Card Model Building Instructions for:

Robert Goddard’s first liquid-fueled rocket

Paper model designed by Carl Hewlett, May 24, 2007
(Instructions created by Mike Vink)

1st, a look at the History:

Robert Hutchings Goddard (October 5, 1882 – August 10, 1945), U.S. professor and scientist, was a pioneer of controlled, liquid-fueled rocketry. He launched the world's first liquid-fueled rocket on March 16, 1926. Though his work in the field was revolutionary, he was often ridiculed for his theories. He received little recognition during his own lifetime, but would eventually come to be called one of the "fathers of modern rocketry" for his life's work.

Goddard launched the first liquid-fueled rocket on March 16, 1926 in Auburn, Massachusetts. His journal entry of the event was notable for its laconic understatement: *"The first flight with a rocket using liquid propellants was made yesterday at Aunt Effie's farm."* (The launch site is now a National Historic Landmark, the Goddard Rocket Launching Site.)

The rocket, which was dubbed "Nell", rose just 41 feet during a 2.5-second flight that ended in a cabbage field, but it was an important demonstration that liquid-fuel propellants were possible.

People familiar with more modern rocket designs may find it difficult, on viewing the well-known picture of "Nell", to distinguish the rocket from its launching apparatus. The complete rocket is significantly taller than Goddard, but does not include the pyramidal support structure, which combined, averaged about 11 feet tall.

The rocket's combustion chamber is the small cylinder at the top; the nozzle beneath it. The fuel tank, which is also part of the rocket, is the larger cylinder near the bottom of the structure. The fuel tank is directly beneath the nozzle, and is protected from the motor's exhaust by an asbestos cone.

Asbestos-wrapped aluminum tubes connect the motor to the tanks, providing both support and fuel transport. Improved understanding of rocket dynamics, and the availability of more sophisticated control systems, rendered this design—in which a motor at the top pulls the rocket—obsolete, supplanted by the now familiar design in which the motor is located at the bottom and pushes the rocket from behind.

Sources: Wikipedia & Clark University’s Robert H. Goddard Library.

<u>You will need the following items:</u>

1. PDF reader software
2. Computer Printer, (Color), with 8 ½”x11” media carriage
3. 8 ½”x11” bond copy paper
4. 8 ½”x11” card stock paper
5. Clear drying PVA Glue
6. Clear drying Glue Stick
7. Hobby Knife
8. Scissors
9. Straight edge, (For cutting guide).

Prepare for your build by doing the following steps:

1. Plot/print the Parts in the PDF file. Print page 5 on the back, blank side of page 1.
2. Plot/print with the "fit to page" feature turned off.
3. Cut parts out on a cutting surface, (i.e. cutting board or mat). This protects the table and prolongs the life of your knife blade.

Steps for Build:

Note: You may wish to use heavy card stock for part 1 as it will be extremely flimsy otherwise.

1. Cut out all white areas surrounding part 1. Fold the four "wings" downward and glue the seams making a caged framework.

   Note: It might be easier to cut away the upper right and lower left sections and glue them to the other two sections individually after folding the remaining framework.

2. Cut out all white areas surrounding both parts 1a and glue them to the upper sections of part 1 as shown in the Side Elevation on page 3.
3. Cut out, score, fold and laminate part 2 before gluing it to the base of part 1 at the point shown on the bottom cross bar. Use the Front and Side Elevations on page 3 for placement details.
4. Cut out, score, fold and laminate part 3 before gluing it to the base of part 1 at the point shown where the bottom cross bar meets the lower right section. Use the Front and Side Elevations on page 3 for placement details.

   Note: You may want to leave this part unattached until completion of the model so it will not interfere with placement of the center rocket stage onto the frame.

5. Place the support structure aside for now.
6. Cut out part 4 but DO NOT cut away the interior white areas yet. CAREFULLY score down the joint between the two sections, fold and laminate together taking care to get a good alignment of the two sides. Set aside to dry.

   Note: You may wish to print part 4 on gray or silver card stock in order to mask any alignment problems.

7. Cut out part 5 and its associated parts. Affix the glue tab to the rear, unprinted side of part 5. Score and fold the upper and lower glue teeth downward toward the unfinished side in preparation of attaching the end caps. Roll this assembly into a cylinder and glue the other end of the glue tab to the other, unprinted end of part 5, making a tube.
8. Glue the two end caps to the cylinder and set aside for now.
9. Cut out part 6 and its associated parts. Affix the glue tab to the rear, unprinted side of part 6. Score and fold the upper and lower glue teeth downward toward the unfinished side in preparation of attaching the end caps. Roll this assembly into a cone and glue the other end of the glue tab to the other, unprinted end of part 6, making the exhaust nozzle.
10. Glue the two rings back to back. When dry, cut out the center circle and glue the "doughnut" to the bottom of the nozzle. Make sure the finished nozzle opening is clear of any obstructions or glue teeth.
11. Glue the part 6 nozzle assembly to the bottom of the part 5 combustion chamber assembly as shown at the right of page 2 and set aside for now.
12. Cut out part 7 and roll into a cone, gluing the tab to the rear, unprinted side and set aside to dry.
13. Cut out part 8 and its associated parts. Affix the glue tab to the rear, unprinted side of part 8. Score and fold the upper and lower glue teeth downward toward the unfinished side in preparation of attaching the end caps. Roll this assembly into a cylinder and glue the other end of the glue tab to the other, unprinted end of part 8, making a tube.
14. Glue the two end caps to the cylinder and set aside for now.
15. Cut out part 9 and its associated parts. Affix the glue tab to the rear, unprinted side of part 9. Score and fold the upper and lower glue teeth downward toward the unfinished side in preparation of attaching the end caps. Roll this assembly into a cylinder and glue the other end of the glue tab to the other, unprinted end of part 9, making a tube.

16. Glue the end cap to the bottom of the cylinder.
17. Glue the part 9 assembly to the bottom of the part 8 assembly as shown at the right of page 2.
18. Glue the part 7 asbestos cap to the top of the part 8-9 tank assembly and set aside for now.
19. Cut out part 10 and its associated parts. Affix the glue tab to the rear, unprinted side of part 10. Score and fold the upper and lower glue teeth downward toward the unfinished side in preparation of attaching the end caps. Roll this assembly into a cylinder and glue the other end of the glue tab to the other, unprinted end of part 10, making a tube.
20. Glue the two end caps to the cylinder and set aside for now.

    Note: Don't worry, that was the last one you had to do.

21. Locate part 4 and CAREFULLY remove all white areas inside the frame structure of the rocket.
22. Using the assembly drawing at the right of page 2, insert and glue the part 5-6 rocket motor assembly at the top of the part 4 frame structure.
23. Again, using the assembly drawing at the right of page 2, insert and glue the part 7-9 fuel tank assembly at the lower end of the wide part of the part 4 frame structure.
24. Finally insert and glue the part 10 tank to the bottom of the part 4 frame structure, again using the assembly drawing at the right of page 2.
25. Now, CAREFULLY insert the rocket assembly into the part 1-3 support structure assembly, using the Front and Side Elevations on page 3 for guidance.
26. If you did not install part 3 earlier, do so now.
27. Your model of Robert Goddard's first liquid-fueled rocket is now complete.

Enjoy your finished model.

Note: Those of you who are more ambitious, may wish to use the parts 1 through 4 as templates for a framework made of wire, giving you a more accurate and rugged model.

Mike Vink