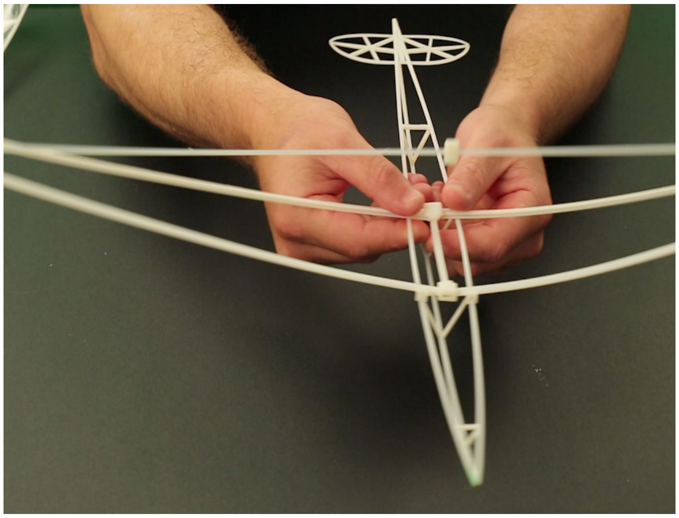
LESSON GUIDE

Glider Challenge



Level	Intermediate
Academic Connections	Aerodynamics, Engineering, Hands-On Learning, Prototyping, Design for Manufacturability
Core Concepts	Engineering Design, Engineering Analysis, Design Optimization, Print Optimization, Assembly, Computer Aided Design (CAD)
Duration	1 – 2 weeks

Students are challenged to design a glider with these rules:

- The glider may be composed of several parts, but they must fit within one printer tray.
- The entire glider must be made of 3D printed material, except for the wing covering and a minimal amount of adhesive.

LEARNING OBJECTIVES

By the end of this workshop, the student will be able to:

Design, construct, and assemble a glider where the main structure is made of 3D printed materials.

ESSENTIAL QUESTIONS

1. What is the most effective existing design in terms of:
   a. Wing aspect ratio?
   b. Wing profile?
   c. Wing placement (high/low, canard, flying wing)?
2. Can you create a more effective design, given the challenge constraints?
3. What are the essential components of a glider in terms of flight? Structural strength?
4. What is the correct balance between strength (for launching, flight and landing/crashing) and weight (for longer flight times)?
5. How can 3D printing technology allow you to create a more effective design (complex shapes and profiles, weight savings by "trimming" non-load bearing areas, rapid prototyping)?
6. What is the best way to divide the glider into parts? In terms of printing time? Maximum content on tray? Strength?

REQUIREMENTS

- Educator PC with access to:
- Microsoft PowerPoint
- QuickTime
- Internet connection
- Projector
- 3D printers
- CAD design tool

DESIGN TIPS

1. Different wing profiles are available, as well as a sample asymmetric profile in DXF format. However, for a glider of this size, a flat profile will probably be good enough.
2. Wings can be covered by many foils and films such as Mylar, plastic wrap, cellophane, rice paper, and adhesive tape. The lightest option is perhaps food wrap foil adhered with a little instant glue.
3. The glider will usually need a balancing weight to bring the center of gravity to the correct place for level flight.
4. A lump of Plasticine (or equivalent modeling clay) can be used for the weight, or 3D printed weights can be used.

DESIGN TIPS FOR FDM®

1. The minimal wall thickness varies depending on the layer thickness. For load bearing parts, the minimum wall thickness is approximately the width of 2 contours.
2. You can print connectors that hold parts together. They can be based on friction, snaps or a little drop of adhesive. As a design rule of thumb, for moving parts, leave a clearance of 0.31 - 0.51 mm (0.012 -0.020 in.) between parts in the X/Y-axis (please reference FDM Best Practice – Assemblies). Clearance equal to at least double the layer thickness for the Z-axis is recommended. Typically, a (0.051 – 0.102 mm (0.002 to 0.004 inch) offset or clearance will work for mating features (please reference Best Practices – Building Assembly Parts, available in the Advanced Applications section at http://www.stratasys.com/3DLC).
3. Use smooth fillets in corners since sharp corners can cause premature failure. Know the material limitations by referencing material data sheets. Consider printing a simple model to get the feel and design accordingly.

OPTIONAL

1. Look at the part arrangement on the printer tray and ensure the proper orientation is chosen to resist the forces and interface with other parts (See Nesting: Orientation & Support Removal. Available in Advanced Applications section at http://www.stratasys.com/3DLC.)
2. Use mechanical analysis/simulation software to help you reach an optimal design.
3. Print prototypes of your design, test them and improve it accordingly.
4. You can make your design modular. For example, the fuselage will be constant but you can use it to test various wing designs.

SUGGESTED NEXT LESSONS

GOLF PUTTER

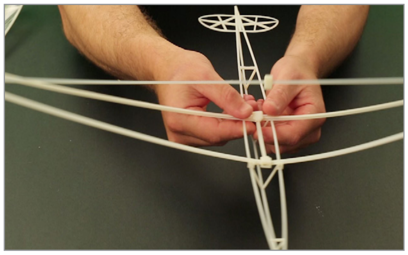
Design a golf putter and explore moment of inertia and how it affects a putter's action when striking the ball. Use the swing weight scale and the putter's length to determine the approximate head weights that will be needed for the design.

ROCKET

Covers all topics necessary to pass the Certified SolidWorks Associate (CSWA) exam while designing a printing a rocket. Although the SolidWorks rubric is discussed here and the course is designed to prepare students for the CSWA exam, the lesson can accommodate a range of 3D CAD packages.

CATAPULT

Design a catapult that can throw a 3D printed ball as far as possible.



To access additional 3D Learning Content and resources visit:

http://www.stratasys.com/3DLC

stratasys

HEADQUARTERS

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

STRATASYS.COM
ISO 9001:2008 Certified