National Aeronautics and Space Administration
Langley Research Center
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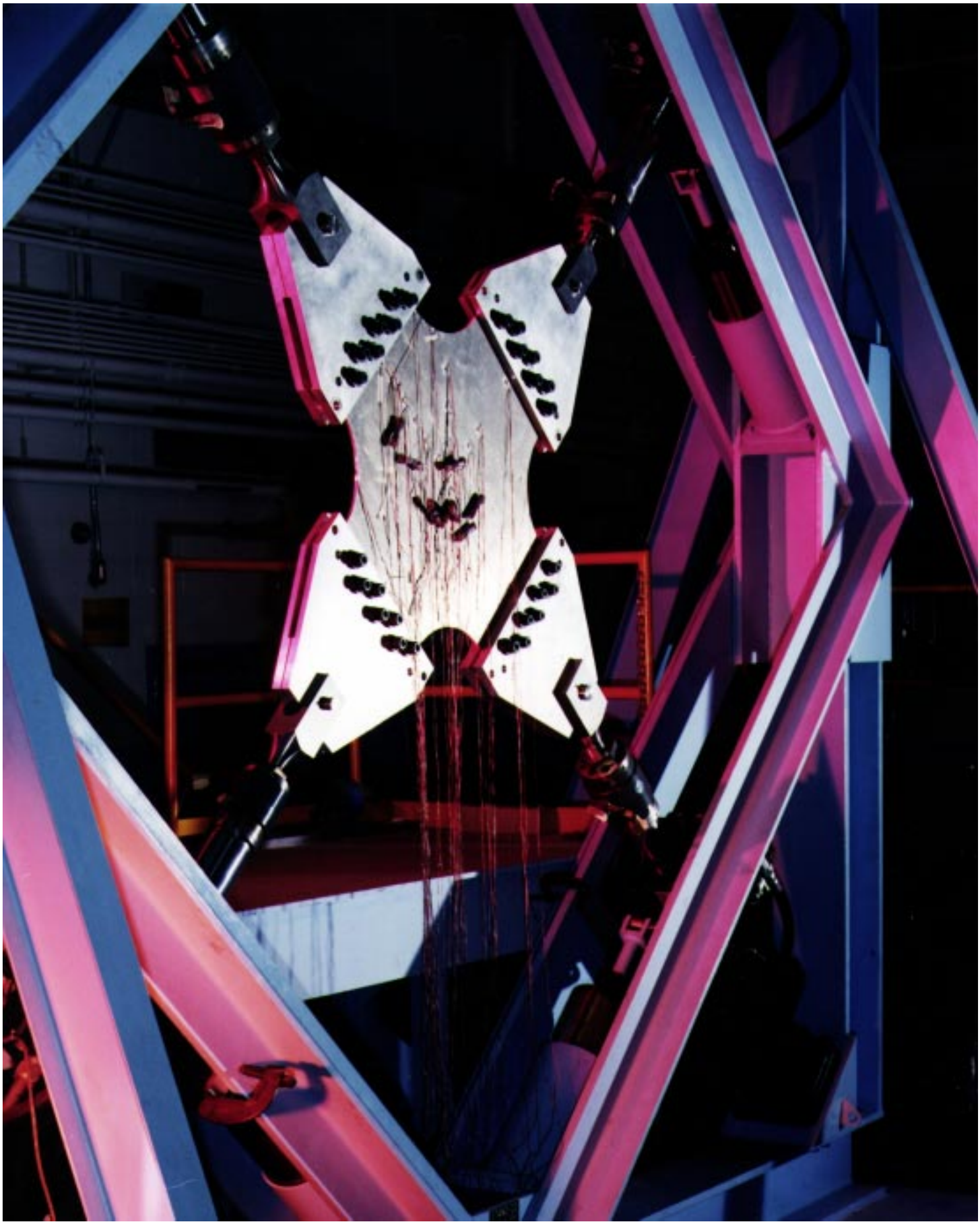
Futuristic Materials: Part of Our Present



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Futuristic Materials: Part of Our Present

What do ancient Egyptians and scientists at NASA's Langley Research Center have in common? They both learned long ago how to combine two materials to make a third one that is stronger than the two ingredients. The ancient Egyptians mixed mud with straw to make their houses. NASA Langley scientists use much more sophisticated combinations like carbons or textile fibers mixed with a glue-like polymer for space shuttle, satellite, airplane and other aerospace uses. In both cases, the materials are called composites: a combination of a base material (straw or carbon) with a glue (mud or polymer). NASA Langley's continued development of new and stronger materials for aerospace use brings new technology to everyday life.

NASA has launched its New Millennium Program which will focus on developing smaller, more capable, less costly vehicles powered by micro-spacecraft and micro-instruments. The success of this program depends on future new materials.

Important considerations for materials

Light Weight. It takes ten pounds of resources to get one pound into space and back. Therefore, the lighter the material, the less costly it is to get a structure into space.

Dimensional Stability. A dimensionally stable material retains its size and shape with changes in temperature. This is especially important in a spacecraft which may orbit the Earth every 90 minutes, moving in and out of the sun's heat.

Life Prediction. Some missions run for years. Some run only a few weeks. The life of a material can determine the length of the mission and if not predicted correctly can lead to premature failure.

Environmental Stability and Durability. Some components must be durable in the harsh space environment which includes radiation, atomic oxygen and a vacuum.

Strength/Stiffness. How much load a material can hold before breaking and how flexible it is are two different considerations determined by the desired application.

Manufacturability. A material that is hazardous to the people who are manufacturing it or to the environment can be more expensive to make because of the special requirements to handle and dispose of it.

Cost Effectiveness. The cost of a material, including production and testing, is a major consideration and can be the determining factor in whether or not it is used.

What does your stereo speaker and a space shuttle sensor have in common?

Piezoelectric (pi·e´zo·e·lec´tric)***materials!***
Scientists call these "smart" composite materials because they respond to electrical impulses by changing shape or moving. Their ability to move causes mechanical movement in other components. They can also be programmed to indicate when heat, light, motion or pressure has changed. In the aerospace industry, piezoelectric components are used in satellites, in optical positioning and for onboard adjustments. At home, piezoelectric components are in the tweeter section of a stereo speaker and act as a sound modulator by vibrating at different frequencies.

What do race car brakes and spacecraft heat shields have in common?

Carbon-carbon! These materials make up another group of composites. They are made using high temperatures where carbon particles are bonded in a carbon matrix. They can withstand extreme heat, like in the nozzle cone of a rocket and in a space capsule's heat shield. You have seen them on the space shuttle where they are used in the black nose cap to protect it from the incredible heat of re-entry into Earth's atmosphere. They are also used in the brakes and clutches of Indy and Formula I race cars.

What do satellites and the valves in your car have in common?

Micro-Composites! Micro-Composites are a combination of a metal, carbon or ceramic with a polymer. They can withstand extreme temperatures, from almost 400°F to below freezing. Future aerospace uses include screws, rings, satellite optical mounts and mirrors, just to name a few. Here on Earth we find micro-composites in the automotive industry in components such as valves, bearings and shaft seals.

Classroom Activities

1. List ten composite materials you use (examples: paper mache´, a peanut butter sandwich, etc).
2. List some composite materials used in an automobile or bike and comment on why they are or are not effective. What characteristics would improve them?
3. Make some composite materials like the ancient Egyptians and list the pros and cons of each material. Think about durability, cost, appearance and ease of construction.

What do auto parts and a passenger jet have in common?

New metals! Here we are not talking about composites but rather new metals like aluminum lithium and improved titanium alloys. These new metals are stronger and stiffer. They also are lighter weight which means vehicles using them can have smaller engines, carry less fuel, and fly longer. Like composites, the new metals can tolerate extreme heat.

New metals are now used mainly in rocket tanks, such as the propellant tank on the space shuttle. Commercial applications include components in the automobile industry.

From a nozzle cone on a rocket to the brakes on a race car, Langley's development of new materials is influencing not only the way we explore space and travel but the way we live on Earth as well.

LG-1996-08-0003-LaRC