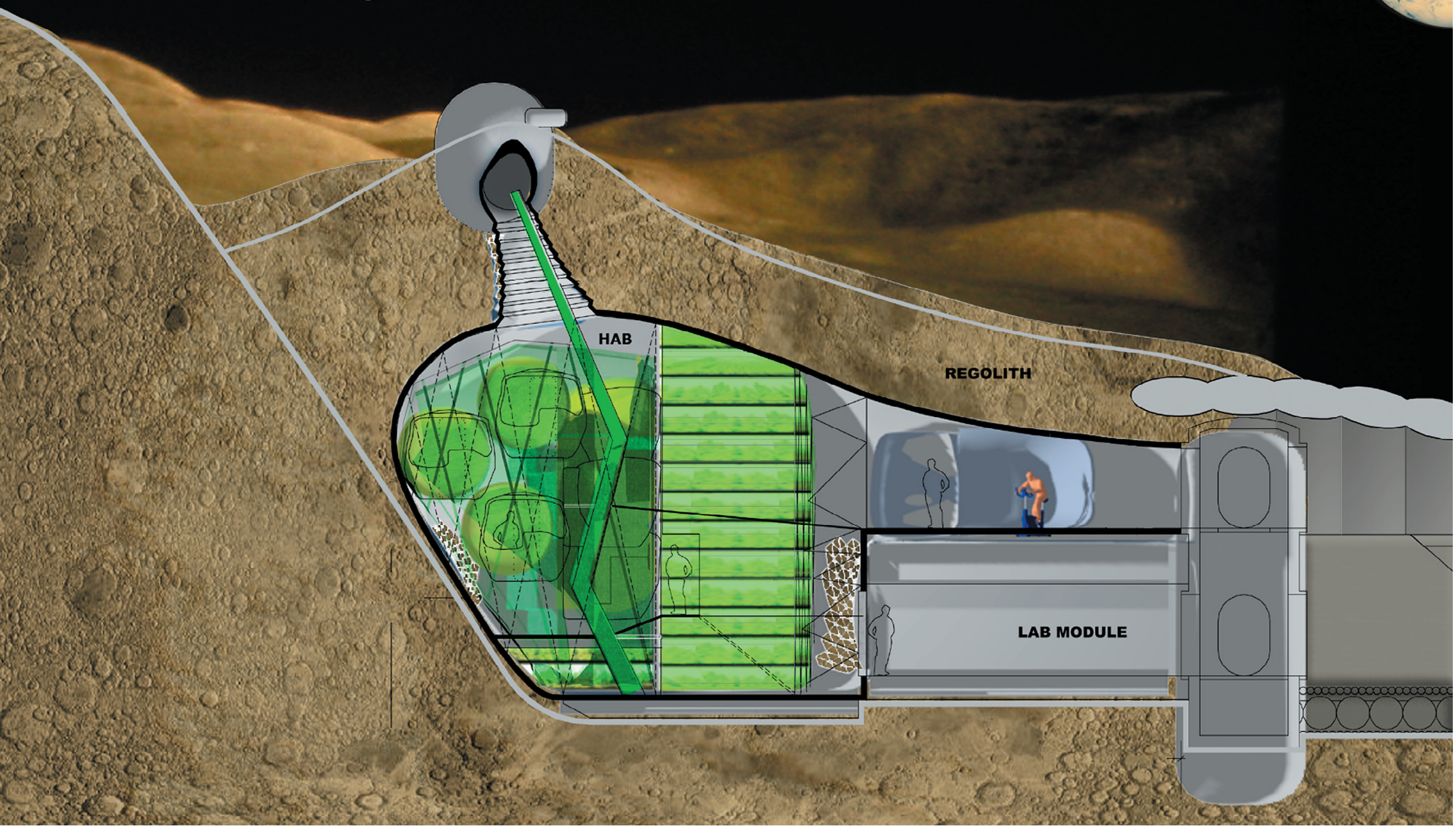
Story by Shonquis Moreno

Being John Glenn(ovich)



Almost 40 years after the first man stepped onto the surface of the moon, the 2004 flights of privately funded SpaceShipOne to the edge of outer space and back signaled the twilight of government-run space agencies like NASA. It also heralded the ascendancy of a loose global network of young designers and private entrepreneurs who are now setting the pace for the second race to the moon and the first race to Mars—and imagining the first shelters we will live in when we get there.

One of these next-generation designers, India-born, San Francisco–based Susmita Mohanty, doesn't look old enough to have earned her multiple advanced degrees in electrical engineering, architecture, and industrial design. But between Mohanty and her Vienna-based colleague, architect Barbara Imhof, the two have already worked with NASA, the European Space Agency, and Boeing, among others, and are poised to outpace these hoary and cumbersome institutions with the establishment of two space-design consultancies in the U.S. and Europe. MoonFront and Liquifer are breaking away from the creakily bureaucratic, man-in-a-can methods of space design, which from the beginning have been largely dominated by men, engineers, and the West.

No longer. Mohanty and Imhof have coined the term "third genre" to describe the latest phase of architectural design for space, which is focused on humans instead of machines and uses creative methods that are multicultural, multidisciplinary, and pragmatically visionary (not, in this case, an oxymoron). "We're like the underground," Mohanty says. "I collaborate with a virtual network of experts scattered all over the world and tap into that network in different ways for each project." It is an outspokenly progressive design underground that brings together biology, robotics, materials, informatics, artificial intelligence, and the quantum and cognitive sciences to build living space in outer space and on other planets.

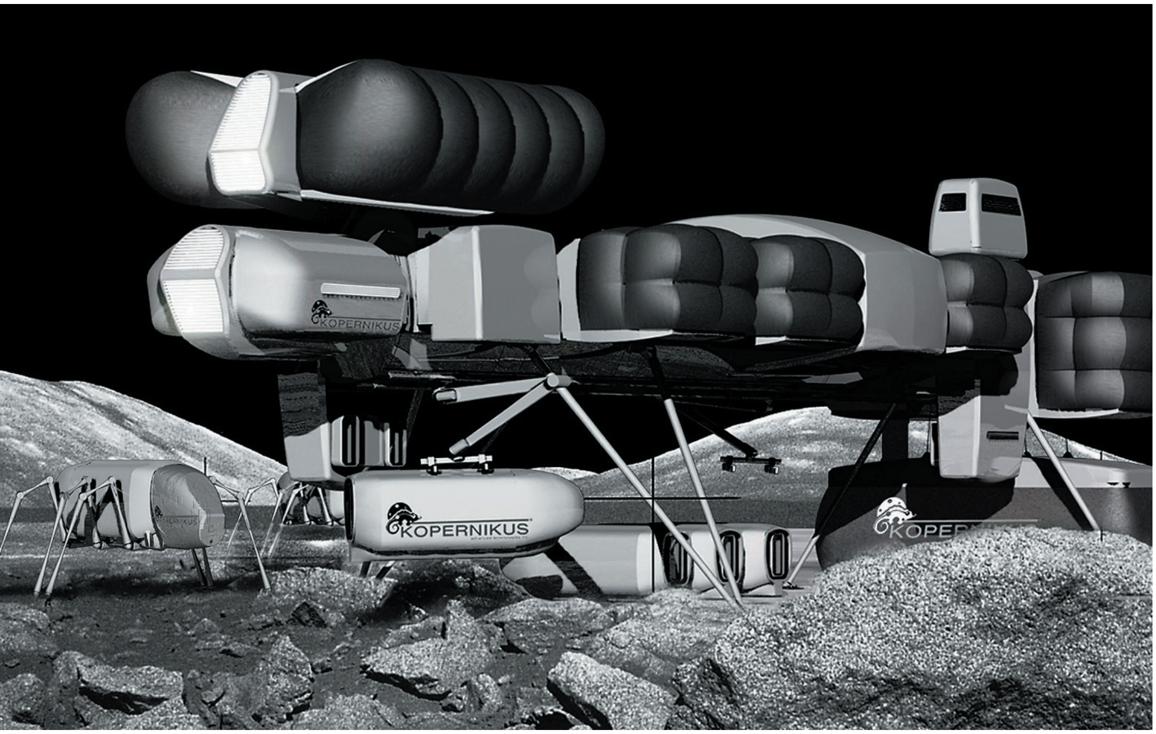
Spurred by renewed interest from the U.S., Japan, India, China, and Europe in returning to the moon, Mohanty, Imhof, and colleagues organized a workshop in 2002 to design lunar bases. The concepts generated fed into the European Space Agency's Aurora program, which has the goal of establishing human missions to the moon, Mars, and beyond within 30 years. From 16 countries, 50 students—including engineers, architects, industrial designers, and experts in mining, applied physics, and medicine—formed teams to design habitats for hypothetical missions, including ice and helium mining and solar cell production. Mohanty predicts that we humans will have actually established a first-generation moon base by 2025: "It's not a question," she says. "It's an imperative. Going to the moon, in addition to Mars, is not an either/or scenario if we are looking at sustainable ways to explore."

These young technocrats view design for outer space as a natural extension of design on earth. Nonetheless, space presents unprecedented challenges. To name a few: Instead of 1 G (9.81 meters per second squared) of gravity, humans experience

The Kepler (opposite), one of nine conceptual moon dwellings, includes greenhouses to maximize the crew's exposure to the "outdoors." Tycho's design (below) focuses on reducing the stress of its inhabitants. "Stimulation in a sensory-deprived area has to be established," says Barbara Imhof.

0 G in orbit, 1/6 G on the moon, and 1/3 G on Mars. "In zero gravity," Imhof explains, "buildings have no more foundations. Their structure no longer reflects the human sense of equilibrium. 'Vertical' is not a valid concept." Reduced gravity affects not just our orientation in space but our mobility. It takes less energy to move but you make less headway. On the moon, for instance, it's easier for a person to walk on a wavy surface than on a flat one. Mobility is also diminished when dust settles so heavily on and in astronauts' space suits that they become exhausted within a few short hours.

Longer stays in space present even greater challenges. It takes only four and a half days to get to the moon, but any mission to Mars would require nearly two and a half years. Though it is rarely discussed (by NASA in particular, says Mohanty), long sojourns in space are difficult both socially and psychologically when it comes to love and sex between crew members, boredom, lack of privacy, the inability to go outdoors, maintaining productivity, and so forth. These ▸



Another moon-dwelling concept, the Kopernikus, has robotic arms tucked beneath its belly to assemble rovers in diverse configurations, depending on use (paramedic services, cargo transport, etc.).

are issues, insist Mohanty and Imhof, that are just as significant and natty as the physical and engineering obstacles. According to Imhof, “Interaction between humans and their closest environment—the habitat—is a crucial factor for mission success.”

To explore and address this broad spectrum of issues, workshop participants came up with nine concepts for dwellings on the moon. One, the Kepler Base, supports a crew of six researchers buried in the rim of a crater and consists of three autonomous modules—living quarters, workspace, and a rover—connected by airlocks and assembled in phases. In contrast to Kepler, the Kopernikus Base—intended to provide commercial services to nearby communities—is jacked up on legs above the moon’s surface to avoid disturbing lunar dust. Modular and scalable in order to support future expansion, it consists of a combination of solid and lightweight inflatable units. Because real estate is at a premium—the crew might as well be living in Mumbai in terms of population density within the habitat—at least some of the rooms, especially public areas, must be reconfigurable to serve multiple purposes.

Like Kopernikus, most of the “habs” achieve their efficiency by blending various resources, functions, methods, and technologies. “When it comes to habitats,” says Mohanty, “my mantra is, Think hybrid. Blend informatics, artificial intelligence, and advanced sensor technologies. Habitats in space should be holistic, not a patchwork of disconnected, fragmented entities or an assortment of hardware parts.”

Because the mining crew of the Tycho Base needs to find and follow helium 3 sources along the mares of the moon, this inflatable habitat is designed as a sphere that rolls, through mass displacement, a few dozen feet each week. It relies on a bladder of water around its circumference to shield the crew from radiation. Tycho consists of several decks that can be reconfigured depending on how the crew needs or wants to use it. Windows give views to the outside and—significant psychologically—homeward. Private living spaces are visually isolated and insulated for sound. Most intriguing, the Tycho project explores the potential of technology to virtually extend the limited physical dimensions of the habitat.

“A space habitat is a space permeated by technology,” says Imhof, who imagines the rooms of a lunar dwelling to be soft, flexible, and transparent to different media, allowing the crew to modify and adapt the space to changing needs. To communicate with earth, an astronaut could, for example, enjoy a game of table tennis with his daughter back home, the astronaut playing against an interior wall of the ship, equipped with active sensors that transmit the information to a similar wall on earth, and the daughter returning the virtual ball to her father in space. The blurring of virtual and physical space becomes more than a cool gimmick in outer space. It becomes essential. “Future habitats should be programmable,” Mohanty says, “able to self-deploy, self-repair, adapt to environmental variations such as dust, radiation, quakes, and storms, as well as adapt to the needs of the inhabitants.”

What next-generation designers are learning in order to work in outer space has important applications for building in extreme environments on earth, and vice versa. Developed for space, systems in which air, water, and waste systems are maintained and resources reclaimed self-sufficiently (think Biosphere 2—except it works) could be adapted to eliminate costly sewage networks and allow waste to be recycled locally, according to Mohanty. After a 1999 earthquake in Turkey, the European Space Agency developed a SpaceHouse for earth applications, using the same ultralight carbon-fiber-reinforced plastic composites that it uses on its spacecraft. The house’s shell could withstand rattlers up to 7.0 on the Richter scale. On the other hand, designs for the densest cities on earth, can be applied to space habitats where crews share cramped interiors for extended periods. Mohanty and Imhof are looking for reciprocities like these between earth and space, and applying them to their designs. The possibilities, for the first time in a long time, seem as endless as the expanding universe. ■