

Paper Chair Engineering		Grade 7 – Form and Function
<b>Lesson Plan</b>	<b>Safety Notes</b>	Choose a load that can be reasonably supported by a paper structure. Choosing an extraordinary load might risk damage to you or your work surface.
<p><b>Description</b> Can you create a chair that can hold a load using only paper and tape? Explore what makes a chair strong and stable enough to sit on, and apply learning about what elements lend support, strength, and stability to structures.</p>		
<p><b>Materials</b></p> <ul style="list-style-type: none"> <li>• Paper (8.5x11” office paper is fine – you can recycle scrap paper!)</li> <li>• Scotch or masking tape</li> <li>• Scissors</li> <li>• Something to serve as a load to test your structure. It can be a small/medium toy or stuffed animal, or it can be a small can of food.</li> </ul>		
<p><b>Science Background</b></p> <p>Some structures may seem simple, but a number of design elements go into making that structure stable and able to withstand external forces (e.g., gravity, wind, earthquake) and internal forces (compression, tension, shear, and torsion). Some of the elements that add strength and stability include: material choices, support pieces such as beams, trusses, and struts, the overall weight of the structure and how that weight is distributed (i.e., where is the centre of gravity? Does symmetry matter in your design?), the weight of the load that the structure must support, and where the force of that load will be applied to your structure. You will also want to consider what your structure is being used for and who is using it. Ergonomic design takes the user into account to make a design more efficient (e.g., chair height so the user can sit at a comfortable height at a table; the size and shape of handheld objects so that they can fit comfortably into people’s hands).</p> <p>When you’re designing a structure, there are also many factors that can lead to design failure. These can include: poor design, using the wrong materials for the job, faulty construction, and loads that are too extreme for the structure to support.</p> <p>Design engineering follows a series of steps, known as the Engineering Design Process. These steps are important for planning, building and improving a successful structure.</p> <ol style="list-style-type: none"> <li>1. Ask - Identify and research a need.</li> <li>2. Imagine - Develop possible solutions</li> <li>3. Plan - Design a prototype</li> </ol>		

4. Create - Build and test your design
5. Improve - Make changes to your design and retest it

### Activity Procedure

- The goal is to design a chair using paper and tape that will support a load. You can take some time to look at chairs around your house or search chairs online. You might be surprised at how many design variations exist (e.g., wooden dining chairs versus modern or experimental designs; laser cut chairs, Ikea furniture, folding chairs, egg chairs, inflatable bubble chairs popular in the 90s). Consider which chair designs might be useful for your goal.
- The design phase is an important step to the engineering process that should not be skipped. Take time to think about your chair design and how you would like to build it. Does your chair have to look like a dining room chair? Can it have a different shape and still be strong? Consider that your chair is being built using paper and tape, rather than standard chair materials (wood and screws, metal, molded plastic). Does your design need to be altered to take your material into account? How much material will you need?
- Construct your chair using only paper and tape as materials.
- Don't forget to test your structure. When you "sit" your load on the chair, what happens?
  - If the chair buckles, wobbles, or falls over, try making changes to your design, or test a new design. How can you shape paper to make it stronger? (eg., folding, adding layers, adding structural elements of support such as struts)
  - If the chair is stable when you add your load, are there ways to iterate on your design to make it more ergonomic for the user, to make it more aesthetically pleasing, or to make it even stronger (perhaps to support a second load?).

### Debrief

This activity is meant to be challenging. Paper and tape are not ideal materials for constructing a chair that can support a load, but it is possible with the right design elements applied. Folding and adding layers can strengthen paper to make it more useful for construction. Including supportive elements like struts or cross-beams will make your design stronger. Placing your support elements so that they strengthen the chair where it has to support its load will help to make it more stable.

The Engineering Design Process often involves repeating steps, redesigning, re-testing, and improving based on learning from where designs fail. It's important to understand that design failure isn't bad unless you use a faulty design as a final product.