the background to react properly to an emergency because "he was a former jet fighter pilot." When Readdy's statement was challenged after the show, he admitted that he'd misspoken; Garn had never been a fighter pilot, only a transport pilot. And Readdy hadn't even been asked about the other congressman, Bill Nelson of Florida, who wasn't any kind of pilot.

NASA's public proclamations about safety being first stood in stark contrast to debates chronicled in internal NASA documents, which did not deal with Tito's flight at all. At a Safety Review Panel on February 28, two controversial subjects came up, fire safety and harmful noise levels. In both cases, there were serious doubts that NASA had learned or had properly applied lessons from previous space station experiences.

A safety official named Gregg Baumer raised a concern about the fact that program managers had removed a portable fire extinguisher from a March shuttle mission in order to make room for more cargo to be carried to the station. According to the meeting minutes, another engineer “questioned why the manifesting of hardware is given precedence above safety.” When told that the decision had already been made and that it wasn’t the business of the review panel, the engineer persisted. He “stated that the question is why the [extinguisher], which is defined as safety critical hardware, is at the bottom of the program’s manifest list.”

“Considerable discussion” ensued, noted the minutes. Experts asked “whether this sets an uncomfortable precedent.” Another senior safety engineer “stressed that NASA as an organization has indicated safety has the highest priority, yet the management decision to demanifest the [extinguisher] implies safety is not the top priority.” The issue was bumped back up to managers for reconsideration, but the outcome isn’t documented. What’s significant, however, is that it was even a subject for debate.

As for the hazards of excessive noise, the panel noted that Russia’s short-term waiver for not meeting NASA safety standards had expired, and that nothing had been fixed. All the agency could do was extend the waiver.

An interesting pattern emerged from the first space station crew’s debriefings and from the second crew’s first detailed report. Some ground teams got kudos from the crews for operating smoothly, and some were criticized for poor procedures and inadequate support. One engineer noticed a correlation and sent out a memo on April 11, noting that the teams that operated smoothly were “on-board with this because of their experience during Phase I [shuttle-Mir].” As for the groups that were criticized, they did not have this experience and had evidently paid no attention to the volumes of “lessons learned” written by those who had.

However the new teams were learning the lessons they needed in order to operate a permanent space station, they were learning them, and it didn’t take very long. Some shuttle/Mir veterans hit the ground running and operated well from the very beginning. Other groups struggled for a few months before evolving their own efficient techniques. Few had really learned much from shuttle-Mir, but the first months of the ISS showed that this really wasn’t a big problem. The teams quickly learned what was needed, and they were able to adjust their unrealistic plans with ease.

We’ve encountered this theme before. The possibility remains that the previous U.S. experience on Skylab and shuttle-Mir, as well as all of Russia’s experience with space stations, wasn’t that critical after all. NASA’s current workers proved themselves to be fast learners based on their own experience. Maybe we really didn’t need the “Russian experience” after all.

But that opinion remains heretical. Not only is the emotional desirability of a partnership with the Russians frequently extolled, but such a partnership has been regarded as absolutely unavoidable. If you believe NASA officials, the Russian alliance didn’t just help the International Space Station project, it was an essential factor in making it possible. In other words, it’s widely claimed that NASA and its traditional allies would never have been able to create the ISS if the Russians hadn’t been involved with critical aspects of the project.

I think that this is a slur on the American, European, Canadian, and Japanese engineers who had been working on space station designs since the mid-1980s. It is more than a little insulting to NASA's own space station workers, especially those who developed systems that predated the Russians' and that still form the backbone of the current ISS design. American space station technology leapfrogged the evolutionary but severely limited Russian space station assembly techniques, which advanced year by year in small increments. Mir was an elaboration of technological approaches introduced in the 1970s, and the two main Russian-built modules for the ISS are only minor improvements on that technology. In contrast, the equipment from the original Freedom team (the United States and its traditional international partners) is a generation or more ahead of the Russian designs.

The American hardware provides a great deal more electric power and communications capabilities than anything that the Russians were ever able to deploy. By using the shuttle itself as a workbench, the shuttle's robot arm—and later the even more capable station arm built by the Canadians—could move station modules and structures from place to place, attaching and reattaching the units as new ones arrived. These techniques allowed the modules to be equipped with normal-sized doors instead of tight hatchways (as on Mir), which in turn created the capability to move large objects (such as payload racks) from Earth to space and back again. Perhaps the boldest breakthrough on the American side of the ISS is the command and control system. This system is based on distributed processing by several dozen linked minicomputers, interfacing with the crew almost entirely through laptop computers and replacing heavy, inflexible mechanical switches and dials. All of these technologies are based on designs by NASA and its original international team, long before the Russians showed up.

Yet Dan Goldin never seemed to miss an opportunity to adulate Russian space expertise and deprecate American accomplishments. In 1997, Russian engineers threw together a special hatch door for the leaky Spektr module. It allowed the power cables inside Spektr to interface with cables leading to the rest of the complex. Goldin was so impressed that he exulted, "I tell you, my hat's off to our Russian colleagues. That's one incredible piece of hardware to put together in days. I wish we had the rapid reaction time in the United States that I see sitting in your hand there. We have a lot to learn from the Russians." NASA veterans winced at the slur, remembering—as Goldin may have forgotten—the crash development of equally impressive hardware to rescue the crippled Skylab space station in 1973. Time and again, Goldin repeated his litany about how the NASA team was made up of dunces who wouldn't know how to tie their own shoelaces on a space station if the Russians weren't along to share their secrets. Of course, when it came to the question about whether to fly Dennis Tito, Goldin decided that the Russians weren't quite so smart after all.

The Russians themselves take pride in their necessity to NASA. In discussing American intentions regarding the Russian alliance, Mir cosmonaut Aleksandr Poleshchuk told an August 1999 radio interviewer, "Their goal is our whole rich experience in manned space flight—this experience is very rich and the Americans are acquiring it at very little cost, they absorb it like a sponge." Added the cosmonaut, who is slated for a future ISS mission, "They could not create the Alpha station independently."

Yuriy Grigoriev, deputy chief designer at RSC-Energia, used the same metaphor to explain why the Russians were disregarding all American design suggestions (such as noise

abatement) for the Service Module. In April 1999, he spoke to a Russian TV station. “There was no strong influence from the Americans because they have been actively absorbing our experience like a sponge over the last five years,” he boasted. This was, he added, “because we have 30 years of uninterrupted experience and they just don’t have that experience.” (Space engineers often joke that there’s a big difference between 30 years of experience and one year of experience repeated 30 times).

Even with the hardware issues set aside, many still argue that the Russian presence was a necessary ruse to guarantee continued White House and congressional support in 1992–1993, when the Freedom project appeared to be stuck in a political mire. That’s a fairly cynical view, in that it admits that NASA deceived the U.S. government with promises that failed in every case. The success of the project, in this view, was godfathered by fraud. If this is true, it hardly bodes well for future attempts to play the same trick for other big space projects.

In his dystopia 1984, George Orwell defines the mental process called “doublethink” as the ability to hold two fundamentally conflicting opinions simultaneously. And there’s no better example of space doublethink than the twin belief of many Americans that while the Russian presence did (admittedly) make ISS more expensive and slower to finish, it remains crucial to the major space projects of the future, which would be “too expensive” without the Russians along.

The “feel good” aspect of the partnership with Russia is equally frustrating. It implies that the only alternative to partnership is nuclear confrontation. NASA’s official vision statement for the ISS reads: “A human outpost in space bringing nations together for the benefit of life on Earth—and beyond.” The philosophical framework adds: “Our Mission—Safely build, operate, and utilize a continuously inhabited orbital research facility through an international partnership of governments, industries, and academia.” Once upon a time, the primary goals of space exploration, the results of which was required the assembly of an international team of scientists and a continuously manned space station. But somewhere over the years, the means to the end became ends in themselves. So as Aldous Huxley once wrote, “The nature of the universe is such that ends can never justify the means. On the contrary, the means always determine the end.” When ‘international partnership’ became the only acceptable means to build the space station, in the end it became the primary rationale for the project.

As a result, if there is a philosophical theme to the ISS project today, it is that its success means the end of all major national space activities in the future. In this view, when it comes to manned flight to the Moon or Mars, there should be no option for a purely U.S. project or for a U.S. project with traditional space allies. If the Russians aren’t involved, the project should never occur. “What’s really important is how we’re doing it,” exulted author Brian Burrough (Dragonfly) in a celebratory op ed on the occasion of the launch of Expedition-1. “This is humankind’s station. . . . It’s a real-life step toward a Star Trek universe, the first foray into The Federation.” The science fiction metaphor was very apt.

Bob Cabana, the astronaut who commanded the first space station assembly mission in December 1998, voiced an almost theological passion for a permanent space partnership in a radio debate with me in mid-2000. “When we leave low Earth orbit, it’s not any one country’s responsibility, we need to do this united,” he insisted. “If we can learn to work together 200 miles above Earth, in the vacuum of space, and pull this project off, we can do

anything. And I think we're setting the stage for the future, and it would've been really wrong to do it without the Russians, without one of the major spacefaring nations of the world.” With words such as “really wrong”, Cabana let on that he had elevated philosophy above practicality. At a prelaunch press conference at Baykonur, shuttle-Mir veteran astronaut Michael Foale asserted that “the model for space exploration is international cooperation.” His strategy: “This flight is the keystone to all future exploration from this planet—to the Moon, to Mars and asteroids.” Former astronaut Mike Baker, now a NASA official, agreed: “From now on, I think that all of our endeavors in space, human endeavors, will be joint.”

Cosmonauts agreed. Yuriy Malenchenko stated. “This is how we in the Russian cosmonaut corps view the International Space Station: as a bridge to an international expedition to either the Moon or Mars.” John Fabian, speaking before the House Science Committee in October 1993, voiced the same thought: “We are in a unique position to globalize human endeavor in space.... Cooperating with Russia gives the United States the opportunity to develop interdependent relationships.”

Astronauts and cosmonauts are not the only ones to support the partnership (it is certainly possible that they are sincere, but they also are well aware that a lack of public enthusiasm for the partnership is a sure road to never getting another space flight assignment). Government bureaucrats said the same things. The U.S. State Department spokesman in Moscow, Nicholas Burns, told Interfax on August 7, 1998, “Our future in space is one of partnership with Russia. We have given up the space race, we have given up competition, and we’re working together. . . . In the Cold War, we tried to compete with Russia. Now we try to put our efforts together, and that’s a much better way of proceeding.”

Speaking of his personal relationships with Russian cosmonauts, NASA space station commander-in-training Ken Bowersox told a press conference that “when you get close to [the effort], the emotions are so strong that Americans sometimes have to take a break from it.” Bowersox then went on to the traditional false dilemma: “When you get that kind of relationship with people, you realize it is much better to be working together than building bombs and missiles.” Dan Goldin made the same specious arguments: “Instead of pointing missiles at each other, instead of competing with each other, we learn from each other,” he boasted, shortly after the launch.

“I’ve seen a change, not just in the Russians but in the Americans,” he continued. “There was stress between our people, there wasn’t trust.” Then, thanks to joint activities over the past decade, things changed and mutual trust developed. “This trust is very important to do things. This trust is also a good sign for the future of the world.” Goldin had trusted the Russians for years even as they continually misled and deceived him, and he wasn’t going to give up now.

Once again, we’re seeing the passionate belief that the example set by cooperating space workers will change the world. Dieter Andreson, senior space station manager for the European Space Agency, told a reporter, “There will never be strong conflicts between countries involved in the space station as long as we have astronauts for each others’ countries on the outpost. That is one of my beliefs. And if it proves to be true, then it justifies not only the Russian delays in the program but the tremendous amount of investment the world is making in that bird.”

Just about everyone agreed, it seemed. The project is “a test bed and training ground for large-scale international collaborations,” wrote Dr. Robert Davies, a professor of physics at Seattle University who spent a year working in Moscow on technical liaison duties. “The vastness of the international collaboration [is] the station’s preeminent value,” he continued. “ISS becomes the metaphor for the challenges facing our planet in the coming century, and a model for tackling them. Global warming, mass extinctions, overpopulation, epidemics, pandemics—all are problems whose solution can be found only through consensus among all nations. . . . The skills acquired in the ISS training ground will not be lost to the far more serious challenges ahead.”

These views reflect a backward interpretation of international diplomatic relations and joint space projects, as I have argued before. In the typical self-aggrandizement of space enthusiasts, experts and ordinary workers continue to repeat the mantra that friendship in space will promote friendly relations between nations. They continue to confuse the cause with the effect, potentially with dangerous consequences. As the Apollo-Soyuz Test Project (ASTP) showed, nations engage in joint space projects as a consequence of better Earthside relations, and as post-ASTP showed, they withdraw from such projects when diplomatic relations cool. The politicians and diplomats are not inspired by the space achievements, they exploit those achievements for shifting political purposes.

The participants in such projects see themselves as heroes forcing an amicable view of international relations upon unwilling political leaders. This is a very satisfying self-image, and potentially a very imprudent one.

Here’s why. As agents of a foreign policy perhaps not shared by Washington, some space program workers could justify a wide array of actions, some of which are imprudent or even illegal. The American impulse to perform acts of unselfish generosity in order to be liked has banged its head against the wall of reality for decades (especially with Russians), yet it still survives. In the aerospace sector, the technology involved makes this private impulse potentially dangerous. In an example I personally observed in 1995, when Russian engineers expressed an interest in acquiring U.S. equipment for laser ranging between space vehicles, the American side eagerly tried to find a way to get them the equipment. They were frustrated and upset when they found that giving them this equipment would violate U.S. technology transfer regulations. Whether any of them went further in helping out their new Russian friends with this problem, I could never discover.

At the extreme (and there is no evidence that space workers have ever been in this situation), we can now recognize the twisted idealism of certain Americans in the 1940s. While working on the Manhattan Project to build the atomic bomb, they took it upon themselves to lay the groundwork for a balanced world order by sharing technology secrets with the USSR. In hindsight, they described—and many still rationalize—their motivations as ethically superior to those of the U.S. government.

It doesn’t take much imagination to see what is behind the impassioned and sincere speeches of space officials when they defend the Russian partnership as “changing the world for the better.” At the very least, there is the potential that these officials will take unilateral measures to keep the Russians happy, with or without (or in violation of) the permission of

higher government leaders. “Good intentions” pave star-crossed orbits in space, as well as unwise roads on Earth.

An explicit example of this occurred in early 2000, when NASA found itself in conflict with U.S. law with respect to payments to Russia. Congress had stipulated that no further cash be paid to Russia until the U.S. government certified that the Russian space industry had shut down aid to missile programs in Iran and other “rogue states.” The White House was unable to obtain any such assurance, but NASA was confronted with a Russian space funding crisis that was bringing the ISS program to a halt. Arguably motivated by higher purposes, NASA decided to consider itself exempt from governmental constraints and chose to circumvent the law, using a provision that had been designed as a prudent exemption: This provision stated that if crew safety was involved, cash transfers to Russia were permitted. NASA simply declared that all human space-flight expenditures involve crew safety, and hence none of them could be limited by the law.

In another lamentable case, NASA medical officials had been dispensing about \$20 million in American money to various Russian research laboratories to prevent them from collapsing. One group, called Biopreparat, was supposedly a pharmaceutical research institute. But it turned out that many of its facilities and staff, as well as its director, General Yuriy Kalinin, had formerly been conducting Russian germ warfare experiments. According to many Russian experts, such activities continued to take place. The NASA official in charge claimed that he had never heard of Biopreparat.

“What happened in these cases was outrageous,” a senior U.S. national security official told the New York Times in January 2000. “A.I.D. [Agency for International Development] and NASA were essentially running their own foreign policy.” A former senior space medicine expert who had served in the NASA office that was involved in the payments told me that the officials in charge were “not trusted” and that “the whole process was tainted, but it would be impossible to prove.” He concluded that “they really ought to get someone honest, competent, and credible as head” of that department at NASA.

From the start of the partnership, the Russians had warned NASA not to insult them by hiring “former spies.” (defined by them as anyone too familiar with Russian culture or Russian space activities) But it soon appeared that there were plenty of strange characters who seemed out of place on the Russian side. Unlike the typical senior Russian bureaucrats, who were overweight, paunchy, and pale, these guys were fitness fanatics who pranced around energetically. Their English was also extraordinarily good. But it was difficult to keep track of them because NASA centers, I was told, often refused to support the FBI by giving it access to personnel and records. Even ex-astronauts in management positions outside NASA were ordered by their former NASA bosses not to cooperate with the FBI so as to avoid offending the Russians, according to two of them who talked to me.

At one private meeting, top Russian and American space officials were toasting each other in order to get better acquainted. One of these “out of place” Russians kept on filling everyone else’s shot glasses, but as he tipped the bottle over his own glass, he slipped his thumb over the opening.

One of the Americans who could still see straight spotted the trick and laughingly protested. “Aha, Aleksey!” he shouted, “That’s an old KGB trick!” The Russian didn’t laugh or throw the joke back at his semi-serious accuser; instead, he grimaced and blushed. His boss didn’t laugh, either; he scowled at the Russian trickster darkly.

There were many reports of the same official being caught wandering around NASA sites on weekends, trying to see how far he could get without the escorts who were supposed to accompany him. But being pushy and nosy is a far cry from being proven a spy.

Leading U.S. opinion makers still seem to harbor delusions about other national security issues. Take the New York Times, the “gray lady” of the U.S. East Coast press establishment. The newspaper’s editorial page had been “lukewarm about the station from the beginning,” expecting it to yield “only limited scientific returns.” In addition, NASA’s promises “have been hyped beyond reason and debunked by expert committees,” it wrote on the occasion of the first permanent crew launch. The newspaper was not wholly negative; it liked the symbolism of 16 nations collaborating. The only other value it perceived was “the participation of Russian space and rocket scientists who might otherwise be tempted to put their skills to malevolent use.” The harsh reality of several hundred thousand unemployed missile engineers, and the ease with which any nation can hire them for work either in Russia or overseas, were blithely unrecognized by the New York Times.

There was one other angle of the Russian partnership that really gnawed at me, to the point that even my friends thought that I was being obsessive. If NASA officials thought that they were above normal security regulations, they also seemed to behave as though they were beyond moral considerations. In a project touted as bringing peace to Earth, one requirement was to avoid thinking about war—in particular, the war in Chechnya. The first war, in 1994–1996, was bad enough, but at that point NASA had little influence on Russia. In 1999–2001, while the second round of the terrible war raged in Chechnya, Russian soldiers engaged in acts against the civilian population that were so hideously cruel that they would be designated war crimes in any nation weak enough to be bullied (like Yugoslavia).

Curious about reports of immense clouds of smoke from dozens of oil well and refinery fires that had been set and left to burn for more than a year in Chechnya, I began to search for the “earth view” photographs from shuttle missions that would show signs of the devastation. Hundreds of shots of surface targets all around the world, including Russia, are routinely taken from shuttle windows, both as part of a menu of desirable locations on daily schedules and as impromptu opportunistic shots. But I soon found that there were no shots of Chechnya, at least none that I could locate. I was given any number of technical excuses, but I suspected a larger one. For the sake of a project that was deemed eminently important to the fate of the world, space workers may have been willing to avert their eyes from such ugly realities, to pretend not to see what was arguably genocide against a colonized nation.

Motivated by the “higher purpose“ of generic peace on Earth, many of the space workers I spoke with about Chechnya acted like moral eunuchs. They felt that the Russians’ actions were too minor to worry about (“And don’t forget what we did to the Indians” was a common response). I would argue that this alone was too high a price to pay for the debatable benefits of the partnership with Russia.

In any case, at this point (mid-2001) it seems as though the metaphorical “marriage in the heavens” between the United States and Russia could evolve along as many different routes as there are different kinds of marriages on Earth. Mutual interdependence could still lead to productive cooperation and fruitful results. An unequal flow of support could lead to resentment and unfulfilled dreams, even if the formal relationship is maintained. Or the alliance could end in divorce, either amicably, through a growing difference of goals, or bitterly, through betrayal.

The possibility of a breakup of the grand space alliance and a physical dissolution of the International Space Station may come as a shock to many observers whose enthusiasm was buoyed by the belated but undeniable success of the initial station assembly. But the Zvezda Service Module, the Docking Compartment, and even the Zarya FGB are not really contributions to the project, they are merely loans—permanent loans, it is hoped, or at least long-term loans, but always subject to foreclosure and repossession. The Russians will always have the option to recall them from the joint project and operate them on their own, in a separate orbit.

Even during the wide-scale Russian anguish over the termination of Mir in early 2001, when politicians, ex-cosmonauts, and space experts loudly lamented the loss of an independent Russian manned space program, nobody pointed out that there really was a successor to Mir. “Mir-2” was already in space, hooked up to the International Space Station. It remains the property of the Russian government, however, and it remains fully capable of independent flight.

Unhooking Mir-2 would not be difficult. Space-walking cosmonauts would have to detach a number of external cables. Then the hooks and latches that keep the two sections locked flush together would have to be commanded to open. After that, the physical separation would be complete. The two spacecraft would then drift apart, and the renamed Mir-2 could fire its thrusters to enter a new orbit at a different altitude from that of the rump ISS. Whether ISS could survive such an amputation is problematical.

The only plausible rationale for such a scenario would be diplomatic developments back on Earth. The ISS, after all, reflects Earthbound realities. The cosmonauts are employees of the Russian government, not of the international partnership. And if any Americans on the station are tempted to argue, they shouldn’t forget that the Russians have the only gun.

Any prediction about the future of the Russian space alliance must depend on an understanding of the cold-blooded calculus of Russian motivations for remaining partners in the International Space Station. Like any rational nation, Russia will remain in the program for as long as it is in its national interest to do so, and no longer.

Currently, the balance sheet shows numerous advantages. “Within the framework of the program’s implementation we gain access to all the results irrespective of where they are produced,” Russian space program director Yuriy Koptev told Rossiyskaya Gazeta in 1998. “Each partner has access to them by agreement. We are thereby substantially enhancing our technological level.”

And it's a bargain. "We have the right of the permanent presence of three cosmonauts out of the total crew of seven," Koptev told a Moscow press conference that same year. "We have 35% of all resources on that station, while paying 6.8 billion [out of] overall cost in the range of 100 billion," referring to the dollar costs. "This is a tribute to our experience, a tribute to our luggage that we brought to the project," he added. Koptev was referring to the "Assembly Complete" configuration with a seven-person crew. That won't arrive for a number of years, but in the intermediate configuration (what wags are already calling "Half-Assembly Complete"), the permanent crew is three (on a normal four-month orbital duty tour). Russia is allocated on average half of those slots.

These numbers show that Russian participation in ISS is a good deal for the Russians. They can earn several hundred million dollars a year, more than enough to cover their expenses, by selling tickets. First, they can sell some of the seats on the Soyuz "swap" missions, currently two flights per year, at perhaps \$15 to \$20 million each. Also, they can sell some of their four or five annual allocated seats on long expeditions to other international partners seeking expanded research opportunities, for perhaps \$80 to \$90 million each.

Koptev also described another reason why Russia needs to stay in the ISS project. He pointed out that Russia's failure to meet its obligations on ISS would be "catastrophic." He explained: "Once we ruin the ISS project, we will never get an access to the international market. The resources that today support Russian space studies will vanish." So in Koptev's view, the ISS partnership is the "cost of doing business": It encourages Western governments not to interfere with the flow of more than half a billion dollars a year into the Russian space industry. Since it is the Russian space industry and not the government which mainly profits from such sales, government officials remain reluctant to spend federal tax money for a project that benefits these industrial entities, and have demanded that the industry itself fund the ISS support from the profits of these sales (probably half to two thirds of the commercial cash flow is profit).

Based on these considerations, the Russian government has good reason to remain a "partner" in the ISS. In order to keep commercial programs running and Western cash flowing, the Russians can be expected to promise whatever it takes, while performing the absolute minimum.

A more optimistic view persists, however. It was recently voiced by Gene Kranz, a former flight director who left NASA when his prescient warnings about the Russian partnership were ignored.

"The space station's current problems and cost overruns do not reflect a failure of NASA technical management, but a failure of political leadership," wrote Kranz in February 2001. "NASA's problems with the space station for the better part of the last decade are the responsibility of Daniel Goldin and the questionable top-level leadership he selected during the re-baselining and initial design of the international space station (ISS).

"The costs faced by ISS program management in the year 2001 are the direct result of the technically and politically inept decisions in re-baselining the program in 1993–1994," Kranz continued. "Goldin embraced the Gore-Chernomyrdin initiatives and drove to establish

Russia as a partner in the space station program, ignoring the technical and economic consequences of his act in a successful gambit to save his own job.”

Kranz described the decisions that were made over his own objections, objections that led to his sudden departure from NASA: “Russia was subsequently assigned partnership responsibilities for critical in-line tasks with minimal concern for the political and technical difficulties as well as the cost and schedule risks,” he explained. “This was the first time in the history of manned space flight that NASA assigned critical path, in-line tasks with little or no backup.”

Nor had Kranz been alone in advising Goldin that his policy was foolhardy and delusional. Goldin knew that all of his experienced technical managers were against the policy, so, Kranz continued, “he bypassed them and established a redesign team headed by astronauts Bryan O'Connor and Bill Shepherd—neither of whom had relevant program management experience. As a result, the team he formed was inexperienced in program management, design requirements, systems and operations integration, and cost assessment.”

Throughout 1993, Kranz and his associates wrote a series of memos warning of the likely consequences of such policies. Finally, it seems, Goldin had had enough. “On Sept. 17, Goldin dispatched his associate administrator for space flight, Gen. Jeremiah Pearson [an outsider Goldin had brought in to carry out his orders], to the Johnson Space Center, to personally deliver the message, ‘no more memos.’” Goldin even brought in other military officers he knew from his industry days, whom he could count on not to get distracted by technical advice from the experienced space engineers.

The results were as Kranz and his colleagues had warned. “Today's problems with the space station are the product of a program driven by an overriding political objective and developed by an ad hoc committee, which bypassed NASA's proven management and engineering teams,” Kranz concluded.

But by early 2001, Kranz was more optimistic. Most of Goldin’s special lieutenants had moved on to more lucrative jobs in the aerospace industry, and Kranz believed that NASA veterans have been able to rescue the faltering project. “In the last two years,” he recently asserted, “station management at Johnson Space Center has reverted to its more traditional technical and managerial roots and is making remarkable progress toward recovery. Today's program management team and the NASA field centers are on track to resolve the budget issues and complete the station program.” That was before the discovery of another four to five billion dollars in cost overruns.

Regardless of one’s viewpoint, the United States and Russia have major roles to play in space—in national programs, in alliances with junior partners, and in partnership with each other. There will be great space projects beyond ISS, involving the construction of bigger space facilities. Human expeditions beyond low Earth orbit will be launched. Such projects will be conducted by partnerships of nations or by individual nations, as determined by the national interests of each government.

The extent of Russia’s future role will be determined both by the lessons learned from the International Space Station and by the persistent power of the illusions and wishes supporting

its role. The success of the projects will be determined by the balance between these two opposing themes.

In March 2001, a discussion about Russia's failure to become a democratic, lawful, and peaceful nation took place at the United States Institute of Peace. Dr. Anatol Lieven, a senior associate of the Carnegie Endowment, made an observation that applies both to Russia in general and to Russia's role as a partner in the rest of the world's space activities. "The problem is that we set hopelessly unrealistic expectations for Russia," he stated. "This is a very old and dangerous tendency in the West. Then when they fail, we don't ask what is possible in practical terms, but we insist upon thinking that they're innately wicked."

There are plenty of optimistic scenarios in which international programs are strengthened and grow more valuable. Earth won't be adequately served by a single space station, and in the coming decades, others may appear that are purely Russian (perhaps in polar orbit), purely Chinese, purely Microsoft or Hilton, purely Mormon or Lamaist, or serving manifold combinations of players. Once we figure out how to do it, expeditions to the Moon and the planets may also fly under different flags, including flags not yet drawn. Russia has a role to play in human expansion into space, and no single strategy for its activities has ever been permanent.

Speaking as a ballistician (an orbital mechanics designer), I see the spacefaring nations of the world as traveling through the years in measurable orbits. An orbit around Earth is a closed path through space that crosses different regions as the Earth turns, but always winds up back at the same point, ready to retrace its route again and again. Many lamentable examples illustrate a comparable repetition in our relationship with Russia, driven as we are by mutual misunderstandings and illusions. The stars surround us, but our pathways have been truly star-crossed. Despite our apparent motion, we have made no measurable progress relative to the stars.

In the world of real space flight, to break free from a repeating orbit requires an "escape velocity," an application of extra energy and careful guidance that leaves the old pathways behind, opening up the Universe. That's the metaphor I think we need, the star we need to steer by. If we ever hope to venture beyond Earth orbit, we must first break free of the star-crossed orbits of misperception that bind us to the ground. Sent by individual nations or alliances of nations or partnerships unimaginable today, these future human expeditions will require energy and guidance that we have so far been unable to muster.