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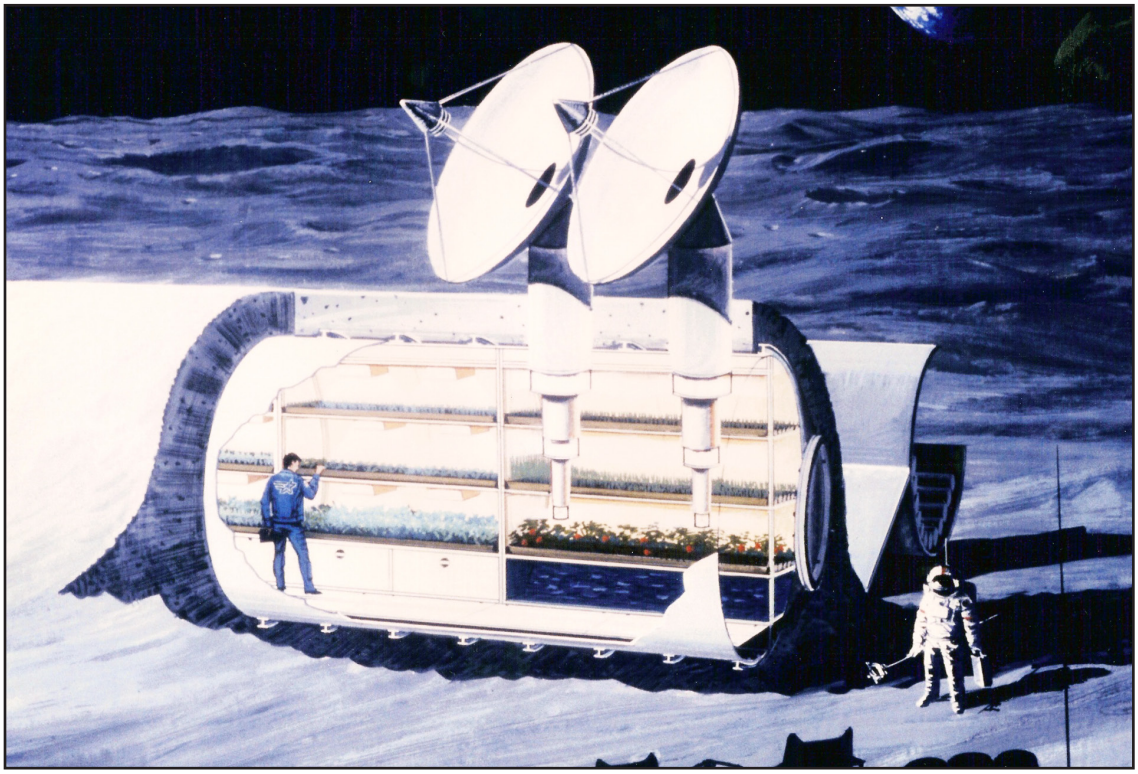
VEGGIE PLANT GROWTH UNIT



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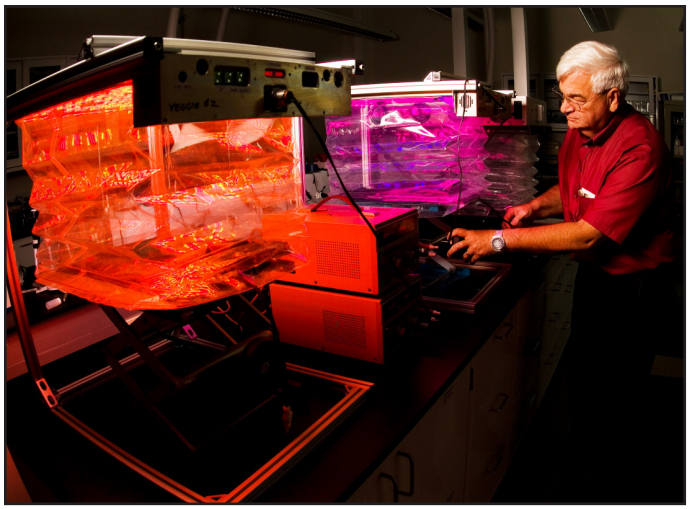
WCSAR Moon Farm Photo

Background

Currently, it takes a lot of planning, preparation and work to send food to Expedition crews living aboard the International Space Station. Stowage is also an issue because many fresh fruits and vegetables must be consumed soon after delivery, and some, such as tomatoes, are susceptible to bruising and damage during shipping. An alternative to shipping would be to grow crops "in-situ," or in space, where they could be consumed immediately after harvest. This could provide a continuous supply of fresh vegetables and small fruits, which would add variety, color and texture to an astronaut's diet. In addition, these fresh foods could provide a source of bio-available nutrients and antioxidants, which serve as a radiation countermeasure. Clearly, early missions are limited by the space and volume that could be allocated to growing vegetables, but even a small but steady supply of fresh food could have an impact on the acceptability of the diet and would improve the quality of life for crew members. And, experience gained with operating small plant growth systems could be used to design larger systems for life support on future long-duration missions, including the production of oxygen and the removal of carbon dioxide through photosynthesis. It also could aid in water purification through transpiration.

The VEGGIE Plant Growth Unit

The VEGGIE plant growth unit was designed and built by Orbitec Inc. of Madison, Wis., on a NASA-funded Small Business Innovative Research (SBIR) grant. VEGGIE was designed to be collapsible to minimize the stowage volume for delivery into space. Lighting for the plants is provided by a combination of



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Photos of VEGGIEs with different colored light

red, green and blue light emitting diodes (LEDs). The red and blue light are absorbed by chlorophyll and are efficient in driving photosynthesis, while the green LEDs add color balance to accommodate human vision for tending the plants. The blue light also is essential for plant phototropism, allowing the plants to grow toward the light, which is required in microgravity. In addition, the LEDs do not contain toxic mercury, a component of fluorescent lamps. They also have a long operating life, which reduces replacement costs, and they do not generate heat, or longwave, radiation on to the plants.

The Habitat Development Unit (HDU) project provides an excellent opportunity to test a small scale plant growth system like the VEGGIE in a mission-relevant environment. The VEGGIE provides 0.16 square meters of growing area and draws about 130 watts of power for the LEDs. The VEGGIE can be set up to operate autonomously with the

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VEGGIE plant growth system in the HDU / PEM unit.

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Testing the VEGGIE could hopefully lead to larger scale life support technologies for space exploration, perhaps similar to this lettuce hydroponic system at Cornell University.

exception of some crew time needed to refill the water reservoir. Testing in a harsh, remote setting, such as the Desert Research and Technology Studies (RATS) site in Arizona, will allow the crew to see some green, living plants. In the future, this could provide a boost in crew morale and performance, especially for a three-year mission to Mars. Currently, the Russian's "500-day" test to study human confinement for a Mars-like mission has plant growth units included to determine their effect on the crew well-being.

For this particular test with the VEGGIE unit, three varieties of lettuce were grown -- two red-leaf types, which are high in the antioxidant called anthocyanin, and a green bibb variety. Extensive baseline data have been gathered in laboratory tests with these same varieties for NASA's Exploration Life Support Project, which will allow the team to compare their performance under operational HDU conditions versus a more optimized laboratory setting. In addition to lettuce, baseline testing has been conducted with radish, green onions, dwarf tomatoes and dwarf peppers, in controlled environment chambers, similar to the VEGGIE unit.

Experience gained from the VEGGIE test in HDU will provide an opportunity to design follow-up testing with other crops and/or expanded growing areas with multiple units. Eventually, the DRATS team hopes to adapt the watering system and upgrade the hardware for a technology demonstration test with the VEGGIE on the International Space Station. This could be a first step to ultimately achieving autonomous, bioregenerative life support systems for future space missions.