WRIGHT BROTHERS

AEROPLANE Co.

of DAYTON, OHIO

1903 Wright Flyer

A synthesis of innovations

1. Wing Warping
For roll control. When the pilot moved the hip cradle from side to side, it pulled wires that twisted the ends of the wings, increasing the angle of attack (and the lift) on one side of the aircraft and decreasing it on the other. When the pilot moved his hips right, the left wing twisted up, the right wing twisted down, and the aircraft rolled to the right.

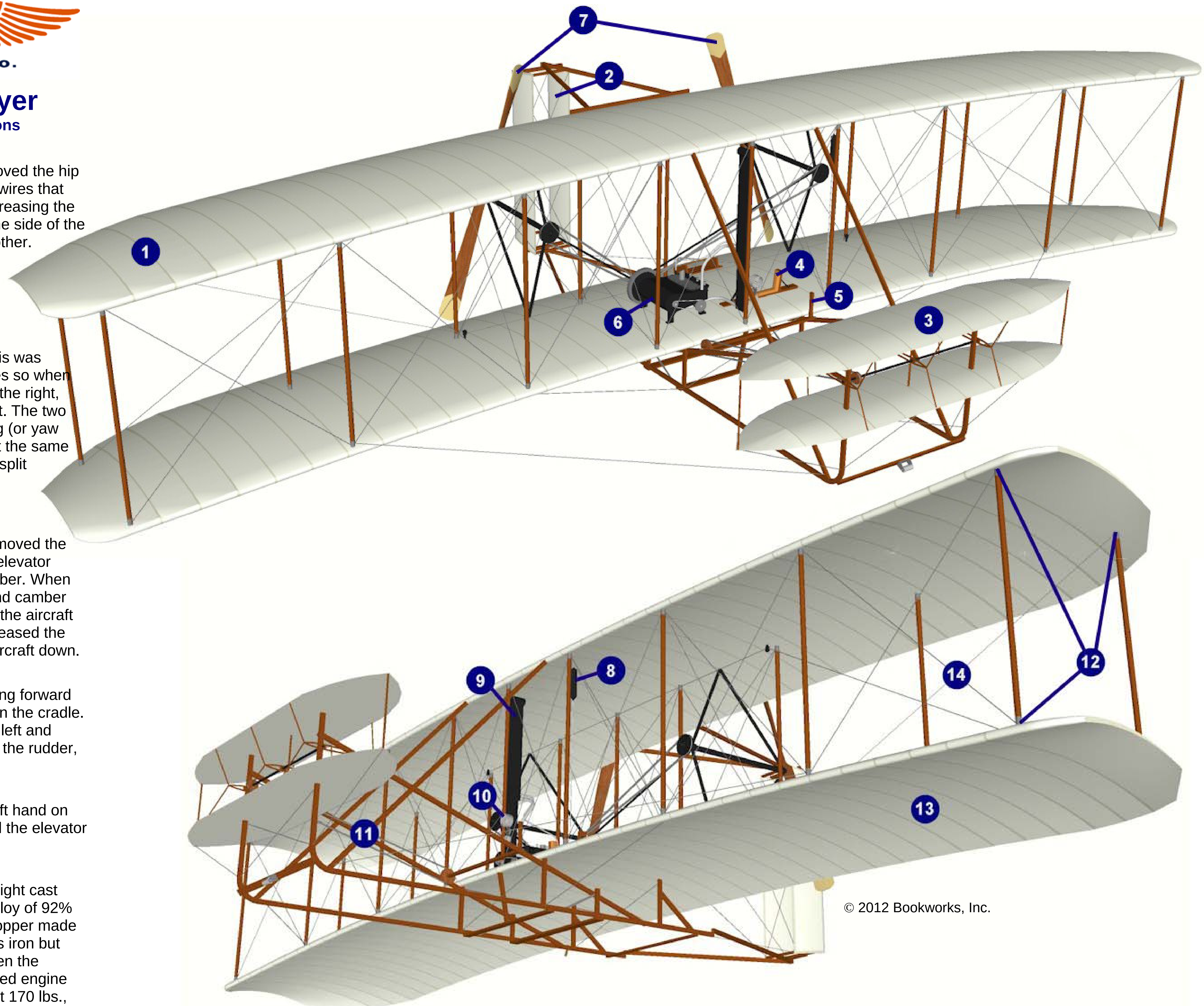
2. Rudder
For yaw (side-to-side) control. This was attached to the wing warping wires so when the pilot pushed the hip cradle to the right, the rudder yawed the aircraft right. The two controls, rudder and wing warping (or yaw and roll) were “coupled,” acting at the same time. In later aircraft, the Wrights split these controls so they could be operated independently.

3. Elevator
For pitch control. When the pilot moved the control lever, the surfaces of the elevator changed angle of attack *and* camber. When the pilot pulled back, the angle and camber increased, creating more lift, and the aircraft pitched up. Pushing forward decreased the angle and camber, pitching the aircraft down.

4. Hip Cradle
The pilot laid prone, his head facing forward toward the elevator with his hips in the cradle. By sliding his hips and the cradle left and right, he moved the wing tips and the rudder, controlling roll and yaw.

5. Elevator Control
By pushing and pulling with his left hand on this 12-inch lever, the pilot moved the elevator to control pitch.

6. Engine
To keep their aircraft light, the Wright cast their engine crankcase from an alloy of 92% aluminum and 8% copper. The copper made the aluminum rigid, not as hard as iron but sufficient to handle the stress when the engine was running. The completed engine generated 12 hp and weighed just 170 lbs., roughly half of what it would have weighed had the case been cast iron.



7. Propellers
8 ft. in diameter, producing 135 lbs. of thrust at 350 rpm. The Wrights realized that propellers were rotary wings generating thrust the same way wings generate lift. They carved their propellers with cambered blades and dramatically increased the thrust.

8. Gas Tank
Capacity 0.4 gallons, gravity fed. Actually, this was a tank within a tank. One tank floated inside the other, eliminating the pressure that might cause the gas to run out too quickly.

9. Radiator
To cool the engine. Water flowed by a thermosiphon effect. Hot water from the engine rose to the top of the radiator, then flowed downward and back into the engine as it cooled. It was ineffective; the engine could not run for more than a few minutes without overheating. On later aircraft, the Wrights added a water pump.

10. Flight Recorder
Anemometer (wind speed gauge), tachometer (rpm counter), and stop watch. With these three onboard instruments and a measuring wheel to determine the flight distance, the Wrights could calculate air speed, ground speed, propeller efficiency, and engine output.

11. Air Frame
The straight parts of the airframe were made from spruce, the bent parts were made from ash. Pound for pound, both wood species are stronger the steel. They are also extremely resilient, able to absorb huge shocks and then spring back to shape without breaking.

12. Strut Fittings
These were movable to allow the wings to twist. Metal eyes on the ends of the struts pivoted on hooks attached to the wings.

13. Wing Covering
To create air-tight lift and control surfaces, the Wrights used finely-woven cotton muslin and probably sealed it with “canvas paint” (paraffin dissolved in a solvent such as gasoline). The cloth was stretched over the air frame so the threads ran at 45^{o} angles to the wooden parts. Every thread became a brace, adding substantial strength to the assembly.

14. Rigging
To hold the air frame rigid, the Wrights rigged their Flyer with 15-gauge bicycle spoke wire, running diagonally between the ends of the struts to create a strong but lightweight truss.