Wing Tips

A CAP Aerospace Education Moment

Did you know?

The Wright Brothers invented the correct way to turn an airplane. This didn't come to them as an "eureka" moment. It was more of a process of discovery. They knew from observing birds that when birds turn, they bank or tilt in the direction of their turn. As experienced bicycle riders, this method made a lot of sense to them. They also knew of the state-of-the-art biplane hang glider that Octave Chanute and his team had tested on the Indiana dunes by Lake Michigan, but they understood that controlling a glider by swinging one's legs one way and another was not a suitable method to control an aircraft. They sought a method that would enable them to change the angle at which the wing tips met the relative wind.

Any mechanical means they thought of would have been too heavy. Then Wilbur happened to twist a small cardboard box with the ends removed. He realized that the box resembled a biplane glider and the twist would cause the bottoms of the wings on one side to meet the relative wind while the tops of the wings on the other side met the relative wind. This would make the glider rotate around its longitude axis. To test this idea, he built a biplane kite with a 5 foot wingspan and a 13 inch chord (some sources say 12 inch) and a horizontal tail. Kite strings were attached to the four front corners of the kite and led to control sticks in the flyer's hands. If he tilted one stick forward and the other backward, the kite would roll around its longitudinal axis (bank). Thus, wing-warping was invented.

The Wright Brothers now had their control system worked out (they thought) and were ready to build a full–size man carrying glider. It was a biplane with a 17 ½ foot span and a 5 foot chord. It had a front elevator (we would say canard today) that they called a horizontal rudder for control around the lateral axis (pitch). They took it to Kitty Hawk, but found the winds too weak to support the glider with a man on it or so strong that it would be dangerous. Mostly, they flew it as a kite with some chains on board for weight and worked the warping controls from the ground as with the original kite. The few free glides they made showed that the front elevator worked as they had planned.

The following year, they were back with the largest glider anyone had flown to date. It had a wingspan of 22 feet and a chord of 7 feet. With this glider, they experienced the "stall" which was what had killed the famous earlier experimenter, the German engineer Otto Lilienthal. They also discovered that having the elevator in front mitigated the danger and only caused a hard landing with little or no damage to the glider or the pilot. Another thing they discovered was "adverse yaw" which occurs because the skyward pointing wing has more lift than the other wing. More lift means more drag. More drag means it goes slower while the earthward pointing wing is going faster causing the aircraft to rotate around its vertical axis and make the nose point opposite to the desired direction of turn.

The Wrights' 1902 glider (their third glider) was the most aesthetically beautiful aircraft that the Wrights ever built. It incorporated their wind-tunnel data and had a 32 foot wingspan, a 5 foot chord and a fixed vertical tail to counter the effect of adverse yaw, but a new problem arose "slip" which simply means that the aircraft slides through the air to the inside of the turn. ("Skid" means that an aircraft slides through the air toward the outside of the turn; if you tried to turn an aircraft without banking it, it would skid.) The Wrights corrected the slip problem by removing the fixed tail and replacing it with a movable rudder for control around the vertical axis (yaw). They had figured out the co-ordinated turn, tested it on this glider and proved it. At that time, nobody in the entire world really understood what they had done!

They patented the 1902 glider and its concept of control, not the world renowned December 17th 1903 powered aircraft which never did make a turn. Their patent used the 1902 glider as an example, the wording made it clear that they were patenting any means of making a co-ordinated turn. Even the famed "patent wars" were not about who flew a powered airplane first or who might have done so with better luck, nor were they about ailerons versus wing warping. They were about the co-ordinated turn. Today, 2016, a pilot is still required to be able to make a co-ordinated turn—the very thing that the Wright Brothers invented (or discovered) way back in 1902.