Commercial Platforms Allow Affordable Space Research

NASA Technology

At an altitude of about 240 miles, its orbital path carries it over 90 percent of the Earth’s population. It circles the Earth in continuous free fall; its crew of six and one Robonaut pass the days—experiencing 16 sunrises and 16 sunsets every 24 hours—in microgravity, an environment in which everything from bodily functions to the physical behavior of materials changes drastically from what is common on the ground. Outside its shielded confines, temperatures cycle from one extreme to the other, radiation is rampant, and atomic oxygen corrodes everything it touches.

A unique feat of engineering, the International Space Station (ISS) also represents the most remarkable platform for scientific research ever devised.

In 2005, anticipating the space station’s potential for NASA and non-NASA scientists alike, the NASA Authorization Act designated the US segment of the ISS as a national laboratory, instructing the Agency to “increase the utilization of the ISS by other Federal entities and the private sector.” With the ISS set to maintain operations through at least 2020, the station offers an unprecedented long-term access to space conditions, enabling research not previously possible.

“There will be new drug discoveries, new pharmaceuticals, a better understanding of how we affect the planet and how we can maintain it,” says Marybeth Edeen, the ISS National Laboratory manager, based at Johnson Space Center. The ISS, she says, represents a major example of the government’s role in making such advancements possible. “The government is key in that researchers cannot afford to build the kind of infrastructure that the government can provide. But we then have to make that infrastructure available at a reasonable cost.”

Enter Jeff Manber, who saw in the ISS National Lab an extraordinary opportunity to advance science, education, and business in ways never before seen.

Technology Transfer

A veteran commercial space businessman who previously headed MirCorp, which leased the Mir space station for two years, Manber co-founded NanoRacks LLC of Houston, Texas, and approached NASA with an idea for a partnership that would transform the way space-based research is conducted.

“We said, ‘We want to put our own research platforms on the ISS and market them to customers, and we’ll pay for it,’ Manber says. He and his co-founders, all industry veterans, envisioned a partnership in which NanoRacks would provide the research hardware and the customers, and NASA would act as a kind of landlord and regulator, providing the necessary comprehensive safety checks and access to the ISS and its crew. The key, says Manber, was that NanoRacks would fund the entire effort as a commercial venture, incurring no additional costs to NASA or the Nation’s taxpayers. NASA and NanoRacks
soon formalized the partnership through a Space Act
Agreement.
To realize its vision, NanoRacks had to devise a
research platform that could be utilized by a broad range
of researchers, for a broad range of experiment concepts.
Considering the many challenges—the conditions of
the space environment; the limited, carefully managed
resources onboard the ISS (including crewmember time);
the breadth of research topics for which the National
Lab could be used; and the significant costs of launch-
ing, maintaining, and sometimes returning research
payloads—this was no simple task.
The ISS already featured standardized lockers and
drawers intended to remove custom research hardware
from the equation, allowing scientists to focus on their
experiments instead. NanoRacks built on that concept,
finding a solution in the increasingly popular CubeSat
model and creating a plug-and-play research platform
both standardized in size and versatile in function.
CubeSats are nanosatellites of a specific, small size that
have been employed largely by universities as an afford-
able means of space research. NanoRacks used the cubesat
form factor to create NanoLabs, four-inch cubes with a
USB port for drawing power from the ISS and transmit-
ing near real-time data gathered from the contained
experiment. Individual experiments can operate within a
single NanoLab, or multiple NanoLabs can be used in
varying configurations for larger research setups.
“All the ISS crewmember has to do is attach
the NanoLab to our platform using the USB, and
immediately power from the station flows into the
experiment, and data can transmit from the station
down to the customer,” says Manber.
Within 6 months of the
Space Act Agreement,
NanoRacks launched
two research
platforms—
with
space for a
total of 32
NanoLabs—
that became
operational on the
ISS in August 2010.
Benefits
NanoRacks has since flown
the experiments of 15 customers,
with over 60 total payloads currently under contract.
Its customers range from high schools to universities to
pharmaceutical research organizations around the globe.
“Researchers have believed, since the dawn of the
space age, that removal of gravity will allow us to better
understand complex processes and maybe even develop
new materials. We’ve never had the opportunity we have
today to test that belief,” says Manber. Because of the
small size and standardized format of the NanoLab cubes,
it is cheap enough where you can try something, and if it
doesn’t work, you can try something else.”

By 2013, NanoRacks expects to have three research
platforms on the ISS, in addition to a plate reader (used
to perform sample analyses), two already operational
microscopes, and a centrifuge developed by Astrium
Space Transportation. The Astrium collaboration is one
example of how the NanoRacks approach to ISS research
is spawning new partnerships and technologies.

“We have other companies designing circuit boards for
us, designing their own NanoLabs, so you see a whole
ecosystem developing,” says Manber.

Plant growth, pharmaceutical crystals, and nano-
materials are among the research subjects targeted by
NanoRacks’ customers. But the benefits of these experi-
ments are not limited to their scientific outcomes; in
keeping with NASA’s own educational mission, inspiring
the next generation of scientists and engineers has become
a key component of NanoRacks’ efforts, as well.

“We have now flown experiments for over 27 school
districts in two missions, and we’re about to fly 11
more,” says Manber. Through a partnership with the
National Center for Earth and Space Science Education,
NanoRacks has developed a national science, technology,
engineering, and mathematics space program for middle
and high school students.

“Around the world, the best and brightest students
know they are being given the most extraordinary oppor-
tunity they can imagine: a chance to perform experiments
on the US National Lab in outer space,” says Manber.
“That will pay dividends for America in the decades
to come.”

The NASA-NanoRacks partnership is mature and
healthy, Manber says, but far from exhausting its poten-
tial. The company is developing a platform for the outside
of the ISS, allowing researchers to pursue investigations
in sensor developments, advanced satellite communica-
tions, and biological studies. NanoRacks and Astrium are
self-funding the External Platform Program, expected to
deploy in early 2014, with NASA contributing hardware
and services.

“This program opens the door to allow commercial
users to fully utilize not only the US National Laboratory
in a pressurized environment, but also outside,” says
Edeen. “It’s another example how companies are invest-
ing their own money to take advantage of this unique
national resource.”

NASA is also soliciting proposals from industry
partners to advance technologies based on the NanoLab
model. Beyond the ISS, Virgin Galactic selected
NanoRacks to design and fabricate research hardware and
a payload rack for suborbital flights.

“We will go wherever humans are going in space in the
next few decades,” Manber says.

“We need to demonstrate that American leadership
and American ingenuity is alive and well in outer space.
With NASA and companies working together, we are
getting value that is not always possible the traditional
way. It’s a harbinger for a great future for the Space
Program.”
“Around the world, the best and brightest students are being given the most extraordinary opportunity: a chance to perform experiments on the US National Lab in outer space.”

—Jeff Manber, NanoRacks LLC