

## **Structures Investigation**

A key component of a car is the underlying structure, or the “chassis”. The chassis is a mechanical component that must provide structural support for the motor, wheels, axles, solar panel, etc. When designing a chassis to perform these functions, you may also find you want to make the structure as lightweight as possible (why?). How do we make a chassis that is strong and light? Some materials have a higher “strength to weight ratio:” than others. For example, similar weight sheets of paper and plastic will probably not support the same amount of weight. In addition to the inherent strength of a material, its stiffness also plays a major role in the forces that the structure can withstand. We will see in these investigations what the relative strengths of some materials are and how the shape of a material can impact its stiffness.

## Structures Investigation #1

The differences in the loads that a miniature car frame can carry with materials of different strength and shape can be demonstrated effectively without building an entire chassis. Here dowel rods are used to stimulate axles and wheels, that is, they allow the material to flex and bend much as real wheels and axles would.

### Materials

2 one inch diameter round dowels, two feet long

Various size sheets of:

Ordinary cardboard sixteenth of an inch thick (such as the back of a pad of paper)

Corrugated cardboard

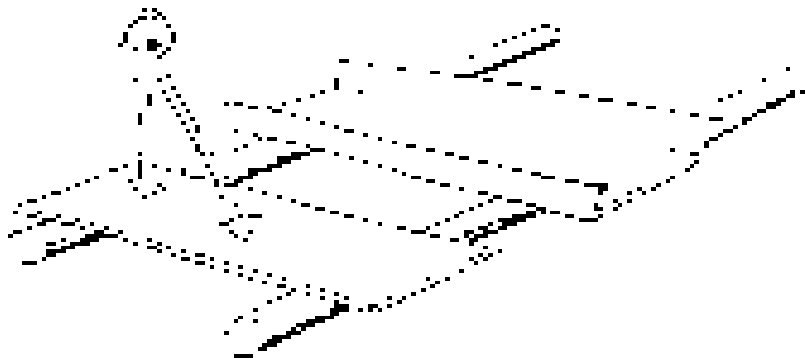
Foamcore board

Balsa sheet, eighth of an inch and a sixteenth of an inch thick

Plastic sheets

Small weights (up to one pound)

- Lay various materials across the dowels and place weights at various positions. Compare how well the materials support the weights. At what positions do the weights have the least effect on the shape of the chassis material?
- Try two thickness of the same material. Is extra strength worth the added weight to you? Can you combine materials to achieve satisfactory performance?
- Vary the shapes of the materials and see how much weight they can support (keep the size and weight of the material constant). What effect does folding have? Does direction matter?
- Try corrugated cardboard with ribs running the long and short way. Why is corrugated cardboard used more frequently than the same thickness of simple cardboard?



Chassis for model solar cars:

What materials (or combinations of materials) would you like to use in a model solar car? Are there any other materials you would consider but didn't have today?

Composite structures, made from multiple materials, can be designed to have high "stiffness to weight ratios" that are much higher than those of the component materials themselves. "Foamcore" (foam sandwiched between heavy paper) is one example. Can you think of others?

Everyday examples

Structural design is a very important part of engineering every commercial product, from machines to clothes. Consider the following examples:

- A rubber band is stronger but less stiff than a circular strip of paper of equal width. (Prove it with an experiment).
- Bridges and buildings use different shapes to increase the ability to withstand loads from different directions, including weight and wind.
- Bridge beams are shaped in cross-section (such as an "I-beam", "channel", or a "box-section") to maximize the stiffness and strength to forecasted loads (such a vertical load against gravity) for a given amount of material. Other cross-sectional shapes are used for different forecasted loading.
- Cars and planes use different structural shapes to withstand loads, provide stiffness, and to connect, support, and protect different systems (driver, engine, wheels, etc.) into a whole product.