

CAPTIVE PLANE

A simple project to introduce the concept of flight is Scorpio's Captive plane. The Captive Plane is driven by a small electric motor. It isn't a true plane (it can't fly by itself).

The plane is attached to an overhead point or strung between two points. The plane needs to be "launched" so that it can begin circling. It will "fly" in this pattern until stopped.

Science

- Sketch an aeroplane. Students identify where the 4 forces (**propulsion, thrust, lift, drag**) are located so that it is possible for the aeroplane to fly.
- Define aircraft terminology: acceleration, force of gravity, weight, wind speed, speed of sound, Aeronautical engineer, sound barrier, velocity, wind resistance, sonic boom, pressurised cabin etc.
- **Beaufort wind force scale.** Make a simple instrument that shows wind force (e.g. anemometer).
- **Bernoulli's principle** is the difference in speed of the air around the wing which causes a difference in pressure. This results in an upward force on the wing from the higher-pressure air under the wing.
- **Newton's laws:**
 1. **Newton's first law:** Unless an unbalanced force acts on an object, an object at rest stays at rest and an object in motion stays in motion.
 2. **Newton's second law:** Force = mass x acceleration or $F=ma$
 3. **Newton's third law:** For every action, there is an equal and opposite reaction.

Technology

- **Propellers** come in different shapes – is an aeroplane propeller different to a boat propeller? Why?
- Investigate which material will be used to construct the Captive plane.
- Develop a **Materials List** – all the materials & quantities required to make the Captive plane.
- The importance of transport in modern society. Make a poster showing how aeroplanes are used.
- Research a person(s) involved in the development of flight.

Engineering

- Aeronautical engineers use understanding of the 4 forces when designing a plane. These forces have been essential in the development of all types of air craft – helicopters, spacecraft, hot balloons, parachutes etc.
- Engineers manipulate air pressure to create lift; they design wings so that the air moves faster over the top than under them, causing aircraft to lift during take-off and during flight. Engines create thrust/ power, and compensate for drag). They fly in a straight line and mostly at a constant speed.
- Engineers often build small-scale models to test how a plane will fly. A model allows them to experiment with many different designs to find the best one.
- Label a diagram of a plane to show main parts e.g. fuselage, wing, cockpit.
- Experiment with the Captive plane design. Will it fly without being tethered? Does it require more power to fly? Does a larger wing surface area change how it flies?
- Try a different shape for your Captive plane e.g. a biplane, a stealth bomber, a flying pig (just to prove that they really can fly!).
- The majority of propeller driven aircraft have an engine at the front pulling it forward. Some aircraft manufacturers have made "Pusher" aircraft, with the motor and propeller mounted at the rear to push the plane forward. How successful were pusher aeroplanes?
- Investigate early planes – monoplanes (1 wing), biplanes (2 wings), Folkker triplane (3 wings) etc.
- Ornithopters – research the development. Record pros and cons of their design.
- What is the difference between an aeroplane and a glider?
- Investigate how a **wind tunnel** is used in engineering. Which industries use wind tunnels? Discuss the reasons.

Art

- What colours (primary / secondary) are used for the artwork on the outside of a plane? Collect sample images from the web. Why do you think these are chosen?
- Design a logo for your Captive plane. Use common shapes as a basis of your design.

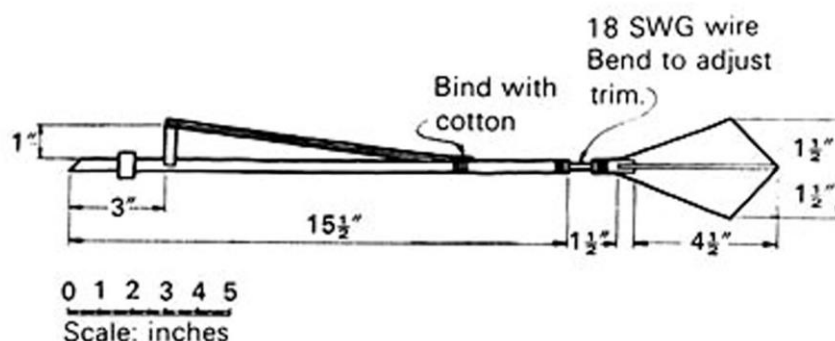
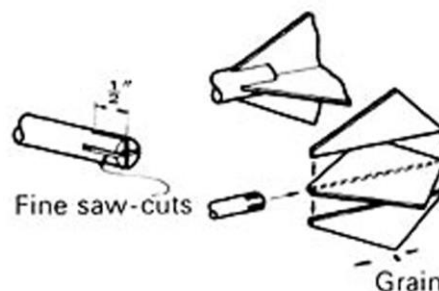
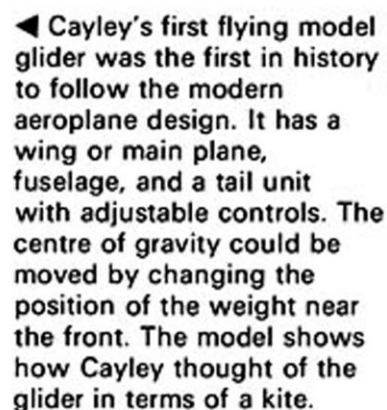
- Measurement – time how long the Captive plane takes to make a full circuit. Does this change if the string is shorter or longer?
- Graphing – graph the speeds of the Captive planes. Compare speeds.
- Line of symmetry – both sides of the plane are the same so they balance.
- Scale drawings
- Averages – find the average of recorded speed.
- How is speed measured?

Average speed = total distance / total time

- <https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/historyofflight.html>
- <https://www.britannica.com/technology/history-of-flight>
- <https://www.britannica.com/topic/Wright-glider-of-1902>
- www.theaerodrome.com
- <https://www.loc.gov/exhibits/treasures/wb-timeline.html>
- <https://cobblestonesandheels.wordpress.com/category/corporate-flight-attendant/>
- <http://www.swissinfo.ch>
- <http://www.voanews.com/content/solar-powered-plane-lifts-off-on-world-tour-2672767.html>
- <https://www.teachengineering.org>

- Construct a model of Cayley's first model glider.

Lead weight wrapped
round dowel slides
to adjust balance.



Cayley's model can be copied at half scale in balsa wood by following the instructions on this diagram. The actual model used a common paper kite for the wing.

<http://www.theaerodrome.com>