COMMENT

ESA/MEDIALAB

Europe's ExoMars mission aims to land a rover on Mars in 2018 to search for traces of life.

When international partnerships go wrong

David Southwood draws lessons from a crisis-ridden year for European cooperation in space.

The recent discovery of the Higgs boson by CERN, the European Organization for Nuclear Research made up of 20 member states, shows how international cooperation can lead to success in science that is otherwise unachievable.

But there are challenges in working across borders. As the current crisis with the euro illustrates, political and financial problems hit some partners harder than others. In my final year as director of Science and Robotic Exploration at the European Space Agency (ESA) in 2011, I had to face withdrawal of US funds from two major joint missions, the James Webb Space Telescope (JWST) and a planned mission to Jupiter. My successor, Alvaro Giménez, has already had worse: withdrawal of the United States from ExoMars, a Mars exploration programme.

All three cases played out differently. Each project holds lessons for managing future collaborations, such as understanding partners' motivations for joining, overseeing projects while bearing in mind the possible withdrawal of players and curbing mission creep. Although it was the United States that withdrew as a major partner in the cases I mention, the lessons are general and will become increasingly important with the rise of large international collaborations involving new players such as China, India and Russia.

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For more on NASA's Mars rover, Curiosity, see:
nature.com/curiosity

The nature of sovereign governments means that rarely is an international agreement to cooperate completely legally binding. A sense of solidarity among partners usually motivates them to remain ▶

ESA

EXOMARS TIMELINE

How changing international collaborations have affected Europe's next mission to Mars.

DECEMBER 2005
European ministers approve flagship ESA mission to Mars with Soyuz rocket launch in 2011.

JULY 2007
First industry contracts awarded. Launch vehicles with more power than Soyuz are canvassed.

JULY 2008
ESA and NASA agree on joint studies towards returning samples from Mars.

JULY 2009
ESA and NASA approve dual-mission Joint Mars Exploration Initiative (JMEI): an orbiter in 2016 and a rover in 2018 with US launch.

AUGUST 2009
Russia and ESA agree to cooperate on two Mars missions: Phobos-Grunt and ExoMars.

OCTOBER 2009
JMEI scenario expands: an ESA lander in 2016 and two rovers in 2018, one from each agency.

DECEMBER 2009
European governments approve a €1-billion Mars programme with NASA.

APRIL 2011
NASA cancels its 2018 rover as US budget crisis hits.

FEBRUARY 2012
NASA ends its involvement in ExoMars.

MARCH 2012
ESA confirms ExoMars go-ahead with Russia as main partner.

committed, as with the JWST, for example. Cooperation between Europe and the United States on this infrared successor to the Hubble Space Telescope began in 2002. Europe agreed to provide the mid-infrared instrument, the near-infrared spectrograph and an Ariane rocket as the launcher. The United States would provide the spacecraft and its operations, another instrument and the complex deployable telescope. The European instruments are now ready, but the US side has seen financial over-runs and delays. Launch is now expected in 2018, seven years later than planned.

In July 2011, after further escalations in budget requests for the JWST, a US House of Representatives committee recommended cancelling the observatory. The Europeans found themselves in the uncomfortable position of having spent well over €100 million (US$123 million) with the possibility of no flight, and having no direct influence other than moral pressure. In the end, deliberations between the White House, Congress and NASA — helped by diplomatic and political pressure from Europe — led to the project's reprieve.

JUMPING SHIP

In February last year, the United States pulled out of a joint Jupiter mission, leaving Europe to go it alone. The mission was the front-runner in a group of similar projects under deliberation by the ESA science-advisory groups. Fortunately, Europe had spent only around €5 million on it. Because more missions enter the study phase than actually fly, this was not a disaster. But, without the certainty of US involvement, long-term planning by the Europeans was thrown into disarray. There were no alternative proposals involving only Europe.

The Europeans bounced back by resetting the clock for entries to the competition, and by rethinking and reconstructing several missions with reduced goals. A final ESA go-ahead for the Jupiter mission came in May 2012. Costing €830 million, the planned Jupiter Icy Moons Explorer (JUICE) aims to fly past Europa and Callisto and then orbit Ganymede and study its subsurface ocean in 2030. US scientists are anxious to get back on board, and NASA has just found US$100 million to secure some participation.

ExoMars, a €1-billion mission for Europe alone, is a different story. This February, the United States pulled out, leaving Europe with a funding gap of up to €250 million and having already spent more than €100 million. Given the committed industrial contracts, cancellation would cost up to €400 million.

The flagship mission to send an orbiter and rover to Mars by 2018 started with purely European ambitions in 2005 — to develop regional expertise in exploration technologies and to apply methods to search for life on the red planet. In this case, the US withdrawal has clearly damaged Europe's position, although not all the fault lies with the United States, which stepped in to help only in 2009 (see 'ExoMars timeline').

MISSION CREEP

Pulling together resources for a large programme is a long, difficult job with numerous pitfalls. Projects start by consensus-building. Compromise is the order of the day and so the first danger emerges: features are added to win further support from participating countries. ExoMars was vulnerable from the start. With participation optional for ESA member states, and no formula to determine their share, each wanted an assured niche role before they committed.

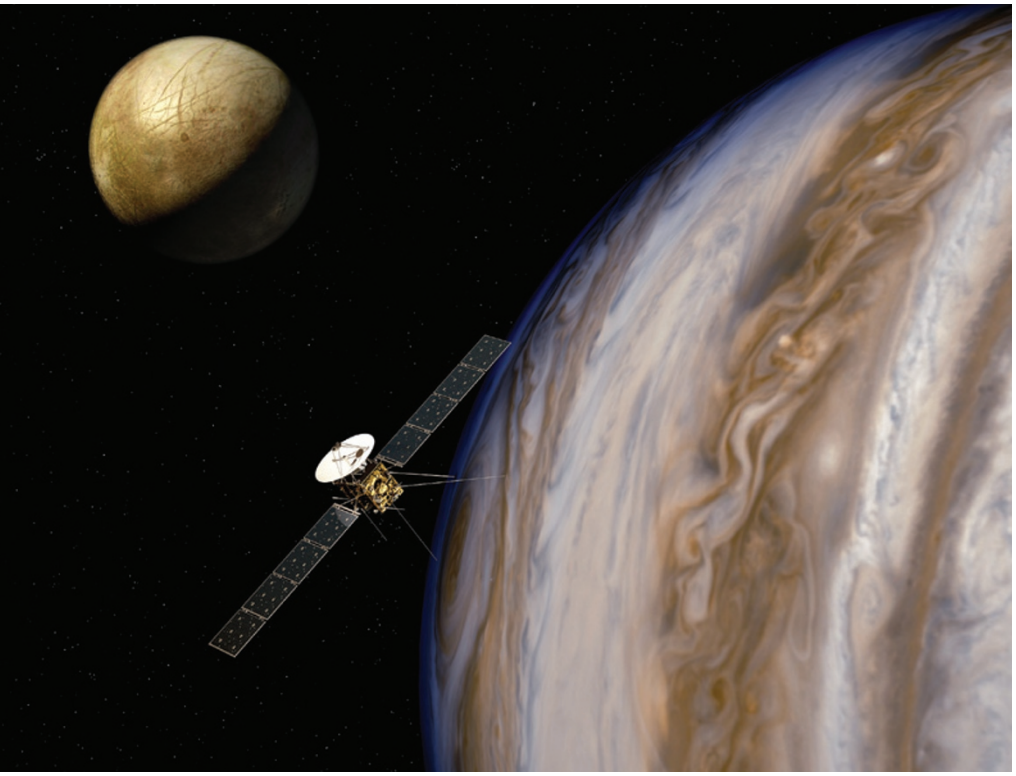
So the ExoMars programme grew. Expanding the scope improved the mission from a scientific and technical perspective, but it became unwieldy and unaffordable. The added complexity increased the risk that some components would not work or might not be on time and budget. Vocal optimists dissuaded the prudent managers who wanted to drop modules to get more done. Instead, ESA sought new partners.

The United States and Russia were approached but didn't sign up, partly because of Europe's need to stick to promises already made within the original European consortium and because there was no joint goal for the potential partner to share.

In 2008, I inherited the programme from another directorate. I went back to talk to NASA. The long-term goal of robotic exploration of Mars, as underscored a few years later by the 2011 US National Academy of Sciences decadal survey, is to return samples. That will be expensive and cannot be achieved by the United States alone. My NASA counterpart, Ed Weiler, and I agreed that cooperation would be inevitable at some point in the next decade. Once this was accepted, it was rational to start working together as early as possible.

The design of ExoMars was modified to suit common European and US goals and to allow sample return. It seemed a win–win arrangement: ExoMars was able to continue, and the prospect of sample return from Mars moved closer for both US and European scientists. I felt confident as the European side of ExoMars moved into the development phase in early 2011. No one foresaw that the US priority for a joint Mars programme would founder as soon as the next annual budget cycle.

Although such let-downs are mercifully rare, a similar thing happened around 30 years ago in the first months of President Ronald Reagan's administration. NASA, faced with a funding crisis, was forced to choose between the Hubble Space Telescope, the Galileo Jupiter orbiter and the International



The European Space Agency intends its Jupiter Icy Moons Explorer to reach Ganymede in 2030.

ESA/AOES

Solar Polar Mission. It withdrew from the last. Reluctantly, Europe assumed the lead in a reduced solar mission, renamed Ulysses. The spacecraft was enormously successful, making three polar orbits of the Sun and operating for 18 years before being switched off in 2009.

Ulysses marked a watershed: the first mission in which Europe led and the United States followed. Many more have been launched since — including the Cluster satellite constellation that mapped the electrical current systems of Earth's magnetosphere and the Herschel infrared observatory. The ESA Jupiter moon mission follows the Ulysses model of downscaling and going it alone.

The solution for ExoMars seems to mark another watershed: Europe has alternative partners. ESA has turned to Russia to make up the deficit left by the United States. It is not the first time that these nations have collaborated in space, but it is the most ambitious project proposed so far. Space scientists should wish the venture well, because the future is likely to hold an increasingly varied pattern of international partners. In recent years, Europe has undertaken joint space-science projects with China and India, and has begun a large cooperation with Japan on BepiColombo, a mission involving two Mercury orbiters.

VALUABLE LESSONS

Five lessons can be drawn from this crisis-ridden year for national space administrators (see 'Steps to success').

First, it is important to understand each partner's motivation for joining a mission. Cooperation cannot be relied on when partners' agendas are incompatible. If a programme is intended mainly to display one group's capability, as with the original plans for ExoMars, then that group must be prepared to go it alone. Mutual goals — such as a collective priority for sample return — can encourage others to get on board.

Second, cooperation means that consensus and compromise rule, and that leads to growth. Multi-partner missions rarely shrink. Moreover, no interested party will voluntarily descope and lessen their project's priority once the programme starts. Be prepared to cancel modules in the preparatory phases if demands keep increasing and resources are spread too thin.

Delay and reflection can lead to a rebirth of a more effective mission. The European GAIA mission to map and track the stars in the Galaxy, scheduled for launch next year, was targeted for cancellation because of a financial crisis in 2001, shortly after my appointment at ESA. A major descoping took place but the programme survived. I am sure it will be a success.

Third, one needs to ensure that managerial risk inside programmes is minimized by making partners' contributions as modular as possible. If one part fails, it need not hinder the whole. Efficiency gains follow, and the programme retains the potential to change partners. Of course, discrepancies in schedule-keeping will leave open the situation where one partner moves ahead of the other (as with the JWST), but the modular approach avoids many potential log-jams.

Fourth, be aware that even the most thoroughly crafted agreements between nations can be broken. It seemed unthinkable that NASA would drop a Mars sample-return mission deemed as a first priority in the decadal review, but it happened. Managers must always consider the possibility of cooperation breakdown as a risk. If such a breakdown does occur, the final levers are those of diplomacy and political persuasion by national administrations, together with moral pressure from the scientific community.

Fifth, in difficult times, space scientists need to know the virtues of collaboration and be prepared to deploy those arguments through whatever channel. In my opinion, cooperation goes beyond simple economics — it breaks down cultural differences, builds mutual trust, opens up scientific potential worldwide and conveys inspiration globally, and thereby benefits all humanity. The damage done by breaking understandings, however technically legal, is to be avoided for all these reasons.

In the end, the economic advantages of international cooperation manifestly outweigh the increased risks. In many cases, such as with the JWST and European exploration of Mars, there is no alternative. Large international partnerships are becoming the norm in other fields, from the Square Kilometre Array telescope to be built in Australia and South Africa, to ITER, the international nuclear-fusion project under construction in France. Pooling resources creates facilities that could not otherwise be built. Learning from what has gone wrong in the past is vital if these consortia are to be successful. ■

COLLABORATION
Steps to success

- Understand each partner's motivation.
- Be willing to drop features to assure completion.
- Keep contributions modular to reduce risk if one fails.
- Be prepared for international agreements to be broken.
- Argue the political case for collaboration in difficult times.

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