

6 Billion-km Space Odyssey

Asteroid Probe *Hayabusa* Returns to Earth

By Isao ADACHI

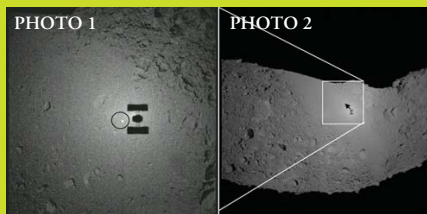
Hayabusa, the unmanned asteroid probe that returned to Earth in June after seven years of space odyssey, no doubt sparked excitement among Japanese people. Although it may not match the frenzy of soccer's World Cup, the feat nonetheless generated a quiet but deep ardor of a scientific nature. The craft took a circular orbit in the voyage to and from the asteroid Itokawa in the solar system, racking up for itself about 6 billion km in total travel. *Hayabusa* got over a series of hitches that made homecoming look almost impossible in more than one instance. That alone may make the odyssey more than worthwhile. But planetary scientists are hopeful that the probe's reentry capsule might contain some substance from Itokawa's surface, even if it is in a trace amount.

Hayabusa, meaning falcon in Japanese, was launched in May 2003 from the Tanegashima Space Center in Kagoshima Prefecture on the southernmost main island of Kyushu. Its main mission was to land on the asteroid some 300 million km in a straight line from Earth, collect rock samples on the surface and return home. The probe was powered by ion-propulsion engines, which are much better in fuel economy than chemical engines burning a mixture of fuel and an oxidizing agent and which are capable of accelerating for long periods. *Hayabusa* landed on Itokawa in September 2005, two years and four months after the launch.

Itokawa is a pea-like minute asteroid measuring only 535 meters in length and 294 meters in maximum diameter. After observation from close range, *Hayabusa* attempted landings in November 2005.

The asteroid had a rugged surface covered with rocks of various sizes, allowing only limited options for a landing site and eventually forcing *Hayabusa* to attempt landing in a very narrow area of about 60 meters in radius. Moreover, remote control from Earth, aided with transmitted video images of the surface, was not an option because it took too much time for command signals from the distant Earth to reach *Hayabusa*. Radio signals took about 40 minutes two ways. As a result, two attempted landings had to be executed by autonomous navigation solely based on data collected

by a laser altimeter, high-precision cameras and other onboard equipment. It was almost like a sophisticated self-contained robot assessing the environment by itself and making necessary moves. (Photos 1 – 3)



The surface of asteroid Itokawa pictured by descending probe *Hayabusa* on November 20, 2005. The craft succeeded in detecting a previously released globe-shaped "target marker" on the surface used as a beacon to guide the way for landing.

PHOTO 3
©JAXA



Artist's sketch of asteroid probe *Hayabusa* in the final stage of descent aided by laser altimeter

PHOTO 4



Visitors watch a model capsule (left) and an actual heat-shield capsule cover brought back to Earth by asteroid explorer *Hayabusa*, both on display at Tsukuba Space Center in Tsukuba, northeast of Tokyo.

After having successfully landed on the asteroid, accomplishing one of the major objects of its mission, *Hayabusa* also succeeded in taking off again, making it the first planetary probe land-

ing on and taking off from a celestial body other than the moon.

But the space voyage had big trouble in store for *Hayabusa* on the final leg of its journey after takeoff. Fuel leaked out of an attitude control engine, spinning the craft and putting its signal antenna in the wrong direction. That left *Hayabusa* incommunicado with ground control. The attitude control system was hampered so badly that people on the ground thought the probe would never make it to Earth.

However, mission scientists of the Japan Aerospace Exploration Agency (JAXA) caught faint signals coming back again from the probe about two months later and immediately capitalized on the slim chance. They came up with a non-textbook and yet successful remedy for regaining attitude control that involved direct outbursts of xenon gas without ionizing the fuel for the navigation engines. By a near miracle, communication was restored by March 2006, although the return to Earth originally scheduled for 2007 was delayed by three years. On top of everything else, the ion engines began to deteriorate and malfunction during the return trip, but on June 13, 2010, *Hayabusa* reentered the atmosphere, precisely following the preset trajectory. *Hayabusa's* main unit mostly burnt up, but the detached heat-shielded capsule made a parachute landing and was recovered in a desert near Woomera in the southern part of Australia.

What is attracting attention now is whether the capsule has in it any material from the surface of Itokawa. It has been determined that Itokawa was formed between tens of millions of years ago and hundreds of millions of years ago. The theory has it that a small celestial body formed in an early stage of the solar system collided with another celestial body, broke up into pieces and was pulled back into one piece again by gravity. If so, the asteroid may hold materials from an early stage of the solar system as they were originally. The probe's sampling system apparently did not function properly upon landing and samples, if any, will be few. However, as a planetary scientist put it, "Even in a trace amount, it will be the first body of planetary resources of the solar system that human beings ever get hold of."

JS

Isao Adachi is commentator, Jiji Press.