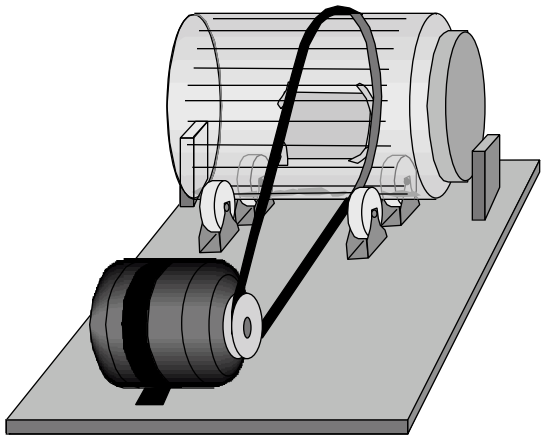
Teacher Tech Brief

Abrasion Tester

Background

Many years before Apollo astronauts walked on the surface of the Moon, some scientists speculated that lunar dust might pose a significant hazard. Dust accumulations in old craters could be quite deep and swallow up an unsuspecting astronaut that tried to cross one. Lunar Surveyor spacecraft that landed on the Moon prior to the Apollo expeditions showed that lunar dust (called regolith or sediment) had only accumulated to the depth of a few centimeters and therefore could not swallow up astronauts. This did not mean that the sediment was completely safe. Rather, the fineness of the sediment could pose a different kind of hazard—fouling equipment and suit components. Viking landers on Mars in the middle 1970s and the recent Pathfinder/Sojourner mission showed that Mars also has a sediment coating that could foul equipment and suit components of future Martian explorers.

Today, it is possible to study the effects of lunar sediment on materials because the Apollo astronauts returned home with samples. Rather than consume valuable lunar sediment samples on materials tests, analysis of the sediments permitted scientists to create simulated lunar sediments to use in experiments. Based on Viking studies of Mars and the discovery of Martian meteorites in Antarctica, scientists have also created simulated Martian sediments. Both simulants have been used in a variety of tests, such as fabric abrasion and penetration of bearing seals. Since astronaut stays on the Moon were limited to a



day or two, Apollo spacesuit materials only had to survive 10 to 20 hours of use. Future Martian explorers, however, will remain on the planet for many months to a year or more, and their suits will need to be constructed of rugged materials.

Purpose

This apparatus will measure the abrasion of fabrics and other suit materials exposed to simulated Martian sediment.

Principle

Test samples are placed in a rock tumbler or a specially constructed tumbler similar to the one shown on the proceeding page. Simulated Martian sediment is placed in the drum and the rotating motion causes the sediment to abrade the samples.

Materials and Tools Checklist

- ☐ Wooden base (12" x 24" x 1")
- ☐ Electric motor with pulley (use motor with low rpms)
- ☐ Pulley belt
- ☐ Plastic food jar (1 gallon)
- ☐ Four casters
- ☐ Wood block stops
- ☐ Fabric samples
- ☐ Masking tape
- ☐ Martian sediment simulant

Fabric abrasion tester in use at the NASA Johnson Space Center. The white drum contains an inflated cylinder made from the outer fabric ofa spacesuit. The drum also contains lunar sediment simulant. An electric motor with a pulley drives the drum.

Operation

The device shown on the previous page is a home-made rock tumbler. It is constructed from a plastic jar of the kind supplied to cafeterias and restaurants with various food stuffs such as relishes or mayonnaise. A motor, pulley, and rubber band belt rotate the jar. The jar rests on inverted casters and is held in place with stops at the ends. Squares of fabric samples are taped to the inside walls of the jar and a measured quantity of Martian sediment simulant is placed in the jar. The jar is allowed to rotate for a day or two and the fabric samples are removed for comparison with fresh samples. Reddish-brown volcanic rock used for landscaping can be used for making Martian sediment simulant. Bags of the rock will have small amounts of abraded sediment at their bottoms or you can crush the rocks to a fine soil-like material. Be sure to wear eye protection and gloves. Use a hammer to smash the rocks. Sort out and discard the larger pieces to leave just the sandy to powdery material behind.

Tips

- Look for an electric motor at an electric parts store. It may also be possible to find a suitable motor in an old appliance. Casters can be obtained at a hardware store.
- Examine fabric samples for signs of wear such as tears and holes. If a sample is opaque, place it on the lighted stage of an overhead projector to look for holes and thin areas.
- If solid materials are to be tested,do not test fabrics at the same time. The solid materials may damage the fabric,making it difficult to interpret the results.
- Estimate the number of rotations of the "rock tumbler" jar by counting how many times the jar

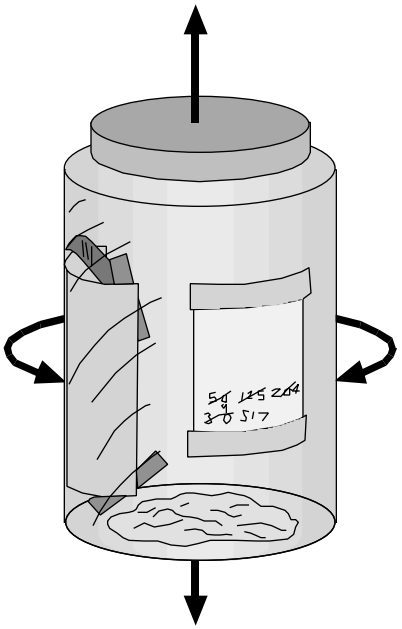
Apollo 16 astronaut Charles M. Duke Jr. samples lunar regolith (sediment) next to the "house rock" in the lunar Descartes highlands. Very fine sediment clings to his suit.

rotates in one minute. Multiply the number of minutes the jar has been rotated by the number of rotations per minute.

- More student interaction with the activity can take place if the motor-driven apparatus is replaced with just a jar. Each day for a week or two, students spend a few minutes shaking and rotating the jar and counting the number of times.

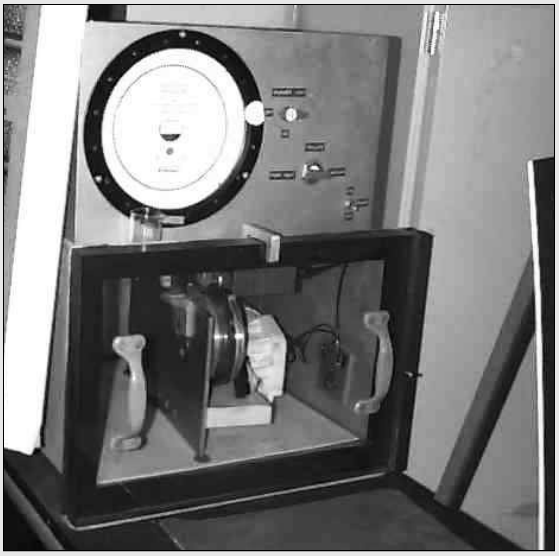
Extensions

- Devise testing procedures to measure the abrasion of the fabric on fabric in places on the spacesuit where fabric rubs against itself (underarms, crotch, etc.).

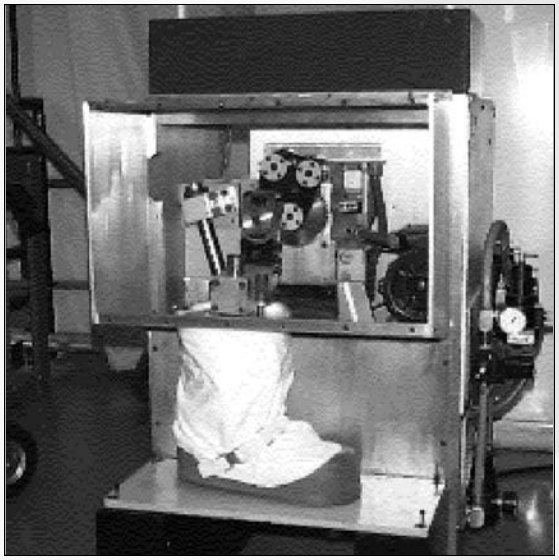


NASA Spacesuit Test Apparatus

In addition to laboratory versions of the testing apparatus described in the Teacher Tech Briefs, NASA spacesuit engineers also employ the apparatus shown on these two pages.

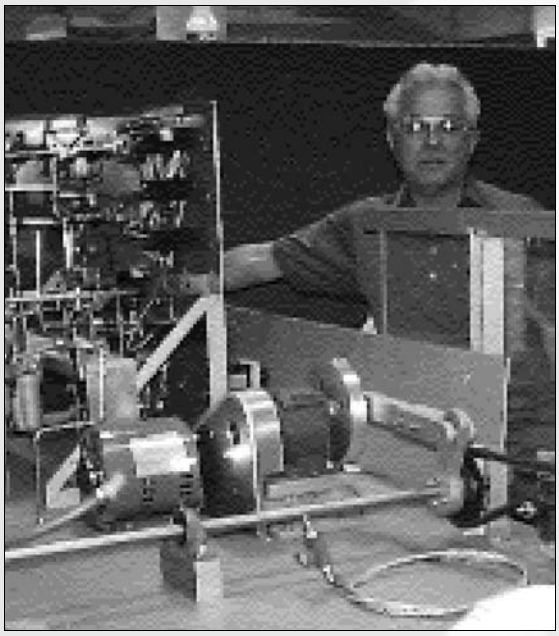


Bearing Tester
Bearings and other joints are subjected to simulated lunar sediment to find out if the sediment degrades their performance. The wrist bearing inside the unit is rotated as simulated lunar sediment is poured over it. The white device in the tester is a winshield wiper motor that rotates the bearing.

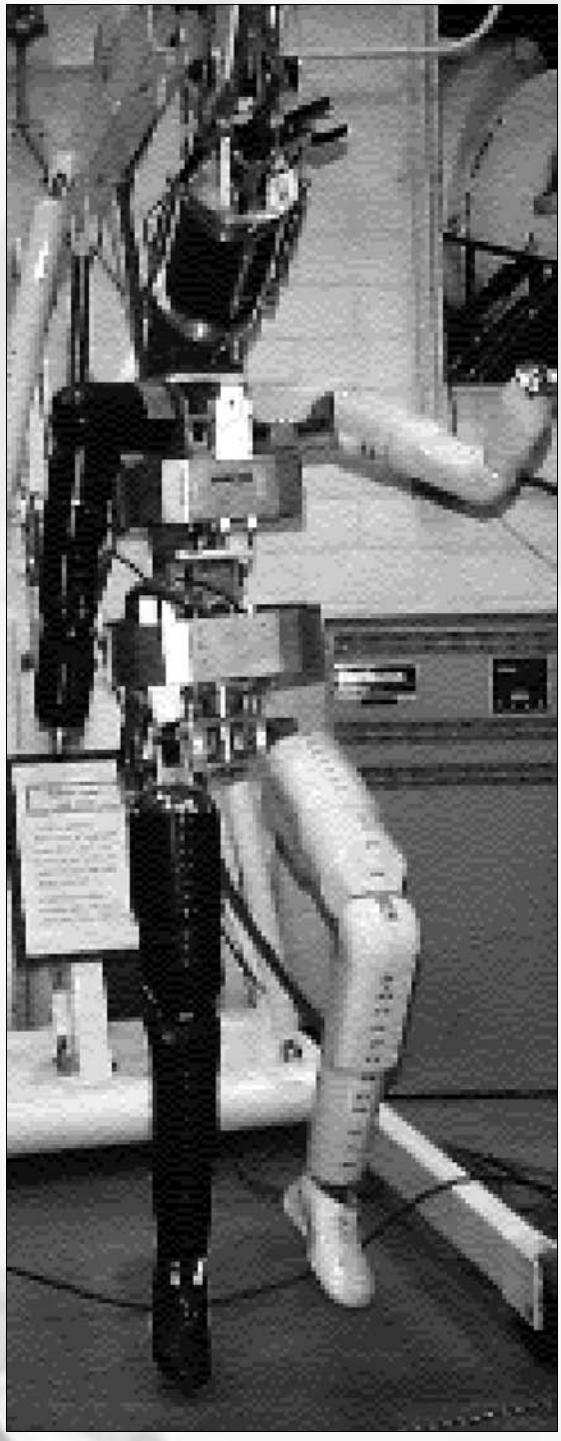


Mechanical Boot Tester
Checks book performance with a walking motion.

Waist Bearing Tester
The waist bearing is placed through a series of bends by this device.



Sleeve and Leg Tester
Inflated segments ofsleeves and legs are bent repeatedly by this device.



Spacesuit Robot
The forces required to move suit arms and legs when the suit is pressurized are measured with this specialized robot. The robot is placed inside a suit. A gasket seals the neck ofthe suit. The suit is then pressurized through the robot's "head." Joints in the arm and leg ofthe black side ofthe robot are bent on command and the forces are measured. The white side ofthe robot is nonfunctioning. Only one side ofthe robot is needed for data and the white side serves only as balance.