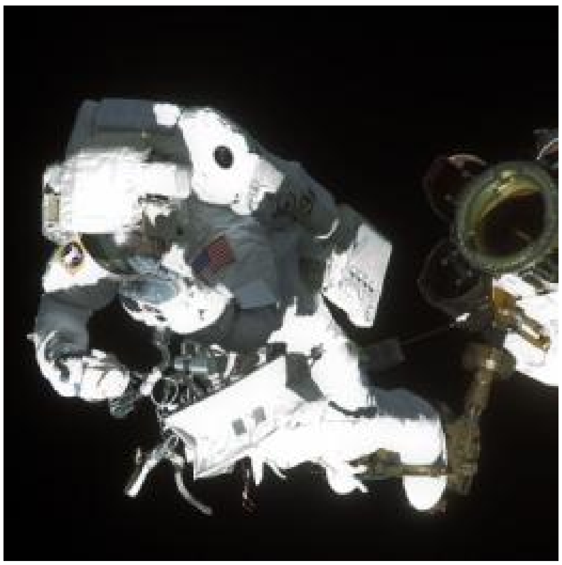
# The pull of artificial gravity

April 15 2010, by Morgan Bettex



Astronaut and MIT alumnus Robert L. Satcher Jr. '86, PhD '93, STS-129 mission specialist, participates in a spacewalk in 2009. Photo: NASA

(PhysOrg.com) -- Although President Obama's vision for NASA's future calls for canceling the Constellation program that was intended to send humans to the moon by 2020, his proposed budget for the agency still holds opportunities for future space research and urges NASA to develop the technology to enable human spaceflight to locations like Mars that are beyond low-Earth orbit.

Several MIT researchers have been intrigued by one item in the proposal that they hope Obama will elaborate on during today's policy speech at the Kennedy Space Center in Florida: extending operations of the

International Space Station (ISS) past its planned retirement in 2016.

According to Obama's proposal, keeping the ISS operational would allow NASA and other nations' space agencies to deploy new research facilities there, such as a centrifuge, which simulates the effects of gravity by spinning. Equipping the space station with a centrifuge would give scientists a valuable opportunity to test whether the device can offset some of the negative side effects of zero gravity, according to Justin Kaderka, a graduate student in MIT's Department of Aeronautics and Astronautics, who has studied the effectiveness of artificial gravity.

Without gravity, bone loses essential minerals, muscles atrophy and the cardiovascular system weakens. bone, muscle and cardiovascular systems recalibrate themselves, which results in bone demineralization, muscle atrophy and cardiovascular de-conditioning. Since the 1960s, artificial gravity has been discussed as a way to keep astronauts healthy during long-duration trips to places like Mars, which would take three years. Creating artificial gravity in space can be achieved either by using a "long-range centrifuge" in which a large spacecraft rotates continuously or a "short-range centrifuge" in which a person is attached to a spinning structure for intermittent periods. In either scenario, the spinning motion creates an acceleration field that mimics the effects of gravity on the human body.

For nearly two years, Kaderka has worked with Laurence Young, the Apollo Program Professor of Astronautics and a professor of health sciences and technology, to understand how artificial gravity compares to traditional countermeasures, such as resistance training and aerobic exercises done on treadmills and cycling machines. Although these methods are currently tested on the ISS, astronauts continue to experience weakening of the bone, muscle and cardiovascular systems upon their return.

Artificial gravity could be an effective countermeasure to deconditioning of a variety of human physiological systems because it supplies the missing stimulus — gravity — before significant weakening can occur. “Artificial gravity is unique because it goes to the source of the problem, unlike other methods that are designed to counter the deconditioning of individual physiological systems,” says Kaderka, who reviewed the results of more than 75 experiments done over the past 40 years on ways to counter the physical losses caused by prolonged weightlessness.

In a thesis that will be published in May, Kaderka concludes from his review that artificial gravity works just as well as traditional countermeasures at treating the adverse effects of long-term weightlessness on the cardiovascular system, especially when combined with other aerobic exercises. As for artificial gravity’s effects on muscle and bone, however, Kaderka suggests that much more research is needed.

William Paloski, a professor of space science at the University of Houston, values Kaderka‘s analysis for organizing a “hodgepodge of test objectives and findings,” noting that the work sets the stage for a “knowledge-driven coordinated approach” to future studies that could lead to successful gravity therapies for missions.

## The meta-analysis

Although Kaderka’s “meta-analysis” tries to provide a scientific basis for future experiments, he acknowledges that the data are limited because so few deconditioning studies involving artificial gravity have been done on Earth. These experiments are expensive because they require subjects to be bedridden for several weeks in order to mimic the deconditioning that astronauts experience in space.

Specifically, Kaderka compared the results of nearly 35 artificial-gravity deconditioning studies (including some done on animals) to those from about 40 experiments that tested traditional countermeasures. Taking into consideration differences between studies, such as their duration, Kaderka drew comparisons between studies that had consistency across certain variables, such as which physiological systems were assessed.

Based on data about subjects' maximum rate of oxygen uptake and tolerance to cardiovascular stress, among other parameters, he concludes that artificial gravity is just as effective as other countermeasures in offsetting cardiovascular deconditioning. But because there have been so few bed-rest studies that examined the effects of artificial gravity on muscle or bone, Kaderka was unable to make the same conclusion about artificial gravity for those systems.

## Not if, but when

Kaderka and Young acknowledge that even if a centrifuge is put on the ISS, much more ground-based research on artificial gravity will be needed to determine certain unknown variables, such as the amount of time or at what speed a person needs to be spun on a centrifuge for its use to be effective. They say that having the ISS centrifuge could provide hard evidence that artificial gravity is a viable countermeasure, which might lead to NASA funding more Earth-based experiments.

According to Young, who submitted a proposal through the Japanese Space Agency to deploy a centrifuge on the ISS months ago, it will take researchers years to quantify the effectiveness of artificial gravity, which is why NASA's plans should include both Earth and space experiments as soon as possible so that the agency is prepared to use the countermeasure when it decides to conduct long-duration flights.

"It's not a question of if, but when, NASA makes that decision," says Young, explaining that after NASA's proposed robotic exploration of

Mars and faraway asteroids, astronauts will need to travel to and explore those surfaces.

Provided by Massachusetts Institute of Technology

Citation: The pull of artificial gravity (2010, April 15) retrieved 24 April 2024 from https://phys.org/news/2010-04-artificial-gravity.html