STAR Design 2005

by Brad Thomas

Architecture students often dream about designing grand skyscrapers or palatial homes on Earth. Recently, however, a group of students had the opportunity to use their rulers and compasses to design an out-of-this-world home for astronauts.

Seven architecture majors and a physics major from Sweden's Lund Institute of Technology participated in the NASA educational outreach program called STAR Design 2005. One of the program's objectives for 2005 is the development of innovative crew habitation systems that could help NASA in realizing the Vision for Space Exploration.

The students spent two weeks at Johnson Space Center in Houston working with the Exploration Systems Engineering Office and the Advanced Extravehicular Activity Team. They learned about the human spaceflight program and designed the interior of a cylindrical living module, with an emphasis on human needs like eating, recreation, and rest to name a few.

STAR Design is a cooperative program between NASA and Lund that began in 1998. Each year there has been a different focus for the students.

Larry Toups, an engineer of the Exploration Systems Engineering Office, serves as the director of the program at JSC. Toups said that the students' work could help NASA as it prepares for future missions to the Moon and Mars.

"Yes, any time we use educational outreach as a means for gathering new ideas and concepts for how we might explore is always beneficial," he said. "Students think of new approaches at how we might live and work on the Moon and Mars based on their terrestrial design experiences."

This year's students were tasked to submit designs for the interior of a silo at the JSC Planetary Rockyard. The silo is an existing structure at the center's Planetary Rockyard, which contains simulated lunar and martian terrain. The silo could be converted into a habitation module mock-up for future astronaut training purposes.

Even though this was an architecture project, Toups said that math and science education played a role in the students' efforts. "Architecture curriculum does include the study of math and science as part of a broad base of training," Toups said. "During this project the students were constantly having to convert between our English units of measure and their metric units. Also, in researching about the lunar/Mars environment that the real habitat would function in, they had to readjust their assumptions used in terrestrial design, such as differences in gravity and atmosphere."

Like the International Space Station or the Space Shuttle, the habitable volume of a structure on the Moon or Mars will be limited and much planning must take place in order to use that space as efficiently as possible.

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Designing the interior of a human habitat for the Moon or Mars offers a challenge that designing the interior of a space station does not – gravity. Since the Space Station is in a microgravity environment, the restrictions on the use of habitable volume are less than they would be in a structure on the Moon or Mars. On the Moon and Mars, gravity will limit the amount of space that can be used.

NASA/Stafford JSC2005E10553

From left to right: Lund Institute of Technology students Elin Mossberg, Niklas Weser and Emma Rytoft discuss their STAR Design 2005 project with Sue and Connie Lee.

There is another twist. Since the Moon's gravity is about one-sixth of the Earth's gravity and Mars is about one-third, the architecture students could not treat the design as if it were for a structure on Earth. For example, the ceilings would need to be higher since the astronauts would have more "spring" in their step when they walk.

Architecture student Hanna Odestig said that their job was to provide ideas that could be used to prepare for future missions and that science played a part in their efforts. "It has been interesting to look at the flexibility," she said. "You have to have science to be creative."

Their design concepts included movable slabs and expandable walls.

Lund Architecture Lecturer Christian Wilke accompanied the students to JSC. He said that the eight students were selected after an in-depth interview process. Wilke said that this project will help the students in their future endeavors, even if they choose work in fields other than space exploration.

"The main idea is to put them in an unknown context in which they can't relate in the beginning, so they will start asking questions instead of using old solutions," Wilke said. "By doing this, they will get a more research-approach to architecture and science."

During the process, some of the students thought about what would be their greatest human need if they were an astronaut going to live on the lunar or martian surface. Odestig said that privacy would be a need for her. "I would want a good way to find my own private space," she said. "It is not a very large area."

Architecture student Sandra Kopljar said that she enjoyed the experience and stressed the importance of education in getting opportunities like she had with the STAR Program.

"If you really put an effort into your education, you have so much more to choose from," Kopljar said. "That is your reward."

Toups said that the students are not the only ones that learned during the project. "Any time I work with students, I feel as though I am learning from them," he said. "We need to remember that regardless of our focus here at NASA, a fresh set of eyes and imagination are needed to look at the way we envision the future. Don't forget that some of these students may be the ones who will actually be there when we establish permanent human presence outside of Earth orbit."

Eyeing the future

by Catherine E. Borsché

In space travel, one thing is certain: We have only scratched the surface when learning about the effects of microgravity on the human body. One topic of particular interest to the medical community is the effect that spaceflight has on the eye health of astronauts. Due to the lack of information in this field, scientists at Johnson Space Center are working to uncover the answers.

NASA/Markowitz JSC2005E10557

Dr. Keith Manuel, senior vision consultant for JSC Flight Medicine and optometrist, conducts an eye exam with patient Lisa Marek of Wylie Laboratories. Annual eye exams enable scientists to track the progression of lens abnormalities for the cataract study being done by the JSC Space and Life Sciences Directorate.

"While we thoroughly examine each astronaut prior to and following a mission, we must always concern ourselves with the harm that is sustained during a mission but may not manifest itself for years," Dr. Keith Manuel, senior vision consultant with JSC Flight Medicine, said.

Investigators in the Space and Life Sciences Directorate at JSC, in association with Brigham and Women's Hospital in Boston, Baylor College of Medicine, Space Center Eye Associates and Wyle Laboratories, have developed a study to evaluate cataract development in space. This study will determine the eye health risks associated with spaceflight and help scientists find ways to countermeasure the harmful effects.

A cataract is a clouding of the normally clear lens of the eye, which can be compared to a window that is frosted or yellowed. Clouding occurs because fiber cells in the lens become abnormal and block light from passing through the lens. Surgery is currently the only option for correcting cataracts.

"Information obtained from the study will provide new insights into the role of various components of space radiation in cataract development, as well as establish new leads for future research," Dr. Francis Cucinotta, chief scientist for the Space Radiation Health Project, said.

To complete the study, investigators will track eye lens changes in various control groups using specialized digital imaging. Three groups are being carefully monitored: astronauts; civilians with a history of military aviation; and civilians with a history of no military, commercial or private aviation.

Recently, a team of investigators in JSC's Space and Life Sciences Directorate reported that cataract occurrence is greater among astronauts when compared with non-astronauts. Also, preliminary studies done with animals using heavy ion accelerators to simulate radiation suggest that cataracts will grow faster in space. Scientists are concerned that risk factors linked to spaceflight and astronaut training could possibly contribute to cataract formation.

"There are many physiologic threats that astronauts sustain when they 'go to work,' and we in the medical community must keep a constant vigil on their behalf," Manuel said.

In space, astronauts do not have the Earth's natural protection from radiation, noted Cucinotta.

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During the first few years of the study, participants will get an annual eye exam and complete a food frequency questionnaire. Using data collected from the participants, researchers will then determine the prevalence and progression of different types of cataracts and probe the potential risks of radiation exposure during spaceflight.

While there have been limited studies on space radiation and cataracts, some basic information has also been acquired from ground-based medical research.

"Patients exposed to increasing doses of radiotherapy for cancer or bone marrow transplantation have been shown to develop cataracts," Cucinotta said. "Another study conducted with commercial pilots showed an association between flight time and cataract prevalence."

"Another goal of the investigation is to develop a means of assessing agents that may slow the incidence or progression of cataracts," Cucinotta said.

Baby Boomers will benefit from these studies as they age and need advanced medical care for ailing eyesight. Future spaceflight will also reap the rewards.

"The knowledge gained from this study will be invaluable for NASA and its population of astronauts by improving radiation shielding in space vehicles and future prevention of cataract development," Cucinotta said. "This investigation will make a significant contribution to spaceflight safety."