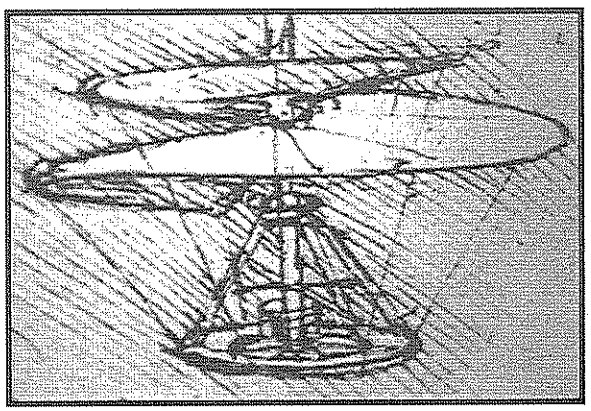
Leonardo's Helicopter

In addition to drawing several different kinds of fixed-wing gliders and flying machines with bird wings, Leonardo also began thinking about the possibilities of flying with a wing that lifted up off the ground like a screw, rather than like a bird. Around 1480, he began experimenting with the idea of using spin to lift a vehicle off the ground, and in 1482, he drew a diagram of a machine that looks a lot like a helicopter.

Just like many other Leonardo inventions, the idea for a helicopter-type machine wasn't his alone: hand-held flying toys developed by the Chinese that used the same principle of spinning lift had been around for centuries. But what Leonardo did was look at the concept of spinning lift and try to apply it to human flight. He drew a model for a helicopter-type machine that he thought could take off from the ground and called it the Helical Air Screw. In his notebook he wrote, "I have discovered that a screw-shaped device such as this, if it is well made from starched linen, will rise in the air if turned quickly."

Leonardo used his knowledge of bird anatomy to design the Helical Air Screw: his plans called for the structure to be made of hollow reeds, so it would be lightweight but also rigid and strong, and covered in starched linen, which would make the wing quite stiff but as light as possible. To power the helical screw, Leonardo called for four men to run around the central shaft, hold-



Helical Air Screw design.

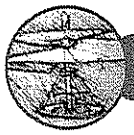
ing on to a bar sticking out of the shaft. His theory was that their combined energy would make the spiral turn and create enough force to make the helicopter bore through the air like a corkscrew.

The problem is that Leonardo's design just wouldn't work: the forward action of the men pushing the shaft wouldn't provide enough power to overcome the turning effect, or torque, produced by pushing the helical screw around the central pole. Rather, the machine would stay on the ground—and eventually fling the men away. You've probably experienced this if you've ever pushed a playground whirligig as hard as you could and then tried to jump on. The force of the turning axle pushes you away, and you have to fight that force to get on.

In fact, it took more than 400 years and many other failed experiments before helicopter innovators designed a machine that could overcome the torque of a spinning axle and make a successful flight. The invention of the internal combustion engine in 1876 made it possible for inventors to get enough power to lift a rotary wing aircraft off the ground. In 1907, Frenchman Louis Bréguet built an X-shaped helicopter with four rotors (one on each end of the X) named *Gyroplane #1*, that he managed to "fly" a few inches off the ground. The age of the helicopter was born.

Leonardo the Innovator

One reason Leonardo was so successful as an inventor was that he could imagine ways to use and improve ideas and machines that already existed. For example, Leonardo designed a trumpet with keys. The trumpet (probably what we would call a bugle today) had been in existence as a military instrument for many years, but because it consisted of a plain tube, it couldn't play every note of the scale. Leonardo designed a trumpet that had keys and a second tube so that the trumpeter could play all of the notes in a scale and actually shift musical keys. Another invention Leonardo modified was the roasting spit. Roasting spits had been around since the Egyptians, but required someone to turn the spit so the meat wouldn't burn over the fire. Leonardo designed a roasting spit that turned itself: the hot air that rose from the fire would turn a fan set into the chimney of the spit, and a shaft connected to the fan turned a set of gears that were attached to the spit—so it turned itself!



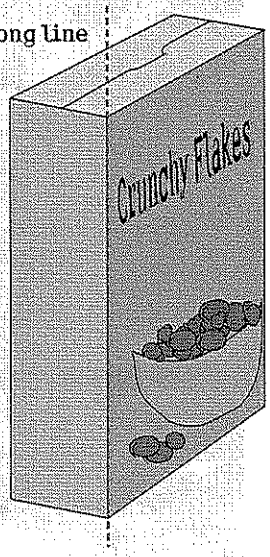
Build It Yourself

Make Leonardo's Helical Air Screw Model

This project requires the use of a drill and a hammer and nails. Make sure you have parental supervision using them, or have your parents help you.

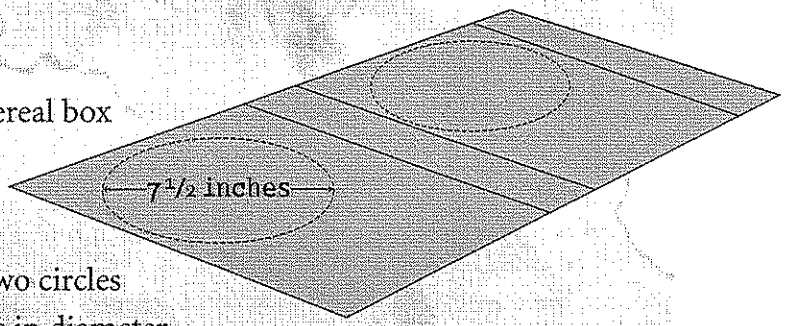
What you'll need

- cereal box
- scissors
- mechanical compass
- pencil
- wooden dowel rod or a smooth, rounded chopstick, about 10–12 inches long and approximately ⅜ inch in diameter
- masking tape
- two small pieces of heavy-duty cardboard
- duct tape
- hammer and nail
- three small pieces of wood, approximately 6–12 inches long for use as a launcher—1-inch-by-1-inch vegetable or garden stakes would be ideal, but any piece of wood at least 1 inch thick is fine
- electric drill with a bit that is slightly larger than the diameter of your dowel
- string

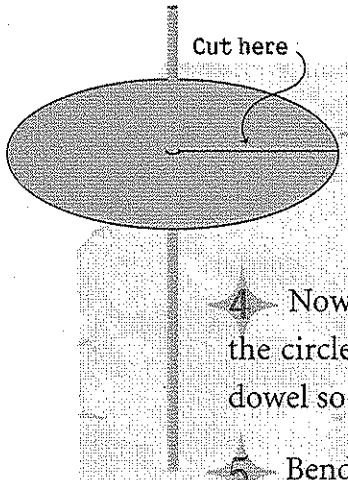


What to do

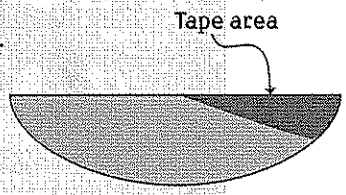
1. Open both ends of the cereal box and cut one seam so that the cardboard lies flat.



2. Using a compass, draw two circles approximately 7½ inches in diameter (3¾-inch radius) on the cereal box. Cut these out.

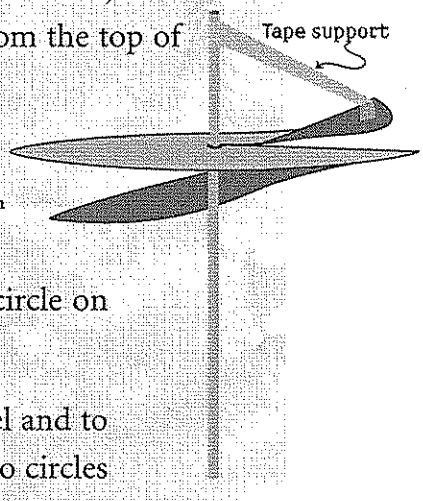


3 Poke a hole in the center of one of the circles and push the dowel rod through it. This is the start of the air screw's wing. Cut the circle halfway through on one side.



4 Now cut the other circle in half. Tape one half of the circle to one of the cut ends of the circle on the dowel so that it is underneath the full circle.

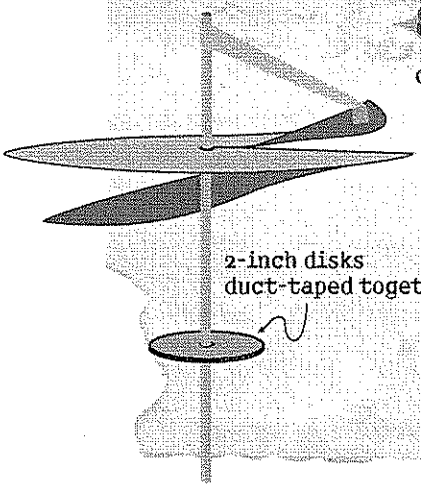
5 Bend the upper rotor (the upper cut part of the circle) up a bit. If it starts to sag, make a tape support from the top of the dowel rod to the outer edge.



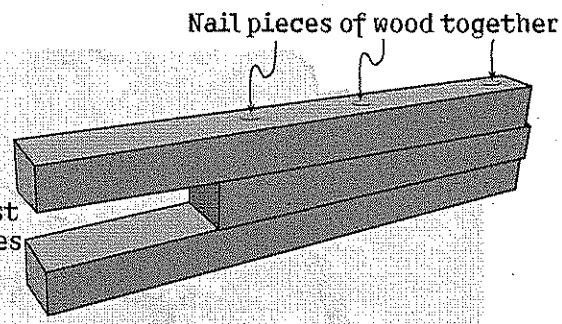
6 Spin the air screw around a couple of times to feel if one side is heavier than the other. You may need to put a piece of tape (adding weight) on the upper rotor to balance out the tape and extra weight of the added half circle on the bottom.

7 Your helical air screw needs a base to act as a flywheel and to store the energy the twirling string will give it. Cut out two circles approximately 2 inches in diameter from the heavy-duty cardboard. Lay one on top of the other and cover the whole thing with a layer of duct tape. This will give the base a bit of weight and better rigidity.

8 With a hammer and nail make a hole in the center of the circle that will fit the dowel—make sure the dowel fits snugly in the circle. Slide the circle onto the dowel, leaving about 3 inches of the dowel below the circle.

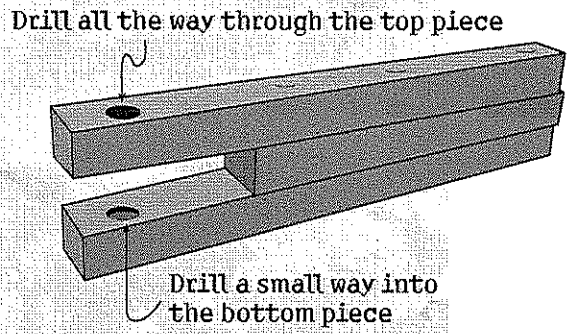


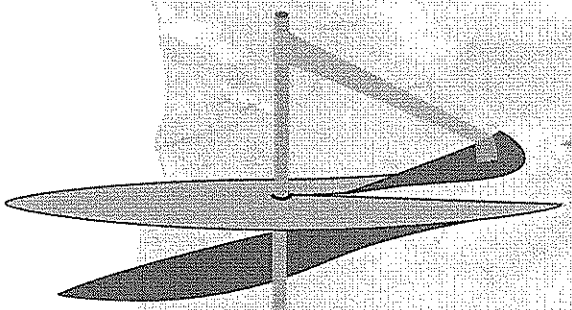
flywheel—a heavy, rotating wheel used to store kinetic energy and minimize variations in the speed of spin



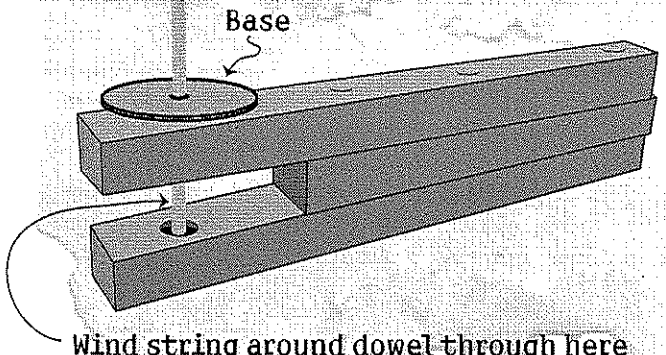
9 Take the three pieces of wood, placing them one on top of the other. Slide the middle piece of wood back so that there is a gap at least 2 inches long. Hammer the three pieces of wood together so you now have a single piece of wood that looks like the above diagram. You could glue the pieces of wood together with wood glue, but they will be sturdier if you nail them.

Now drill a hole through the top half and a little way into the bottom half of the piece of wood. The hole needs to be wide enough that the air screw dowel moves freely in it, but not so wide that it can't stay upright.





10 Now put the helical air screw through the holes in the launcher. Move the base so it is resting on the top part of the launcher. Wind the string in between the top and bottom parts of the launcher, hold on to the launcher, pull the string, and let her rip!

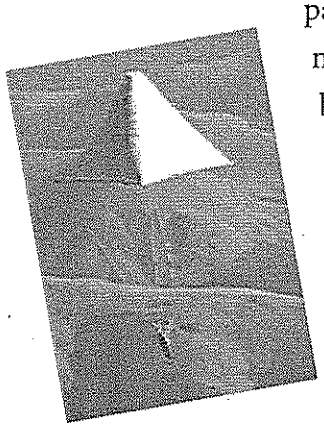


Leonardo's Parachute

One of Leonardo's most famous quick sketches is of a tiny stick figure suspended from a parachute. Although he sketched it more than five centuries ago and probably never had an opportunity to try out his design, Leonardo's parachute bears an uncanny resemblance to parachutes that are used today.

Leonardo described his parachute as follows: "If a man is provided with a length of gummed linen cloth with a length of 12 yards on each side and 12 yards high, he can jump from any great height whatsoever without injury." Leonardo never got to try out his parachute from great heights (it is said that he may have tested it, but it could have only been from trees or tall buildings), but in the year 2000, hundreds of years after Leonardo first sketched his ideas, a world-renowned sky diver named Adrian Nicholas tested a model of Leonardo's parachute.

Nicholas worked for months on a replica of Leonardo's parachute. He even used canvas and wood—materials Leonardo would have had access to—and tools similar to those that Leonardo may have used. Nicholas's parachute weighed more than 187 pounds (compare that to the average modern parachute that weighs between 25 and 30 pounds). Most people who heard about Nicholas's plan were convinced the parachute wouldn't work because it was just too heavy. One safety measure Nicholas took was to attach a conventional parachute to his body as well, in case Leonardo's was a disaster.



"ogNUNO si potrà gettare da qualsiasi altezza senza alcun rischio" ANYONE CAN jump from NO matter what height without ANY risk whatsoever

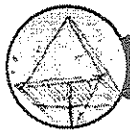
In July 2000, Nicholas jumped off a hot air balloon at 3,000 meters and floated gracefully through the skies of South Africa for almost 10 minutes. He stated that Leonardo's parachute gave a smooth ride—smoother than modern parachutes—and that it felt as though he was floating through space. He cut himself free from Leonardo's parachute about 2,000 feet above the ground because he was afraid that the weight of the parachute would injure him upon landing He then used a modern parachute with a ripcord, which gave him a very safe landing.

History of the Modern Parachute

The term parachute *was coined by Sebastian Lenormand in France in 1783, and though he claims to have invented it, Lenormand apparently never tried the parachute out. A couple of years later a man named Jean Pierre Blanchard built and tested a parachute. First he launched a dog from a hot air balloon. Luckily for the dog, the parachute worked. Later, Blanchard used his parachute to save his own life: his hot air balloon malfunctioned when he used his parachute to safely reach the ground.*

While the first parachutes were made of linen and wood (similar to Leonardo's design), parachute innovators quickly turned to lighter and more compactable materials such as silk. In 1797 a man named Andrew Garnerin tested a silk parachute successfully, and silk became the material of choice in parachute construction. Garnerin later made a vented parachute, which allowed for more stability and a smoother ride. In 1890, two men named Paul Letterman and Katchen Paulus invented the first knapsack parachute. This allowed for an easier launch—the parachute was now confined to a small backpack rather than floating loose.

In 1912, U.S. Army Captain Albert Berry made the very first jump from an airplane and parachuted through the air over Missouri. Today, modern parachutes use "ram-air," or parafoil wings that self-inflate by trapping air between two layers of material and allow for complete control of direction. Parachutes are generally safe, as long as certain precautions are taken (such as packing them correctly). Although it's not common, parachutes can malfunction. Backup parachutes have been designed so that the jumper has a reliable safety mechanism.

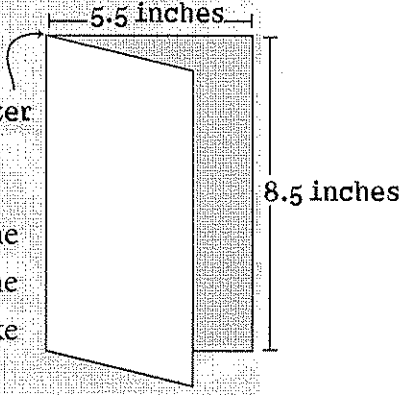


Build It Yourself

Make Leonardo's Parachute

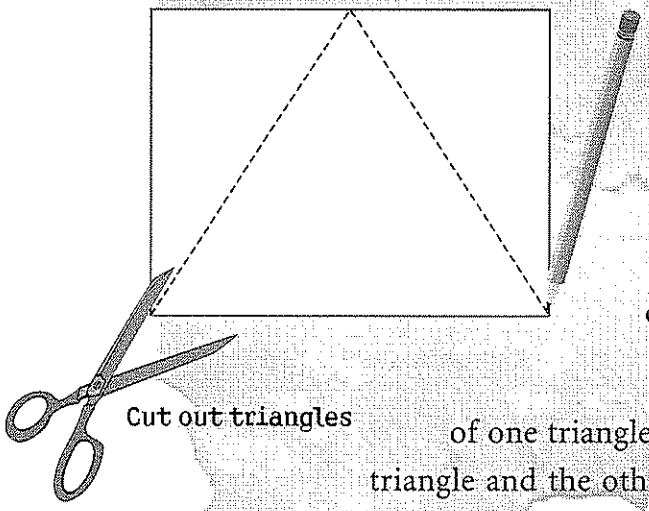
What you'll need

- four 8½-by-11-inch pieces of paper
- pencil
- ruler
- scissors
- markers/decorations/glue (optional)
- tape (Scotch tape will work best)
- dental floss or fishing line
- a small weight like a bolt, washers, or an action figure

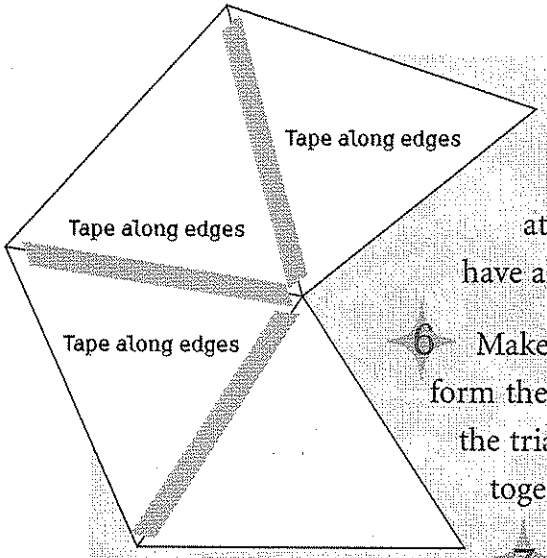


What to do

1. Take one of the pieces of paper and fold it in half, widthwise. Use your pencil to mark the middle of the page. Unfold it. Using your ruler, draw a straight line from the middle mark to the bottom corners of the paper. It will make a triangle.



2. Do the same with the other three pieces of paper.
3. Now cut out all four triangles.
4. If you would like to decorate your triangles, now is the time to do it. Remember that only one side of the parachute will be seen.
5. Place a piece of tape along one side of one triangle lengthwise so that half the tape is on the triangle and the other half is ready to be taped to something

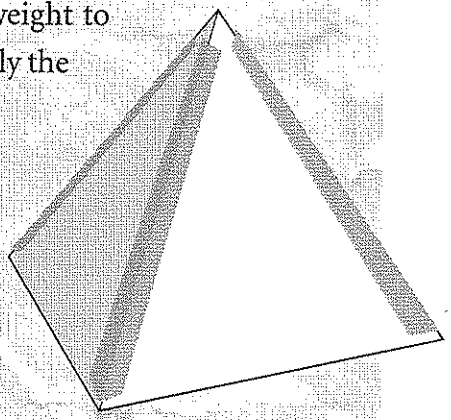


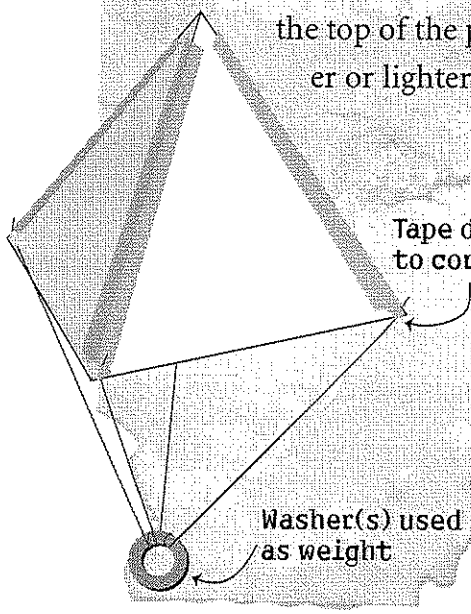
else. Take another triangle, line one side up with the first triangle. Use the tape to attach the two triangles. Repeat this until you have all four triangles taped together.

6 Make a crease on each seam of tape. This should form the triangles into a pyramid, with the points of the triangles meeting at the top. Tape the last seam together, so that you have a sturdy pyramid.

7 Next, cut four equal pieces of dental floss, about 12 inches long. Tape one piece to each corner of your parachute. Tie your weight to the floss, making sure each string stays approximately the same length (this will allow for a smoother flight).

8 Test your parachute by throwing it off a balcony or out a window and watch it glide. You can try all sorts of variations: shorten or lengthen the string, cut a small hole in the top of the parachute, get a heavier or lighter weight, and so on.





You now have a Leonardo parachute replica.

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Web Sites

www.amnh.org/exhibitions/codex. The American Museum of Natural History had an exhibit of Bill Gates' Codex Leicester

www.cyclepublishing.com/history/leonardo

www.lairweb.org.nz/leonardo

www.lib.stevens-tech.edu/collections/davinci. This is a comprehensive online archive of works by and about Leonardo, collected and maintained by Stevens Institute of Technology.

www.museoscienza.org/english/leonardo

www.mos.org/leonardo. The Museum of Science in Boston, Massachusetts has an extensive online Leonardo exhibition, complete with experiments, activities, and quizzes.

www.museoscienza.org/english/leonardo. This is the web site of the Leonardo da Vinci National Museum of Science and Technology in Milan, Italy.

Resources for kids interested in learning more about Leonardo da Vinci