Hiller Aviation Museum Exhibit Safari

Aerodynamics

The Forces of Flight

ANSWER KEY

1. Both the 1903 Wright Flyer and the 1869 Marriott Avitor had 1 engine and 2 propellers.

   An airplane driven by a single propeller is more difficult to control because of turning forces from the propeller. The Wrights and Marriott recognized this and devised mechanisms to turn two propellers with a single engine. The propellers turned in opposite directions, negating the turning tendency. Later light airplanes had stronger control surfaces and could fly safely with a single propeller.

2. Name three aircraft in the Museum that have pusher propellers.

   The 1903 Wright Flyer, the Vin Fiz, Black Diamond, Curtiss Pusher, Little Looper, Buhl autogiro, Stearman-Hammond Y, and Rutan Defiant. Pusher propellers were popular in early aviation but in a rough landing the engine could come loose and crash forward into the pilot. By 1915 most propeller-driven aircraft had changed to tractor propellers that pull the airplane through the air.

3. Name two biplanes in the Museum that have tractor propellers.

   Grumman Albatross, 1928 Monocoupe, Pepsi/Travelair, Honeymooner, Boeing Condor. Tractor propellers pull the airplane through the air and are the most common design for propeller aircraft.

4. What powered the Avitor?

A steam engine. Marriott, like other aviation pioneers of his time, was hobbled by lack of a lightweight, powerful engine. It was not until gasoline powered internal combustion engines came into use at the turn of the 20th century that sustained, powered flight with people aboard became a possibility.

5. What kind of device was used to stop Eugene Ely's plane when he landed on the cruiser *Pennsylvania* in 1911?

Ely's plane carried an arresting hook beneath and between its main wheels designed to catch piano wires strung between sandbags placed at the edges of the wooden platform on the Navy cruiser. Although crude, the system worked well and modern naval aircraft continue to use arresting hooks and wires for their recoveries today.

6. What is the biggest difference between the Curtiss biplanes flown by Lincoln Beachey and Eugene Ely?

Beachey's Little Looper has no forward stabilizer. At the time, most aircraft had stabilizers in front of and behind the wings. At an early flying meet Beachey had a rough landing and damaged the Little Looper's forward stabilizer. The impatient Beachey simply removed the stabilizer and returned to the air. The rear stabilizer proved to be sufficient for his aircraft, and the reduction in weight and drag boosted performance. Within a short time the single stabilizer design had been adopted for most aircraft.

7. Push the button for the Little Looper's propeller and carefully watch what happens. What moves when the engine runs?

Both the propeller and the engine. Beachey installed a rotary engine in his Little Looper. Many rotary engines are designed to rotate while in flight. As the engine's cylinders whirl they are cooled by the air, eliminating the need for a complex liquid cooling system.

8. What is unusual about the rotor systems for the XH-44 and UH-4 helicopters compared to most helicopters today?

Both of these early helicopters had twin counter-rotating main rotors and no tail rotor. The turning motion of the single large rotor on a helicopter gives it a turning tendency. Stanley Hiller believed the solution to this problem was to use a single engine to turn two rotors in opposite directions. This worked, but helicopters with one large rotor and a smaller tail rotor able to compensate for the turning effects ultimately proved more efficient.

9. Name three ways an Autogiro is different from a Helicopter.

    1. *Propeller*
    2. *Wings*
    3. *Control Surfaces of an airplane*
    4. *Rotor blades not powered*
    5. *No true vertical take-off*

10. The L-39 uses a <u>Jet</u> engine.

11. Why might the Grumman Albatross experience more aerodynamic drag than an airplane that does not have to land in the water?

The Grumman HU-16 Albatross is an amphibious airplane, able to land at an airport or on the water. To ensure that it floats upright when on the water, the Albatross has large floats attached to each wing near the wingtips. These floats improve the airplane's ability to operate in the water, but increase drag when the airplane is in flight. Some amphibians, such as the Consolidated PBY on display in model form in the Museum's Atrium, featured retractable floats that would reduce this unwanted drag.