National Aeronautics and Space Administration
Glenn Research Center
Cleveland, Ohio

John Glenn
Biomedical Engineering Consortium
Helping Astronauts, Healing People on Earth

Working Earth Resistance into Zero-Gravity Exercise Regimens

A new treadmill incorporating a dual track and virtual reality may be developed to help maintain astronaut bone mass while in space and minimize the difficulty of readaptation to gravity upon return to Earth. It could be an ideal tool for the rehabilitation of balance disorder patients on Earth, and is already being used to rehabilitate patients with gait abnormalities.

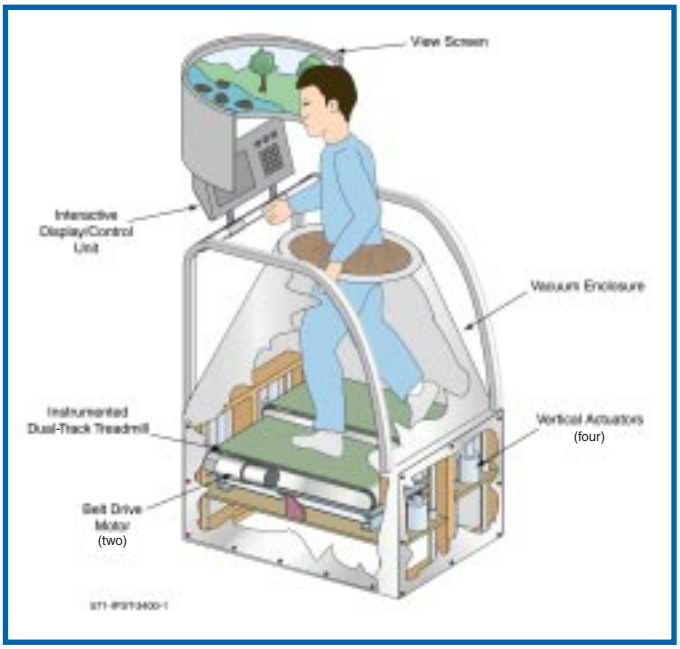
When you work out on Earth, you may be running, hiking, skating, skiing, or cycling; but you're also lifting weights, lifting anywhere from 100 to 200 to 300 pounds every single moment, if you're an adult.

The human body has evolved in the presence of Earth's gravity, which influences our growth, development, structure, function, orientation, and movement. Without this pervasive force, the body experiences many physiological changes involving the cardiovascular, neurological, endocrine, and musculoskeletal systems.

Living in a confined area where they can't walk or run, and where movement meets no resistance, astronauts obviously need aerobic exercise to keep their cardiovascular systems in good condition. It has been suggested that an exercise protocol for space flight should be designed that would also eliminate, or at least reduce, the usual physiological adaptations to weightlessness. This would certainly ease the return to Earth for astronauts who had spent significant time in space. To date, space workouts have concentrated on aerobic conditioning and have had only partial success in addressing bone demineralization, or other physiological adaptations such as disorientation.

Astronauts could benefit from sophisticated training aids that counteract the deconditioning of the human body in microgravity and, if possible, maintain their Earth equilibrium at the same time. Walking or running on standard treadmills, however, provides little input to the neurovestibular system, which helps human beings to maintain their balance on Earth. Principal investigator Susan D'Andrea of the Cleveland Clinic Foundation and co-investigator Jay Horowitz of Glenn Research Center are proposing a new treadmill to be developed under the John Glenn Biomedical Engineering Consortium (GBEC) that will incorporate perturbations to the body during exercise similar to those on Earth, and challenges to the neurovestibular system that increase its ability to adapt to unfamiliar situations.

The proposed treadmill will have split, moveable tracks, and each foot will be moving independently—forwards, backwards, or up and down—on its own belt. The user will experience the sensation of walking around curves, stepping over obstacles, or climbing hills. The effect will be enhanced with a new portable virtual reality system, where astronauts will be able to respond to Earthlike environments. In addition to fostering normal physiological processes of growth, development, and movement, the virtual reality feature could help maintain a sense of physical orientation. And it could increase exercise "compliance"; in other words, astronauts may want to work out because it's fun.



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Researchers will use the NASA Glenn Research Center's Glenn Reconfigurable User-interface and Virtual-reality Exploration (GRUVE) Laboratory to develop the new virtual reality system. The first tasks will be adapting the virtual reality system to the dual-track treadmill and developing a program to simulate the action of walking around a curve. When the treadmill is completed, subjects will run and walk on the treadmill as biomechanical measurements are made.

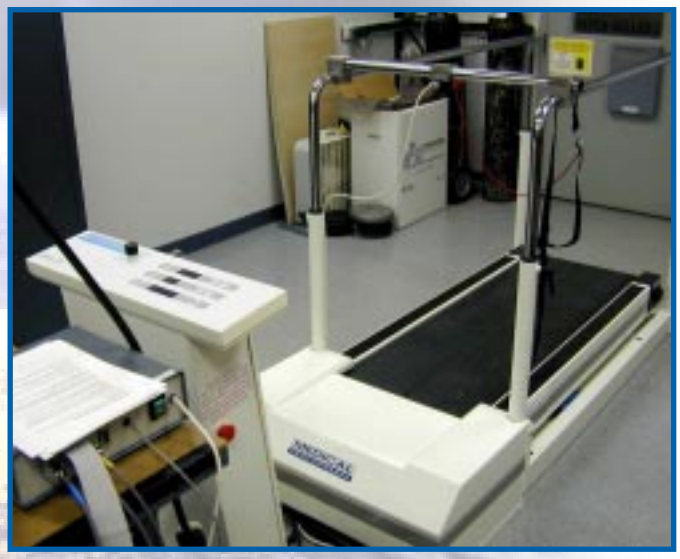
If the new treadmill with virtual reality system looks promising, astronauts and NASA exercise physiologists will be invited to test the prototype and suggest changes that may make it more beneficial. In the long run, the system will need to be adapted for use in space; for example, additional vibration isolation equipment will need to be added, so that the exercise equipment does not induce vibrations in surrounding experiments.

Benefits on Earth

This new system will help to reduce the amount of time required for astronauts to exercise in space by focusing on multiple physiological systems simultaneously. A lot of busy people on Earth would be glad to have a system like that.

Research with the new treadmill would also improve understanding of human neurological response to perturbation during walking or running. It could be an ideal tool for the rehabilitation of balance disorder patients on Earth, and is already being used to rehabilitate patients with gait abnormalities.

Not least, a portable, adaptable virtual reality system could be a boon for applications ranging from job training to recreation.



This dual track measures the force on each foot during exercise.

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