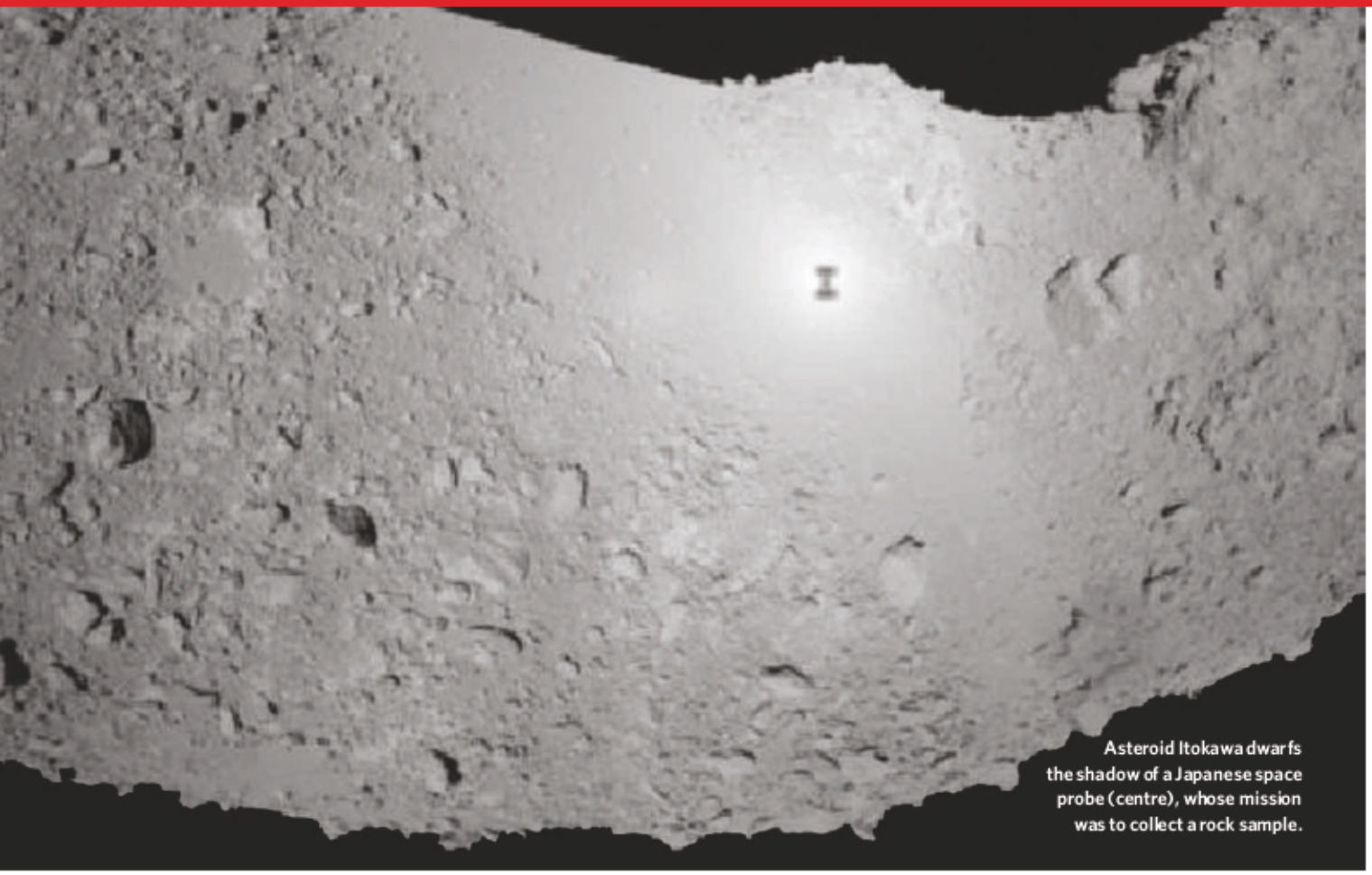


Asteroid Itokawa dwarfs the shadow of a Japanese space probe (centre), whose mission was to collect a rock sample.

JAXA/AP

A shot in the dark?

Japan's mission to collect a sample from a distant asteroid looks to have ended in failure. Ichiko Fuyuno investigates how the setback will affect Japan's struggling space programme.

It was always a high-risk mission. No spacecraft has safely brought back a sample from the Solar System since the Soviet probe returned with lunar soil in the 1970s. So when, on 25 November 2005, a team from the Japanese space agency monitored the descent of the Hayabusa spacecraft towards the bumpy surface of the asteroid Itokawa, everyone in the control room was tense. Once Hayabusa was 360 metres above the asteroid, the touchdown command was issued. "I felt as if all the people in the room were riding on it and descending together," recalls Junya Terazono, the agency's publications officer, who was busy posting photos and live updates to a website as the spacecraft descended.

Despite the risks, after it had travelled 2 billion kilometres, and spent three months imaging the 540-metre-long rock, hopes that Hayabusa would bring back a souvenir from its trip were high. And on the morning of 26 November, a signal from the craft suggesting that it had fired pellets, designed to throw up rock fragments from the asteroid's surface, caused an eruption of noise in Hayabusa's control room.

But the joy didn't last long. Just days later, the Japanese space agency, known as the Japan Aerospace Exploration Agency or JAXA, announced that it was highly unlikely that any pellets had been released or any sample collected. Mechanical problems had been detected in the probe back in July, but these troubles became catastrophic soon after the spacecraft landed on Itokawa. After the team lost communication with the spacecraft in early December, project manager Jun'ichiro Kawaguchi decided to delay Hayabusa's return by three years to 2010 to give them more time to revive it. The chances of a safe return look gloomy.

Hayabusa would have capped a breakthrough year for Japan's space programme — had everything gone well. After a difficult decade, marked by a string of expensive satellite and rocket failures and a tough budget environment, Japan merged its existing space agencies in October 2003.

> **"If you want to climb Mount Everest or a small mountain, either way you have to move up step by step."** — Masakazu Iguchi

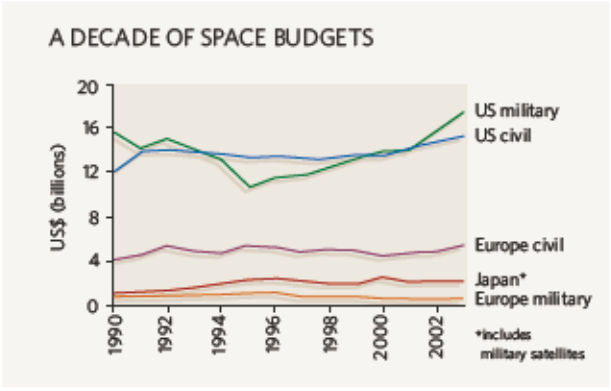
The three agencies were the National Space Development Agency (NASDA) — Japan's main rocket and satellite developer; the Institute of Space and Astronautical Science (ISAS), responsible for scientific missions; and the smaller National Aerospace Laboratory. The merger was intended to cut costs and revitalize a space programme that had lost its way after a strong start in the 1970s and 1980s.

Lost in space

Today, the two-year-old JAXA has an ambitious wishlist for exploration over the next two decades, and a 2% budget increase for 2006 — the first budget increase for Japan's space programme in many years. But turning round Japan's fortunes in space exploration will depend on whether it can find ways to improve its track-record without killing its ambitious spirit.

Critics say Japan tries to do too much with too little. JAXA's budget (¥180 billion for 2006) is a tenth of NASA's, and less than half that of the European Space Agency or ESA (see graph opposite). And, at ¥12-billion (US$100 million), Hayabusa cost only about half that of NASA's Stardust mission, which is set to return

to Earth with captured cometary dust on 15 January. Japan can afford fewer missions, and so has fewer opportunities to launch new technologies. The result is to stuff as many ideas as possible into one launch. Hayabusa certainly carried a lot of hardware 'firsts'. Some of these, such as the Japanese ion-drive engine used to propel the spacecraft out to the asteroid, worked fine. Others, such as the small surface probe Minerva, failed to deliver.



SOURCE: EUROCONSULT

Tales of woe

"Maybe sometimes Japan tries to do too much for its resources," says Andrew Cheng, a planetary scientist at Johns Hopkins University in Baltimore, Maryland, and a member of Hayabusa's science team. "I'm happy to see very brave decisions and to launch very complicated missions. All that is good," adds Cheng. "But they cannot fail every time either."

The year Hayabusa was launched was a particularly troubled time for Japan's space programme. In October 2003, the Midori-II Earth observation satellite failed. The following month, one of the Japanese flagship rockets, an H-IIA, had to be destroyed in mid-flight. Then the Mars probe Nozomi, in trouble since 1998, was finally lost in December. And last summer, the main X-ray instrument on the joint US–Japan Suzaku telescope shut down, reducing scientists' ability to study black holes.

Despite these troubles, many Japanese space experts believe that Japan should not just try to catch up with Europe and the United States, but should blaze its own trail. "Having ambitious dreams is good," says Masakazu Iguchi, head of the space activities commission that reviews Japan's space activities for the education ministry, which oversees JAXA's budget. But, he warns, "Japan should move steadily towards its goals. If you want to climb Mount Everest or a small mountain, either way you have to move up step by step." Iguchi argues that the important thing is to learn from failure. "I think JAXA understands that," he says.

Under pressure to improve the performance of Japan's space programme's after the 2003 disasters, politicians sought the help of outside experts, including top US and European space-agency chiefs. And despite resistance from JAXA officials, the agency formed an advisory commission for mission success in 2004. Headed by former NASA chief Daniel Goldin, the commission released a report in March 2005, listing 21 ways the agency could improve.

The Goldin commission suggested that JAXA strengthen ties with industry by shifting technical responsibilities to its prime manufacturers. In the past, Japan's space programme retained control over most design decisions, and interactions between agencies and the manufacturers were limited. It is hoped that with more responsibility, Japanese firms will gain the expertise needed to allow the country to compete in the global satellite market.

Another key recommendation was to boost the efforts of systems engineers. Toshifumi Mukai, who heads a chief engineer's office established in October 2005, says systems engineers do important work at the start of a project by defining mission requirements and identifying potential risks. Under the new system, chief engineers operate independently of the project managers, who are now required to share development data with others more openly.

But some JAXA officials are concerned that too much focus on risks, as well as constant reviews, will further weaken morale. "Just how to get prepared in the event of failures is becoming daily work. I think that's wrong," says Kawaguchi, who believes Japan must keep being adventurous. Many Japanese space experts are wary of adopting the approach taken by China's space programme. Although China has had two successful astronaut missions, it uses off-the-shelf technology, which many Japanese space experts dismiss as lacking innovation.

Others worry that JAXA will become as cautious as NASA or ESA. "I think ESA is more conservative than JAXA, at least as reflected in design philosophy for spacecraft and in mission operations," Cheng says. He hopes Japan does not become too risk averse.


KYODO

False hope: Jun'ichiro Kawaguchi (centre) and his team eagerly await signals from their spacecraft as it descends to an asteroid.

There is no sign of that in JAXA's 20-year vision for space exploration, released in April last year. Calling for lunar exploration and perhaps eventually manned spaceflight, the ambitious scope of the 20-year plan seems at odds with current funding levels. Since a peak in 1999, the Japanese space budget has shrunk by 20%.

Risk taker

Critics, including the Goldin commission, have long argued for a strategic vision for Japan's space programme — one that will help it set priorities, and that will encourage better integration of the agencies that make up JAXA.

Since the merger, the three agencies have largely retained their separate cultures and resisted being unified further. The vision document is a first important step, says John Logsdon, professor of space policy at George Washington University in Washington DC. "JAXA is right now going through the process to deal with bureaucratic reorganization," he says. "It takes time."

Decisions about human spaceflight and Moon bases won't be made anytime soon, so JAXA can focus on immediate priorities, such as improving rocket reliability, says Kimikazu Iwase, director of the space development and utilization division at the education ministry. Iwase attributes a successful H-IIA rocket launch in February 2005, the first for 15 months, to better pre-launch testing.

Whatever Hayabusa does next, Kawaguchi's team has many busy months ahead analysing the data and images sent back by the craft before its descent. More than 1,500 high-resolution pictures have revealed a rocky surface devoid of debris. This is in striking contrast to the highly weathered surface of the asteroid Eros, which NASA's Shoemaker spacecraft visited in 2001.

Hayabusa did not achieve everything JAXA hoped for, but few question its engineering and scientific achievements. "Whether or not we ultimately get a sample returned to Earth, the mission still is a success from a science point-of-view," says Donald Yeomans of NASA's Jet Propulsion Laboratory in Pasadena, California, and US project scientist for Hayabusa. "The Japanese flight team performed well dealing with unexpected spacecraft anomalies and a bizarre and rocky asteroid surface."

What JAXA learns from such experiences will shape its fortunes over the next decade. "Overall, things are getting better, but we haven't fully gotten out of the doldrums," says Yasunori Matogawa, associate executive director at JAXA. "Hayabusa was the mission that could have opened the door. Now we will have to see whether it has really done so." ■

Ichiko Fuyuno is a contributing correspondent based in Tokyo.