NASA INFORMATION

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058
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Preflight Adaptation Training Facility

Tilt Translation Device & The Dome

(Countering Motion Sickness)

Our perception of how we are oriented and move in space is dependent on information from vision, inner ears, touch and hearing systems. Attention levels and expectations about position and movement also influence perception.

Perceptual errors can be due to a number of things including the incorrect integration of these signals. Illusions that you are moving or the world around you is moving when they are not, spatial disorientation, and poor motor coordination are all evidence of perceptual errors.

When information about one's position and movement is not consistent across all the senses, individuals can develop motion sickness. Motion sickness can occur in all types of transportation vehicles, during spaceflight and during exposure to virtual reality systems.

Humans are extremely good at adapting to different environments, such as those present in microgravity and virtual reality systems. Moving back and forth from a normal environment to a different environment and vice versa many times allows the brain to switch quickly from one sensory-motor control program to the other.

Therefore the person becomes quickly adapted to either environment in a short period of time. There is one main purpose for the tilt-translational device (TTD) and the device for orientation and motion environments called the DOME.

It is to expose astronauts and other human subjects to visual, vestibular (inner ear), and other sensory stimuli that are like those experienced by astronauts in weightless spaceflight. The goal is to help crew members adapt to microgravity before flight.

When astronauts experience the altered sensory relationships again in-flight, the symptoms of space motion sickness, disorientation and lack of coordination will hopefully be reduced in both intensity and duration.

This will help improve the astronauts' health, improve their work, and make them better able to handle any emergency situations that may arise. Frequent training preflight may also allow the astronauts to readapt to Earth more quickly.

It can also reduce their postflight recovery period, allowing them to return to normal duty quickly. The technology can be used for several types of activities:

(1) Treatment of motion sickness, particularly for aircraft crews, (2) research to understand the perceptual and coordination adaptation processes associated with altered sensory environments such as spaceflight, and exposure to virtual environment systems (VEs), (3) development of various types of training scenarios, (4) development of safe, efficient training schedules, and (5) comparisons with and evaluations of technical features of dome and head-mounted VEs.

VE systems provide users with access to hi-tech interactive "immersion" in multi-sensory, 3-dimensional (3-D) synthetic environments. The range of VR applications is large. It extends from research by NASA with its Hubble telescope training experiment, in the military with their many visual flight trainers, to industrial hazardous procedures training, educational, medical and entertainment uses.

Though often brilliantly engineered, two critical and unresolved human factors issues in VE systems are potential "cyber sickness". It's a form of motion sickness, which is experienced in virtual worlds. Also is the transfer of maladaptive cognitive and/or psychomotor performance from VE to realworld environments.

A number of recent publications highlight the growing concern over safety issues related to the use of VE systems by federal agencies and members of industry and academic institutions. If use of VE systems is to be safe, effective and well received by their users, research to address these issues is required.

Technical Descriptions

DOME:

This device is a 3.7 m (12 ft) diameter spherical dome virtual reality (VR) system, with a 1.8 m (6 ft) diameter hole in the bottom. The inner surface serves as a projection surface for a video projector.

The projector and an adjustable chair are mounted on a 1.8 m (6 ft) diameter-rotating base, which fills the hole in the bottom of the dome. The rotator can produce speeds up to 120°/sec and accelerations up to 200°/sec^2.

This spinning rotation is the only real movement allowed by the system. The restraint adjusts for positioning the subject to (1) sit upright, (2) lie on either the left or right side, or (3) lie supine. A 3-D joystick or space ball may be used by the subject to move around the environment (like a video game).

Any real or imaginary visual environment may be represented, and the operator may select different environments for different training sessions. The subject can be placed inside a closed visual environment that represents the Space Shuttle middeck/flight deck, space lab, International Space Station, or a checkerboard room.

TTD:

This device is a tilting platform on which the subject is restrained in a car seat. In the one set-up, the axis of tilt rotation makes you feel like you are rocking in a rocking chair. In the second set-up, the axis of rotation makes you feel like you are rocking side-to-side.

A rectangular box mounted on the platform moves back and forth on rails around the subject. In the one set-up, the subject faces the end of the box and the box moves toward and away from the subject.

In the second set-up, the subject faces the sidewall and the box moves left and right around the subject. The visual surround is a 2.74 m X 0.89 m X 0.91 m (approximately 9' X 3' X 3') white box with 3-dimensional vertical black stripes on the inside walls and horizontal stripes on the ceiling.

Four successively smaller outlined black squares and a solid black square in the center is attached to the inside of the end walls. The line width and separation between lines is progressively smaller from the outer to the inner square to produce the appearance of a tunnel.

This "tunnel" effect produces a distance uncertainty that is designed to allow subjects to feel like they are moving back and forth instead of the box.