

THE TECHNICAL CONTRIBUTIONS
OF THE WRIGHT BROTHERS TO AVIATION

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Abstract

Seventy-five years ago the Wright Brothers, Wilbur and Orville, successfully completed the world's first aircraft flight. In a little over four years, they designed, developed, and test a series of gliders leading to their first Wright Flyer. This paper summarizes their efforts, concentrating on their technical accomplishments.

During this 75th anniversary year of the first successful powered flight of an airplane, it is appropriate to acknowledge the technical contributions of the Wright Brothers to aviation.

By the use of figures to illustrate key events and developments, a chronological telling is utilized to describe their successes; all accomplished in an unbelievable time of four and one-half years.

Wilbur Wright was born 16 April 1867. He grew up having a high school education; Figure 1.



Figure 1

Orville Wright was born four years later, 19 August 1871. He too received a high school education, Figure 2.



Figure 2

It was in the 1895-1896 time period that the brothers began reading of the gliding flights of Otto Lilienthal in Germany. This no doubt began their considerations, and particularly by Wilbur, about powered flight.

However, it wasn't until 1899 when Wilbur, at the age of 32, wrote to the Smithsonian Institution asking for available data that he could study so that in turn he might make contributions to powered flight. His letter, Figure 3, was written 30 May 1899.

Within three months Wilbur constructed a scale model biplane kite and flew it at Dayton, Ohio; an early RPV! This is the same time period that Count Von Zeppelin was developing the rigid airship at Frederikshafen, Germany.

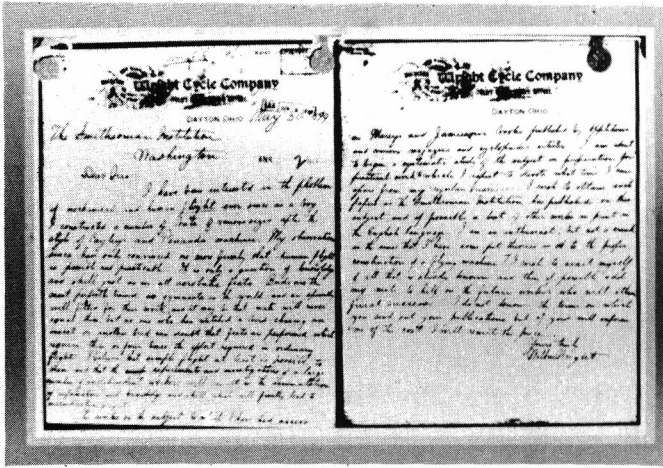


Figure 3

By 1900 the Wrights developed their first full size biplane glider. Glider #1 was flown at Kitty Hawk during the summer and fall by Wilbur. This glider was also flown as a kite; RPV. Figure 4 shows Glider #1.

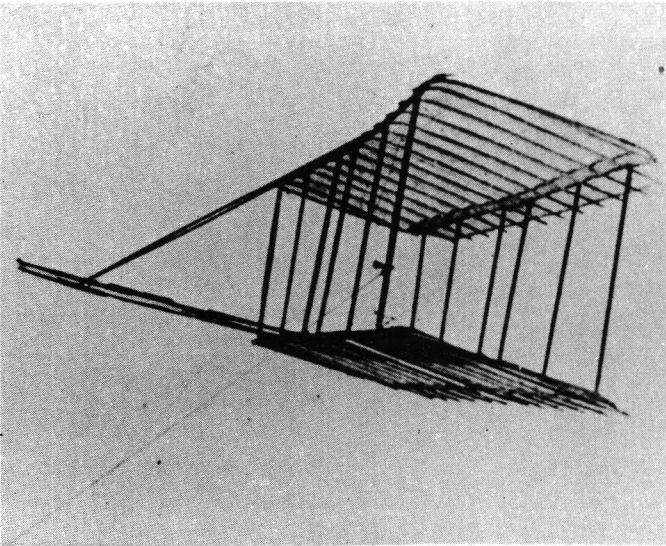


Figure 4

Based on Wilbur's 1900 flights, a biplane, Glider #2, was constructed in the winter and spring of 1901. During the summer of 1901, the Wrights were back at Kitty Hawk; Figure 5. All flights were again made by Wilbur.

Glider #2 utilized an airfoil section based on the reports by Otto Lilienthal. However, insufficient lift resulted. The Wrights realized that to secure an adequate airfoil section, a systematic means of research would be required. Their solution was to set up a wind tunnel in the fall and winter of 1901. Their second wind tunnel was five feet long and had a test section 22 inches by 22-inches; Figures 6 and 7. The throat had a measured velocity of 40 ft/sec (27 mph). The Wrights tested over 200 model wings with various aspect ratios and airfoil sections.

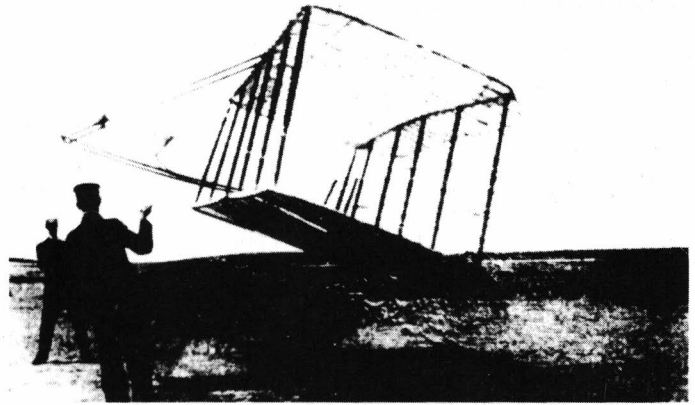


Figure 5

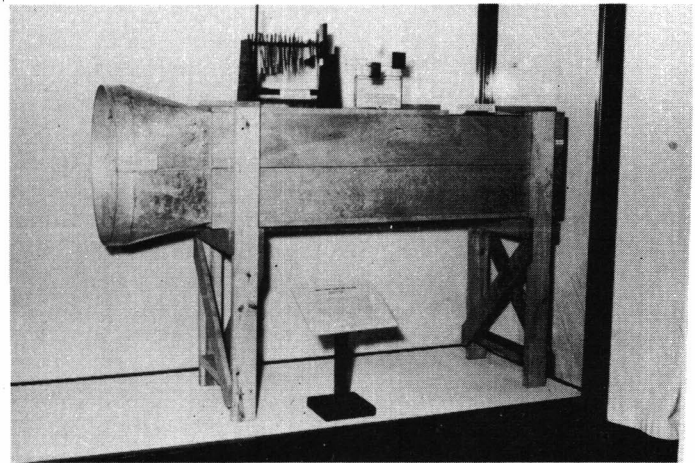


Figure 6

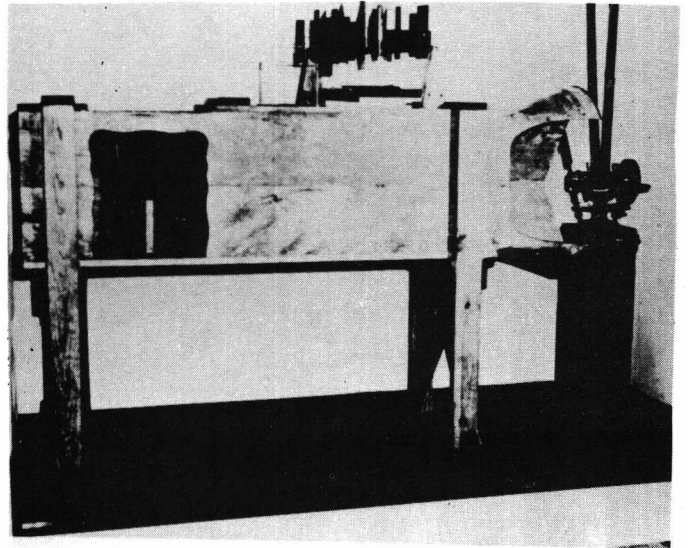


Figure 7

Early in 1902, immediately following the analysis of their wind tunnel work, they began construction of the 1902 Glider #3 utilizing a new airfoil section.

Again they returned to Kitty Hawk, with both Orville and Wilbur gliding during the summer and fall of 1902. By October they had made 1000 glides; Figure 8, 9, 10, and 11. Note that fixed vertical fins were added aft to avoid slideslips and spins. Also an operating canard elevator was placed forward. They calibrated their gliding to compare with their wind tunnel readings.

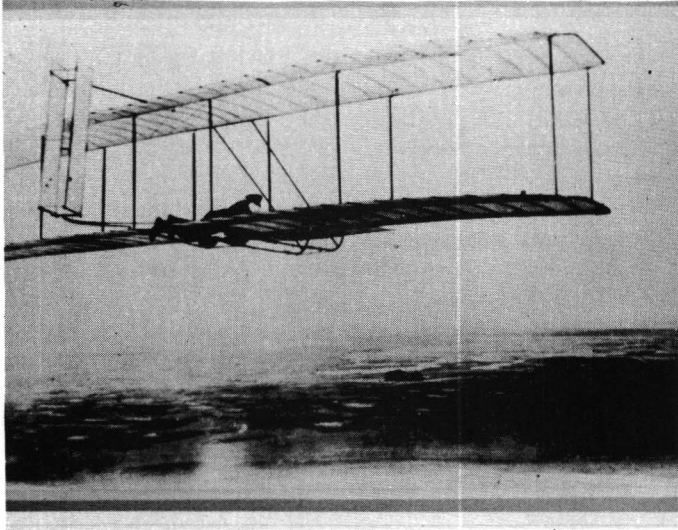


Figure 8

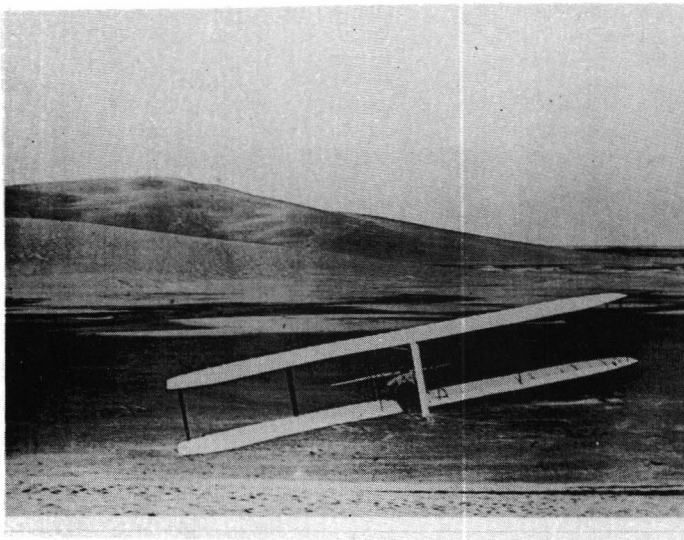


Figure 9

Reasonably satisfied with the performance of Glider #3, the brothers felt it was time to begin the development of a powered airplane now that they understood the importance and need of three-axis flight control.

Upon returning to Dayton, the brothers on 3 December 1902 wrote to manufacturers requesting their need for a piston engine weighing no more than 180 pounds and a ratio of 20 pounds per horsepower. Receiving negative responses the brothers realized they would have to design and develop their own engine. This work was delegated to Orville Wright and Charles Taylor

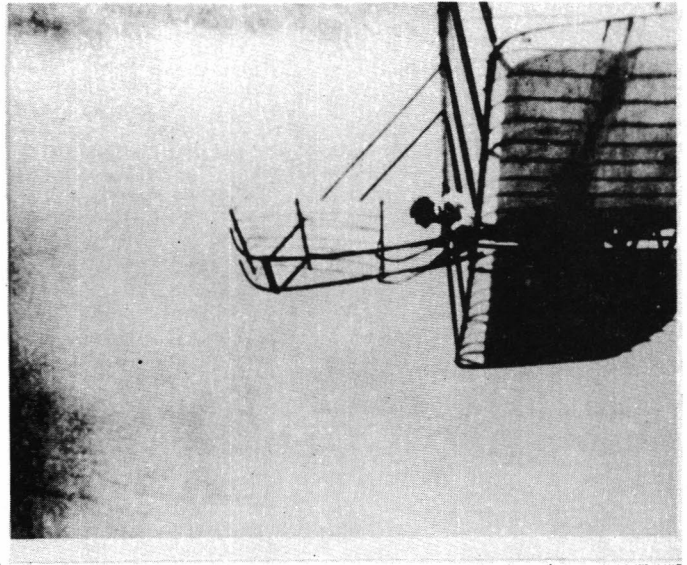


Figure 10

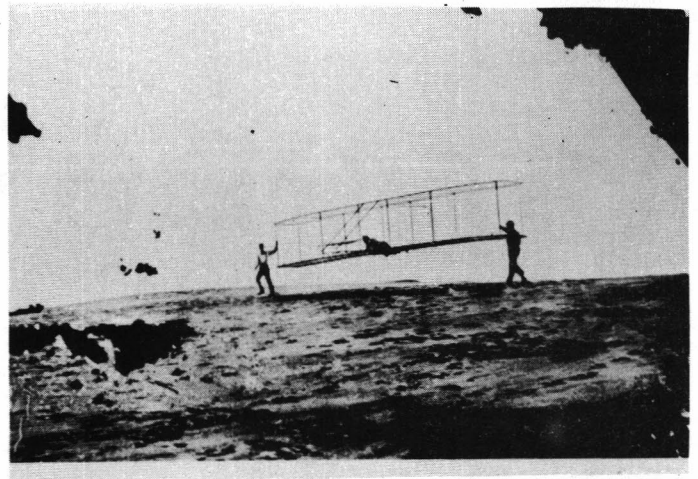


Figure 11

beginning 12 February 1903. The engine shown in Figures 12, 13 and 14 initially developed 12 horsepower.

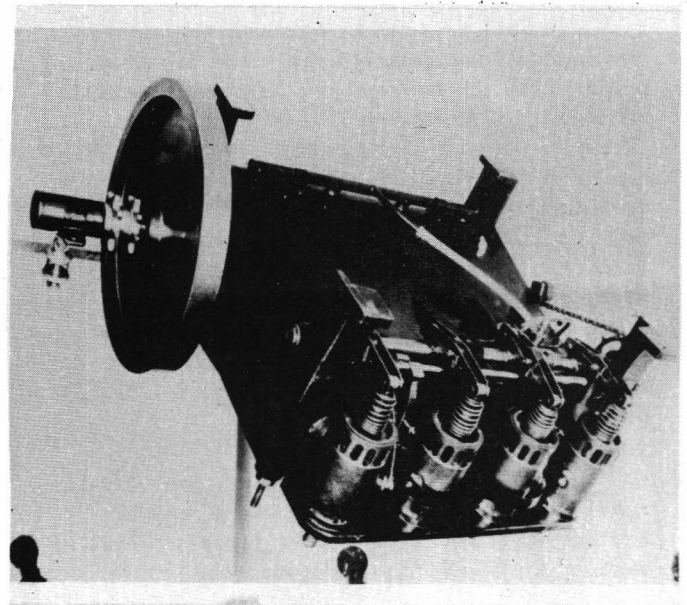


Figure 12

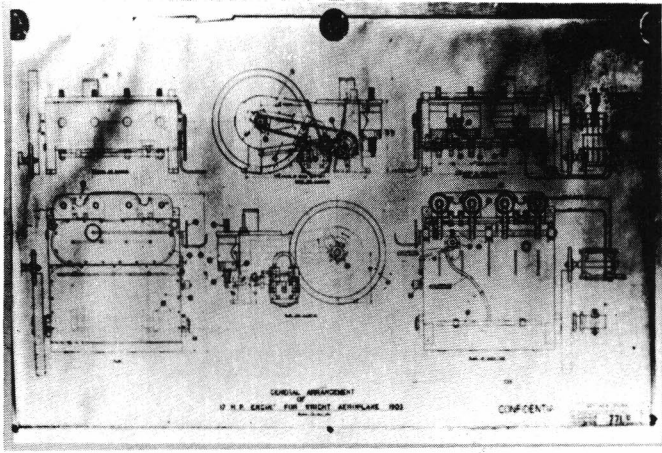


Figure 13

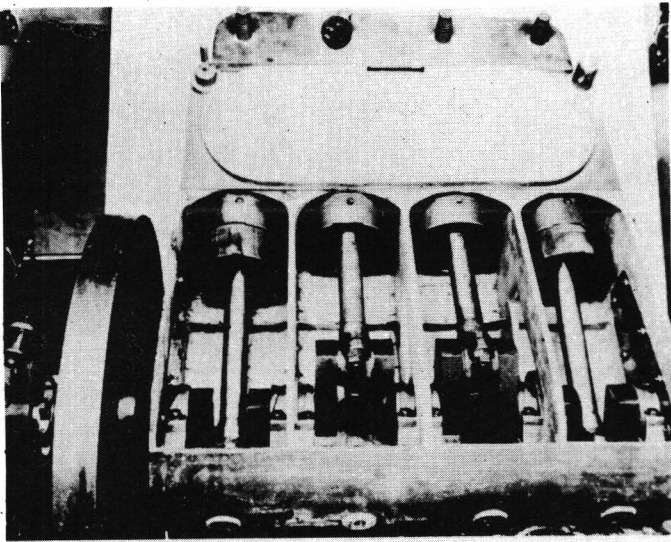


Figure 14

At this same time Wilbur took on the task of designing and carving the two contra-rotating wooden propellers. Wilbur correctly reasoned that a propeller section was actually an airfoil section rotating through the air. His final design of the fixed pitch propeller has a remarkable efficiency of 66 percent.

The following month on 23 March 1903 the brothers applied for their basic patent of a powered flying machine. This is just one of many examples that can be recited of their thoroughness and thoughtfulness in the development of their gliders, airplanes, and hydroplanes. They received their first patent on 22 May 1906. This farsightedness would pay off on later patent infringement suits.

As expected redesign of elements were necessary as they progressed. It was on 20 April 1903 that they received the aluminum alloy casting for the redesigned engine.

By the following month, Wilbur felt enough progress was being made that he wrote to Octave

Chanute on 25 May 1903 saying: ".... plans for our new machine about settled and are engaged in constructing some of the parts."

On 18 June 1903 it was documented that the engine developed 15.6 hp. This left the balance of the summer of 1903 to complete the airframe, controls, and instrumentation.

On 23 September the two brothers with their crated 1902 glider and the 1903 Wright Flyer took the train from Dayton to Elizabeth City, North Carolina. By 25 September they reached Kitty Hawk again.

Within three days, they were both checking out Glider #3. On just one day, 28 September 1903 they recorded between 60 and 100 glides.

By 5 October two buildings were completed for use; Figure 15. One building for their Wright Flyer, the other for eating, sleeping, and storing of supplies. Figure 16 shows replicas of the buildings now standing at Kitty Hawk; being built by and administered by the National Park Service. (A replica of the Wright Flyer is also on display at Kitty Hawk.)

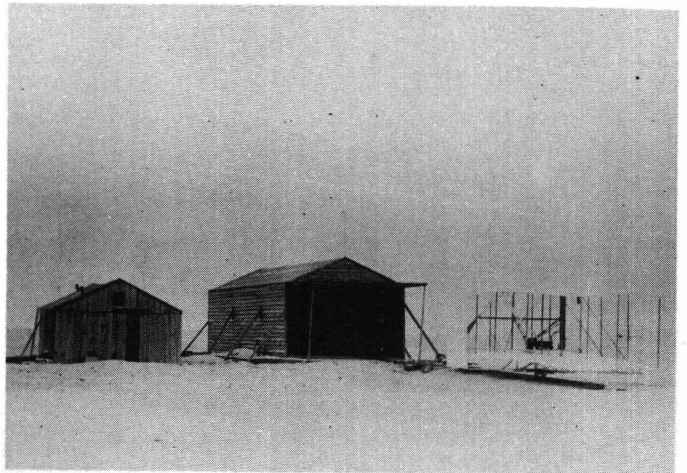


Figure 15

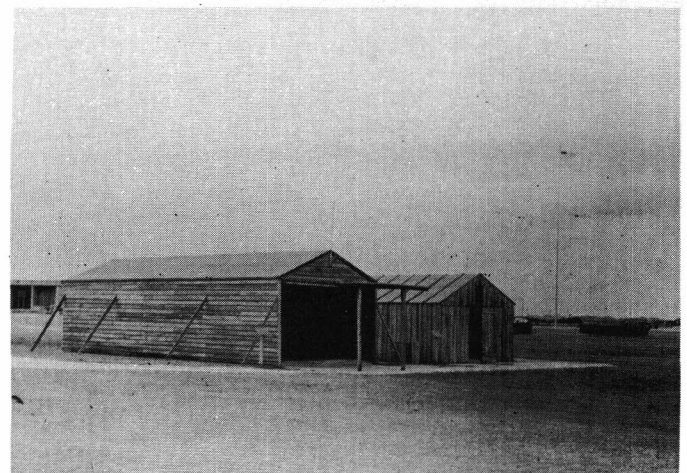


Figure 16

Concurrent with getting ready to launch the Wright Flyer, the brothers were aware that Langley would soon try his second houseboat launch of the Langley Aerodrome. On 8 December the brothers were relieved to be notified of Langley's second failure at manned flight of a powered vehicle.

During this same time period, Orville made a round trip train ride to Dayton as one propeller shaft made from steel tubing has cracked during a run-up test. On 11 December he returned to Kitty Hawk with a new propeller shaft machined from a piece of steel rod.

Three days later they laid their launching track down the slope of Big Kill Devil Hill. Wilbur won the coin toss to try the first flight on that day, 14 December 1903. A down hill flight of 4 seconds was considered unsuccessful by both brothers as the plane landed at a spot lower than the takeoff point.

In another three days the brothers were ready to try again from a level section of sand off the same segmented track that was used three days earlier; Figure 17.

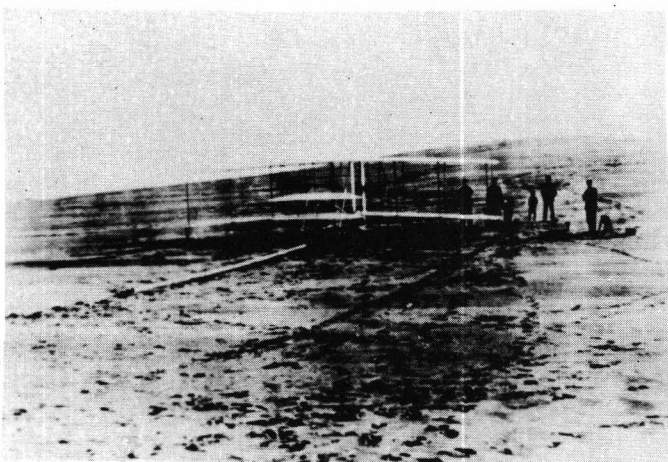


Figure 17

This time it was Orville's turn to pilot the Wright Flyer. Shortly after 10:30 a.m. on 17 December 1903, Orville successfully completed the first flight, being in the air for 12 seconds; Figure 18. At that time Orville was 32 years old and Wilbur was 36. Figure 19 is a plaque commemorating the event. Figure 20 shows the plaque as well as a marker. Figure 21 shows the flight path and distance for each flight made on 17 December. A summary of each brother's flight on that day is tabulated in Figure 22.

Figure 23 is a three view drawing of the Wright Flyer showing arrangements of components. This airplane had the following specifications:

Weight Empty:	605 lbs.
Wing Span :	40 ft.
Length :	21 ft.
Speed :	31 MPH

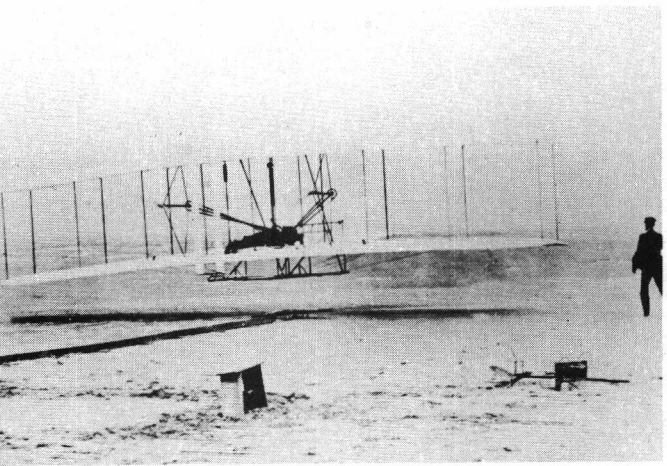


Figure 18



Figure 19

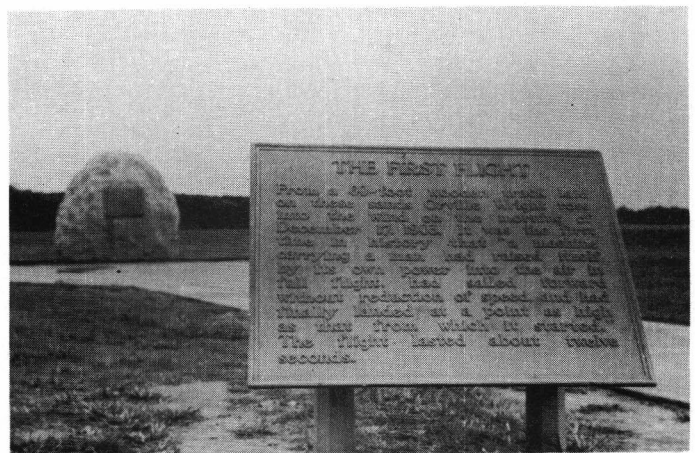


Figure 20

Figures 24 and 25 are of the replica installed in the museum at Kitty Hawk. The original, of course, can be seen at the National

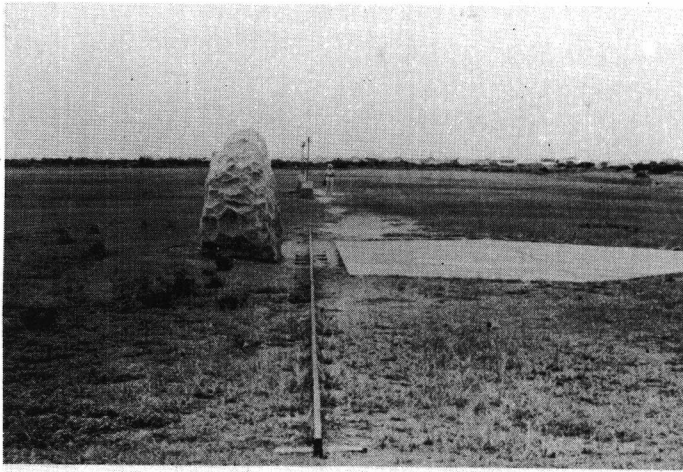


Figure 21

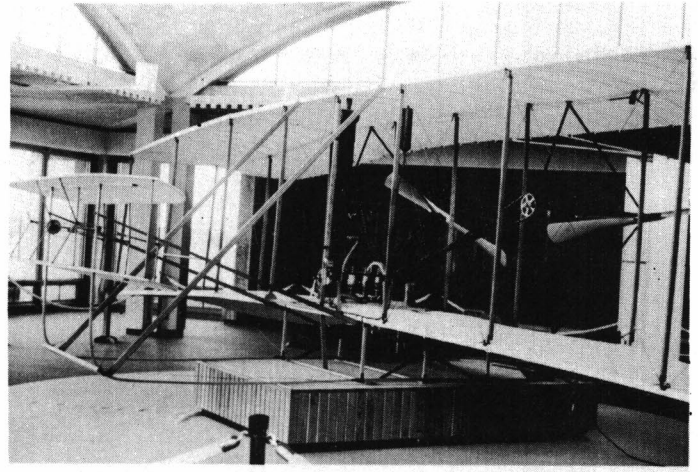


Figure 24

WRIGHT BROTHERS				
DECEMBER 17, 1903				
FLIGHT NO.	PILOT	APPROXIMATE TAKEOFF TIME	FLIGHT DURATION SECONDS	FLIGHT DISTANCE FEET
1	ORVILLE	10:30 AM	12	120
2	WILBUR	11:20 AM	13	175
3	ORVILLE	11:40 AM	15	200
4	WILBUR	12:00 N	59	852

Figure 22

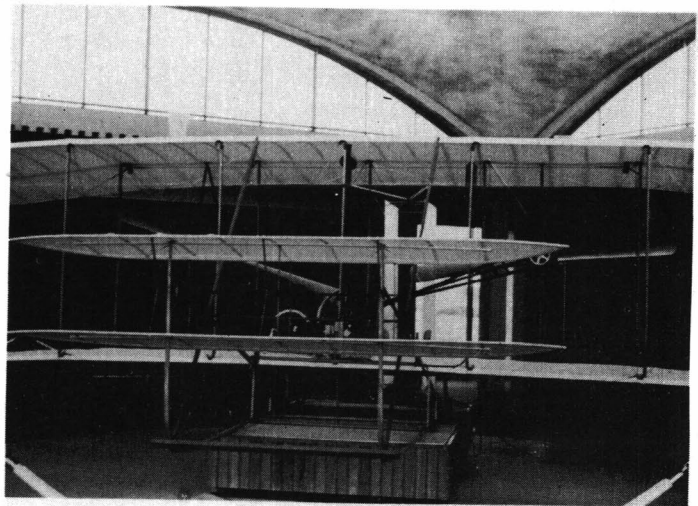


Figure 25

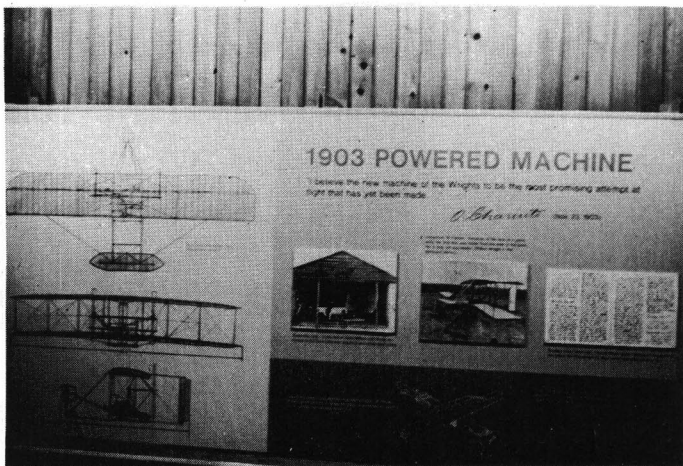


Figure 23

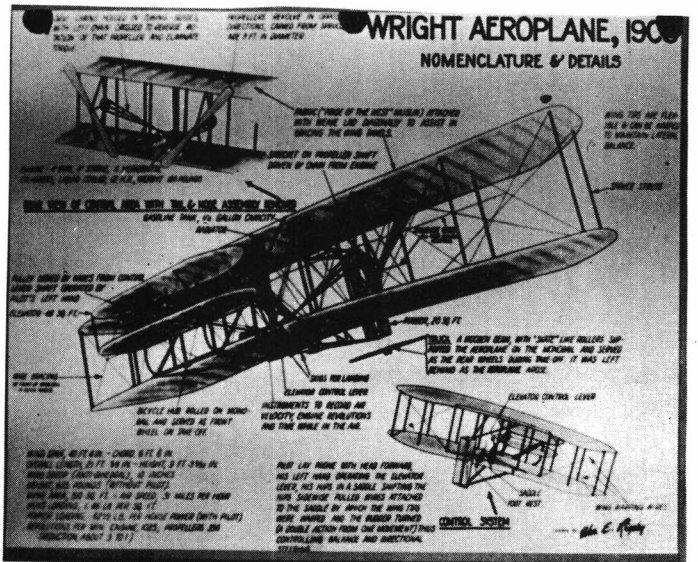


Figure 26

Air and Space Museum in Washington, D. C. Some of the special design features of the Wright Flyer are shown in Figure 26.

Figures 27 and 28 show how the pilot lay prone over the lower wing as he controlled the

aircraft. Figure 29 shows the airspeed indicator designed, built, and installed by the Wrights.

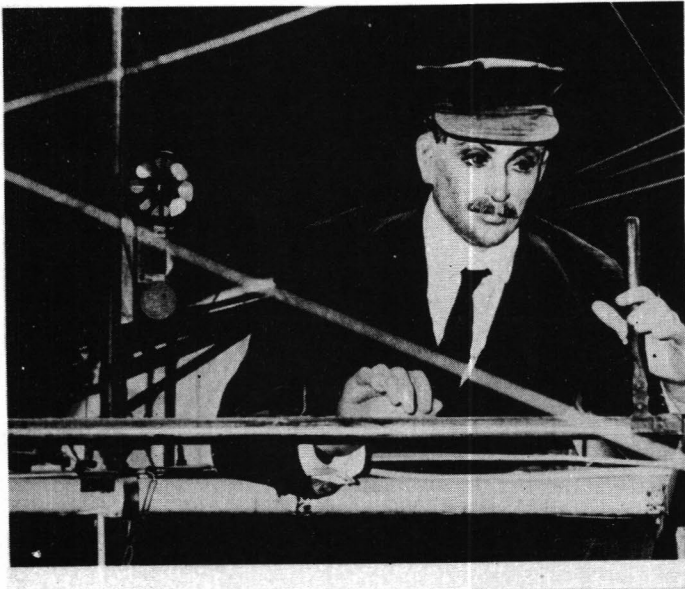


Figure 27

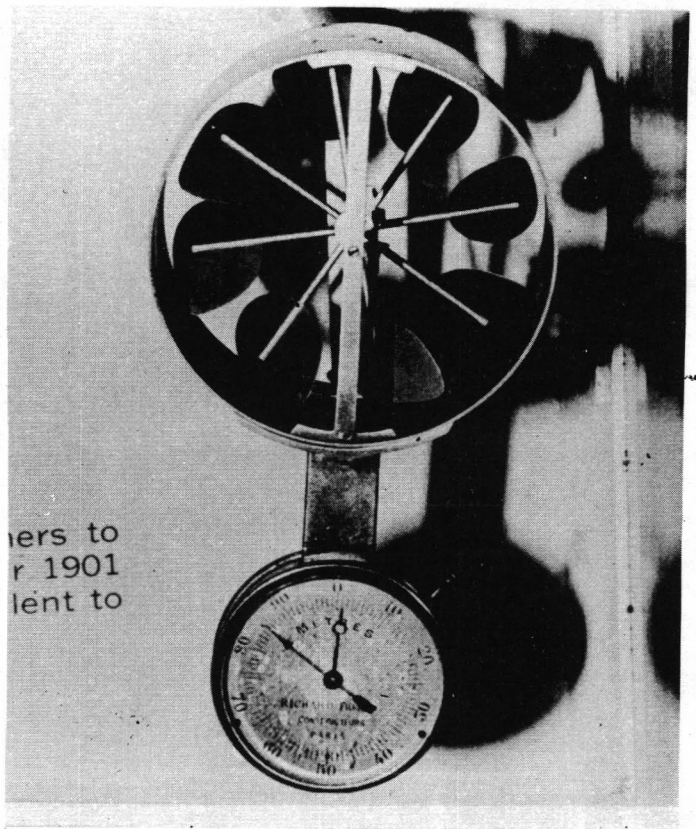


Figure 29

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WRIGHT BROTHERS FULL-SIZE FLIGHT MODELS (UP TO FIRST FLIGHT)	
IDENTIFICATION	YEAR
GLIDER NO. 1	1900
GLIDER NO. 2	1901
GLIDER NO. 3	1902
FLYER NO. 1	1903

Figure 30

WRIGHT BROTHERS FLIGHT THEORY	
●	FLIGHT CONTROLS
●	AERODYNAMICS
●	AIRFOILS
●	PROPELLER BLADES

Figure 31

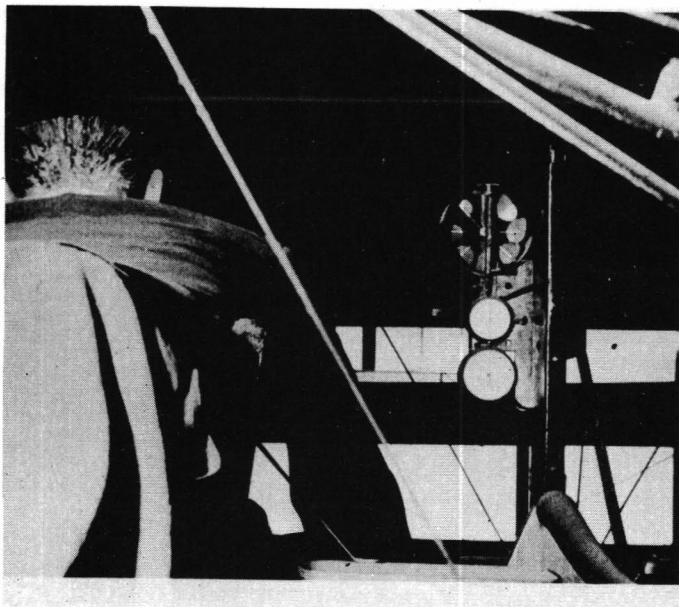


Figure 28

To summarize their initial work, Figure 30 tabulates the man carrying vehicles built between 1900 and 1903.

It is difficult to summarize all their achievements in this time period in three brief charts, but an attempt has been made:

- Figure 31 - Flight Theory Contributions
- Figure 32 - Engineering Practices Contributions
- Figure 33 - Technical Contributions

It should be mentioned two items in Figure 33 were developed after 1903: assisted take-off and floatplane.

Thus from May 1899 to December 1903, Wilbur and Orville Wright, Figure 34, had successfully developed and flown the world's

WRIGHT BROTHERS

ENGINEERING PRACTICES

- LIGHT WEIGHT STRUCTURES
- FLIGHT WEIGHT POWER PLANT
- WIND TUNNEL MEASUREMENTS
- FIXED PITCH PROPELLERS
- STRUCTURAL TESTING
- GLIDER PROOF OF FLIGHT
- FLIGHT INSTRUMENTS
- FLIGHT TEST PHOTOGRAPHY
- 3 AXIS FLIGHT CONTROL SYSTEM

Figure 32

WRIGHT BROTHERS

TECHNICAL CONTRIBUTIONS

- AERODYNAMIC ANALYSIS
- WIND TUNNEL DEVELOPMENT
- GLIDER AND RPV EXPERIMENTS
- FLIGHT CONTROL & INSTRUMENTS
- SYSTEMATIC ANALYSIS
- TESTING & EVALUATION
- POWER PLANT DEVELOPMENT
- ASSISTED TAKE-OFF
- FLOATPLANE

Figure 33

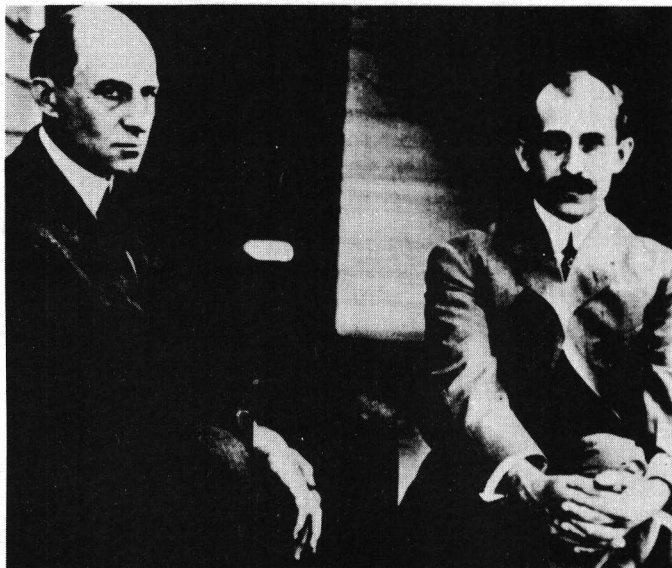


Figure 34

first heavier-than-air airplane. All this remarkable work accomplished in four and one-half years.

Their stimulating work is still looked on with awe and admiration. Even more important, contributions are still being made to enhance the advantages of aviation to the civilization on earth.