

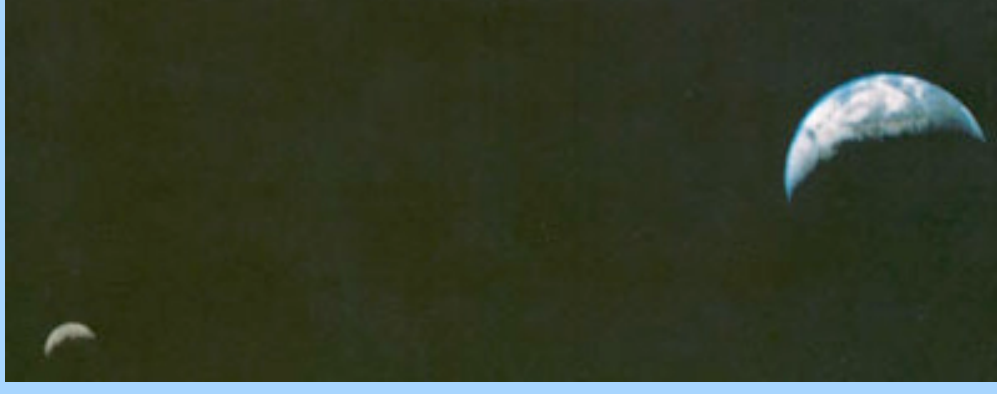
NASA Vision & Mission

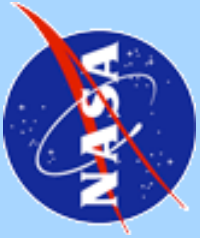
NASA vision for the future is:

- To improve life here,
- To extend life to there,
- To find life beyond

The NASA mission is:

- To understand and protect Earth
- To explore the Universe
- To inspire the next generation
- as only NASA can





Gliding Experiments of the Wright Brothers The Wrights and Flight Research

1899-1908

Al Bowers
Jennifer Hansen Cole
Cam Martin

NASA Dryden Flight Research Center

Background: The Times



Transcontinental Railroad...

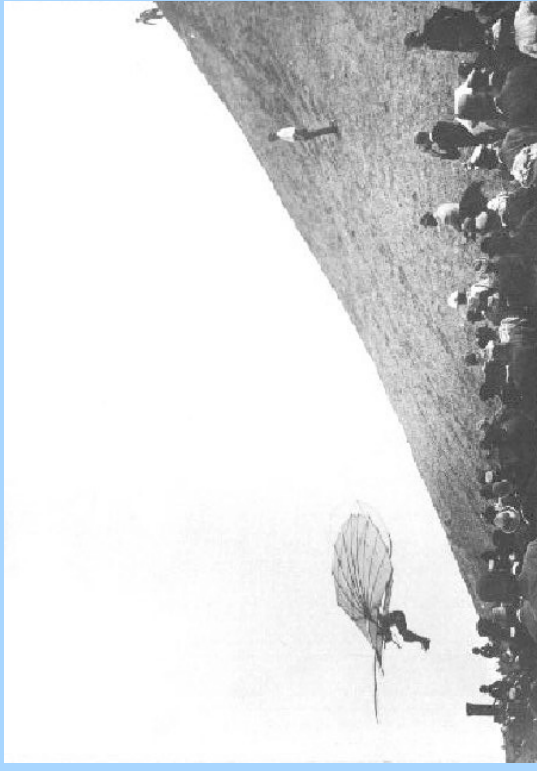
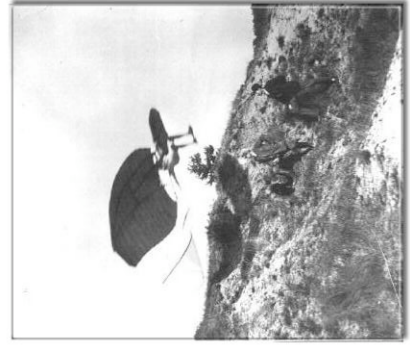
- the great engineering achievement of the time
- understanding of “two-track” vehicle systems (buggys, carts, & trains)
- completed on 10 May 1869 (Wilbur was two years old)

Background: Progenitors

- Otto Lilienthal
 - experiments from 1891 to 1896
- Samuel P Langley
 - experiments from 1891-1903
- Octave Chanute
 - experiments from 1896-1903

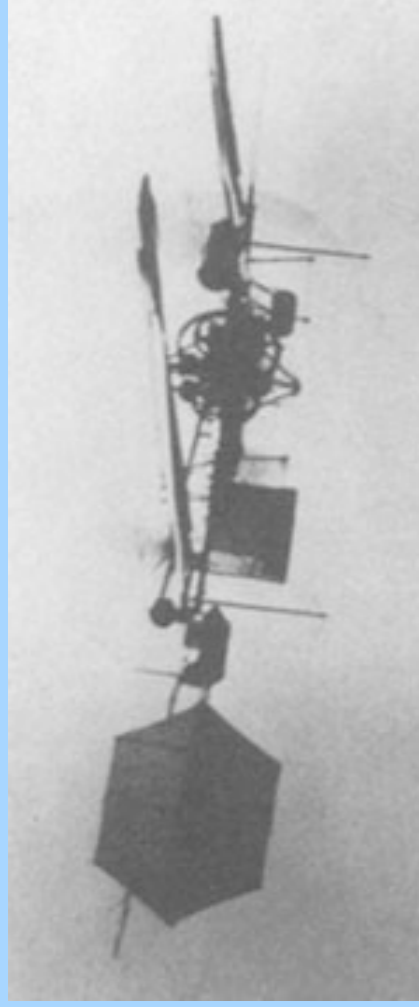
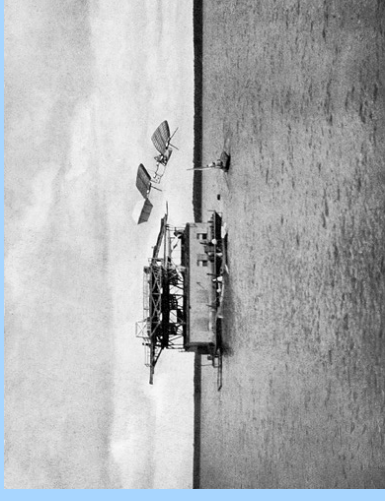
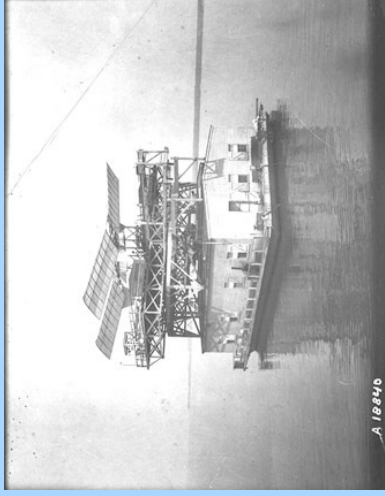
Otto Lilienthal

- Glider experiments 1891 - 1896



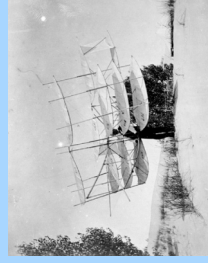
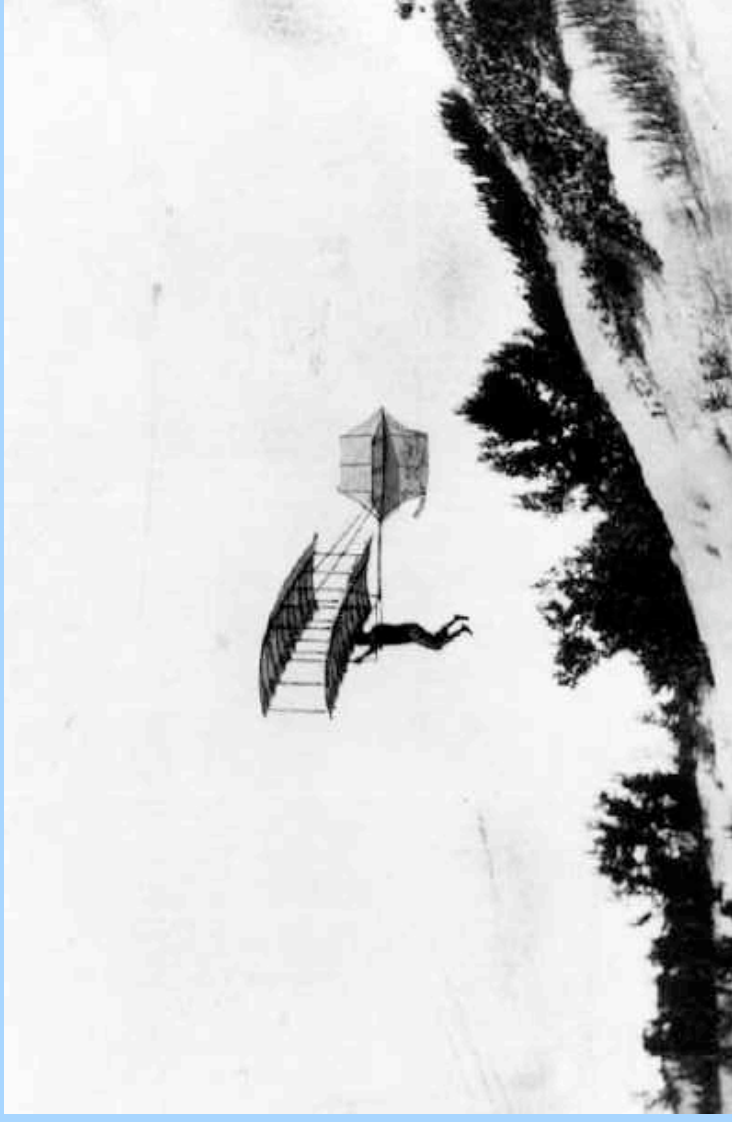
Dr Samuel Pierpont Langley

- Aerodrome experiments 1887-1903



Octave Chanute

- Gliding experiments 1896 to 1903



A Hundred Years
Ago...

1905 Wright Flyer



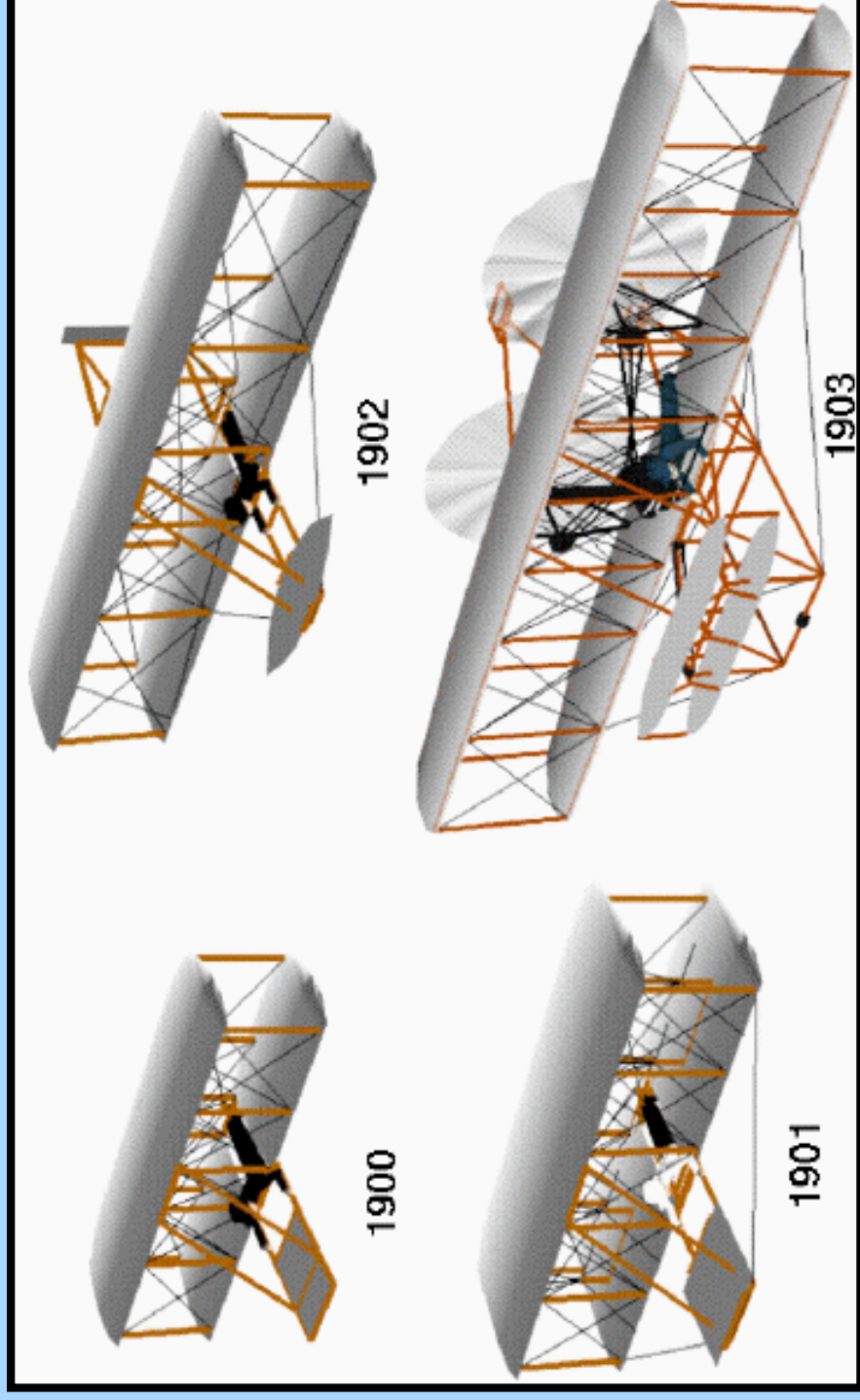
4 Oct 1905



11 May 1908

Kitty Hawk Flight Research

1900-1903



Wilbur and Orville



16 Apr 1867 – 30 May 1912



19 Aug 1871 – 30 Jan 1948

Wright Brothers Timeline

- 1878 The Wrights receive a gift of a toy `helicopter`
- 1895 The Wrights begin to manufacture their own bicycles
- 1896 The Wrights take an interest in the "flying problem"
- 1899 Wilbur devises a revolutionary control system, builds a `kite` to test it; also writes the Smithsonian.
- 1900 The Wright brothers fly a `glider` at Kitty Hawk, NC
- 1901 The Wrights fly a bigger `glider` at Kitty Hawk, NC
- 1901 In Dayton, OH, they build a research `wind tunnel`
- 1902 The Wrights perfect their `glider` and learn to fly
- 1903 The Wright brothers make the first controlled, sustained `powered flight` at Kitty Hawk.
- 1905 In Dayton, the Wrights develop a practical airplane

Wright Brothers' Paper

WEST SIDE NEWS.

DAYTON, OHIO, JULY 20, 1888

No. 19

Vol. 1.

West Side News.

PERMANENT OFFICE,
Vilber Wright Editor
Wills Wright Publisher

TERMS.—Quarter of year, twenty cents
 a year, ten cents.

1216 WEST THIRD STREET,
 DAYTON, OHIO.

Racing a Bird's Nest.

Edward Coeils, the inventor of the Coeils engine, is building an addition to his factory, while engineering the foundation found it necessary to remove a ledge by blasting. The workmen had been employed the materials provided, and the blasting began. The next morning Mr. Coeils passed by the place where work was pro-

gone out of the way, but with a genuine interest in their growth. The old birds had all the time their waddles, and when at last they had steadily helped the clumsy, reluctant youngsters over the edge of the led, and they showed themselves able to get about on their own hook, each were given to resume the building operations and the dull team of the property der tearing the rocks apart was heard where the birds had perched.—*Boston Traveller.*

"The Bargain"

A little colored boy, out over his slight but full of soul, called at a house and requested the privilege of removing three barrels of rubbish for the sum of twenty cents. The request was granted, and the next morning the young African appeared with two com-

one out of the way, but with a genuine interest in their growth. The old birds had all the time their waddles, and when at last they had steadily helped the clumsy, reluctant youngsters over the edge of the led, and they showed themselves able to get about on their own hook, each were given to resume the building operations and the dull team of the property der tearing the rocks apart was heard where the birds had perched.—*Boston Traveller.*

F. M. NIPGEN,
 DEALER IN
DRUGS, MEDICINES
Physician's Prescriptions carefully compounded.

W. W. Cor, Fifth and Williams

NEW DRUG STORE.

WM. P. GRAYBILL
dealer in
 Drugs, medicines, Prescriptions, carefully compounded.

S. E. Cor. Third and Summit

J. W. COATES,
DEALER IN
DRUGS, MEDICINES,
AND CHEMICALS
 Physician's Prescriptions carefully compounded.

111 West Third St.

THE

Dayton's "West Side News"

Wright Brothers' Cycle Company

- “single-track” vehicle mechanics

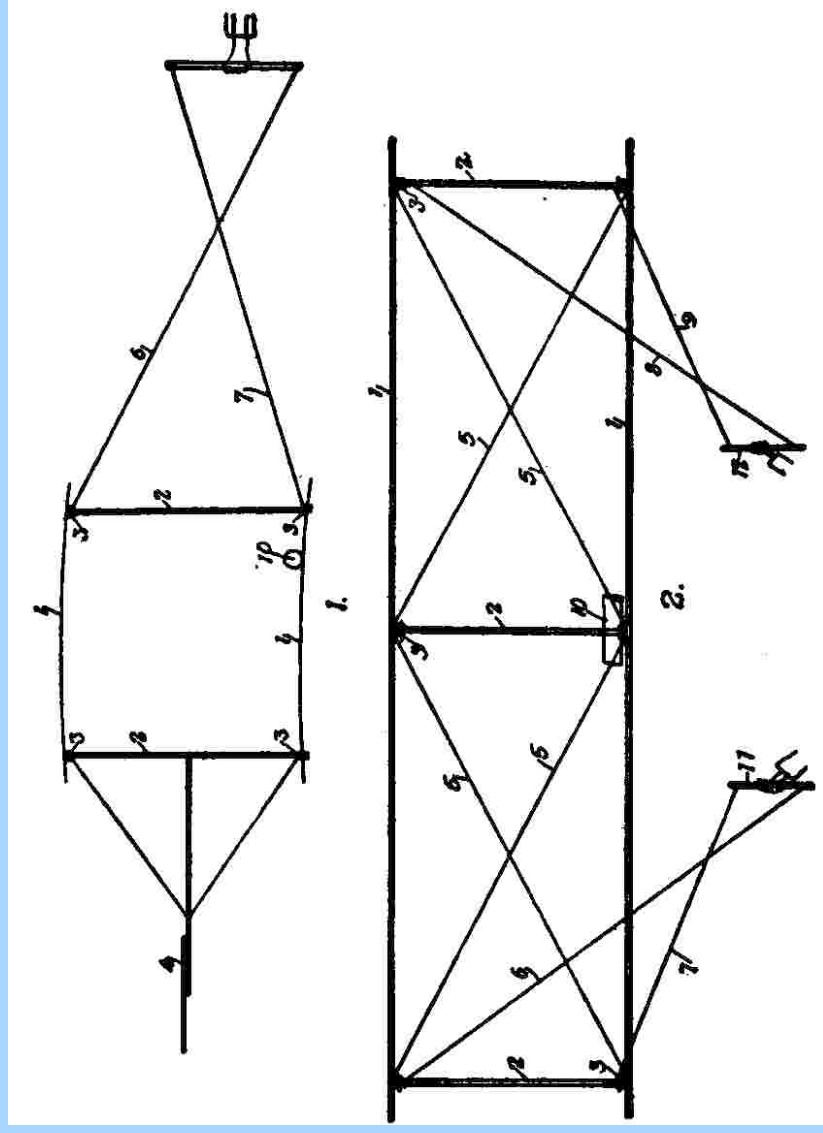
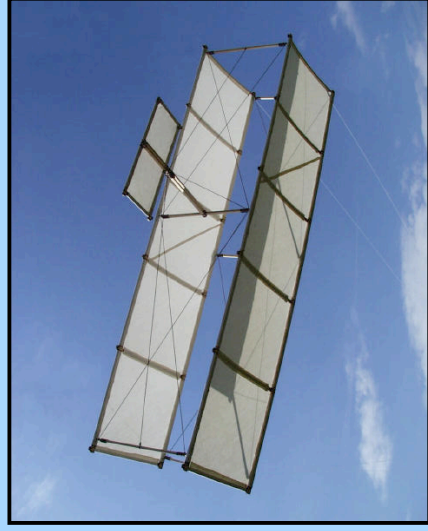


Inspiration: July 1899



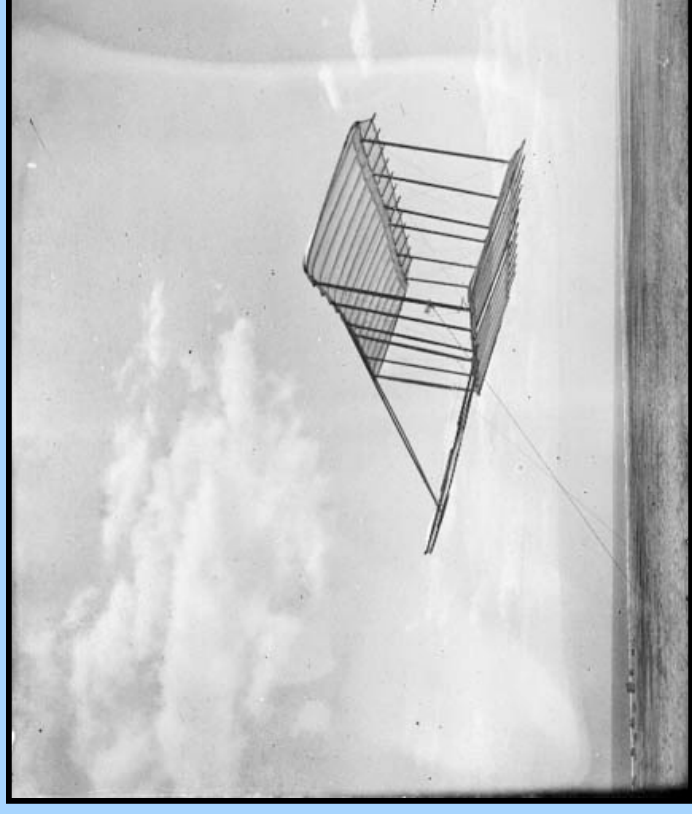
1899 Kite Experiments

Dayton Ohio



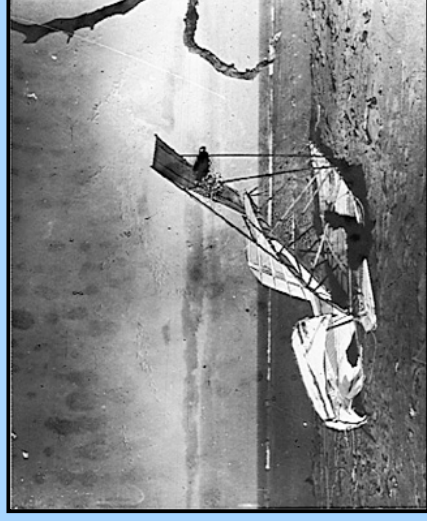
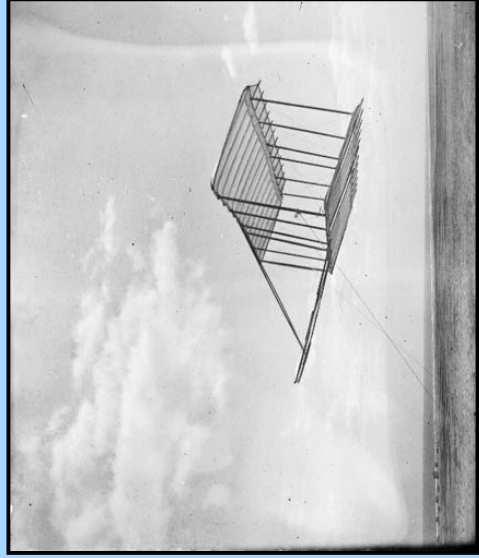
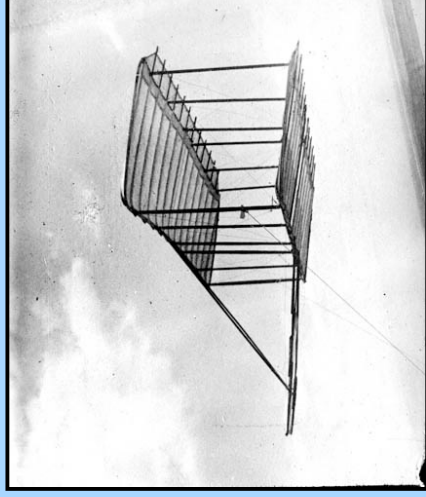
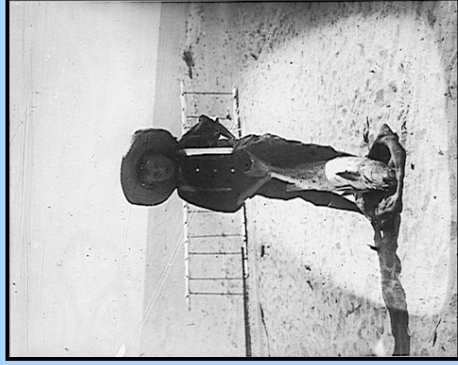
1900 Wright Glider

- Span: 17 feet
- Chord: 5 feet
- Gap: 4 feet, 8 inches
- Camber: $\frac{1}{23}$
- Wing Area: 165 sq ft
- Weight with operator
190 lb



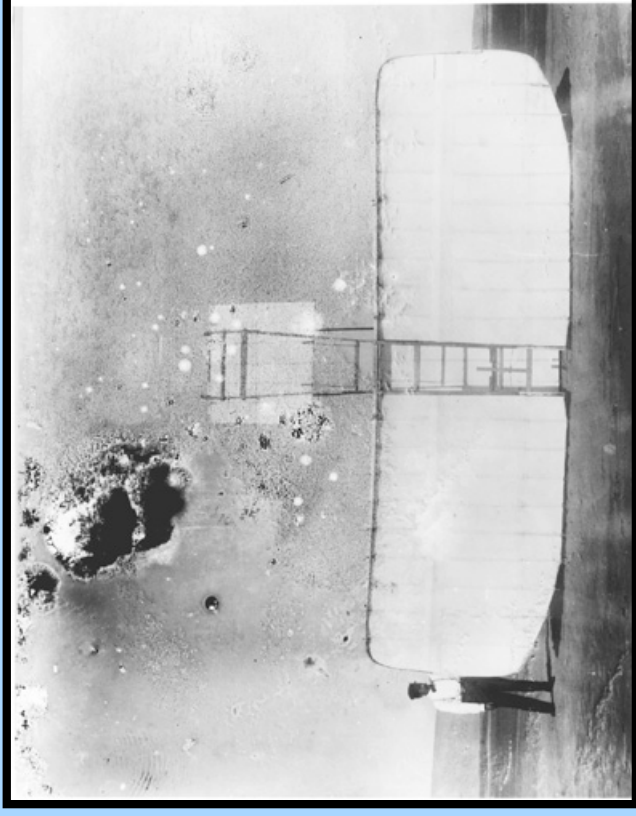
1900 Wright Glider

Kitty Hawk September - October 1900



1901 Wright Glider

- Span: 22 feet
- Chord: 7 feet
- Gap: 4 feet, 8 inches
- Camber: 1/17
- Wing Area: 290 sq ft
- Horizontal Rudder Area
18 sq ft
- Length 14 feet
- Weight 98 lb



1901 Wright Glider

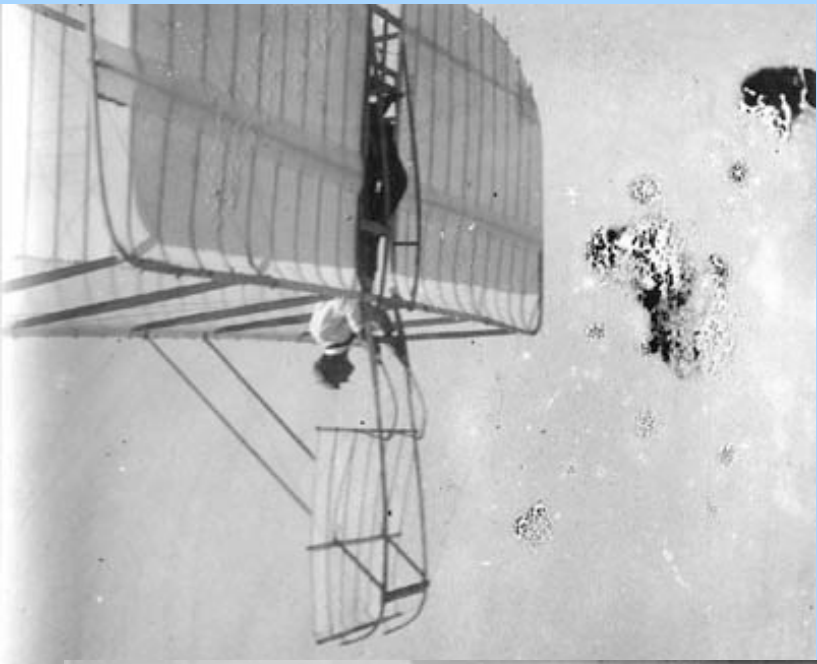
Kitty Hawk July - August 1901



1901 Glider Flown as a Kite



1901 Wright Flown as Glider



Kitty Hawk 1901



They go home, very discouraged.

**On the train back to Dayton,
Wilbur tells Orville that men would
not fly for another fifty years...**

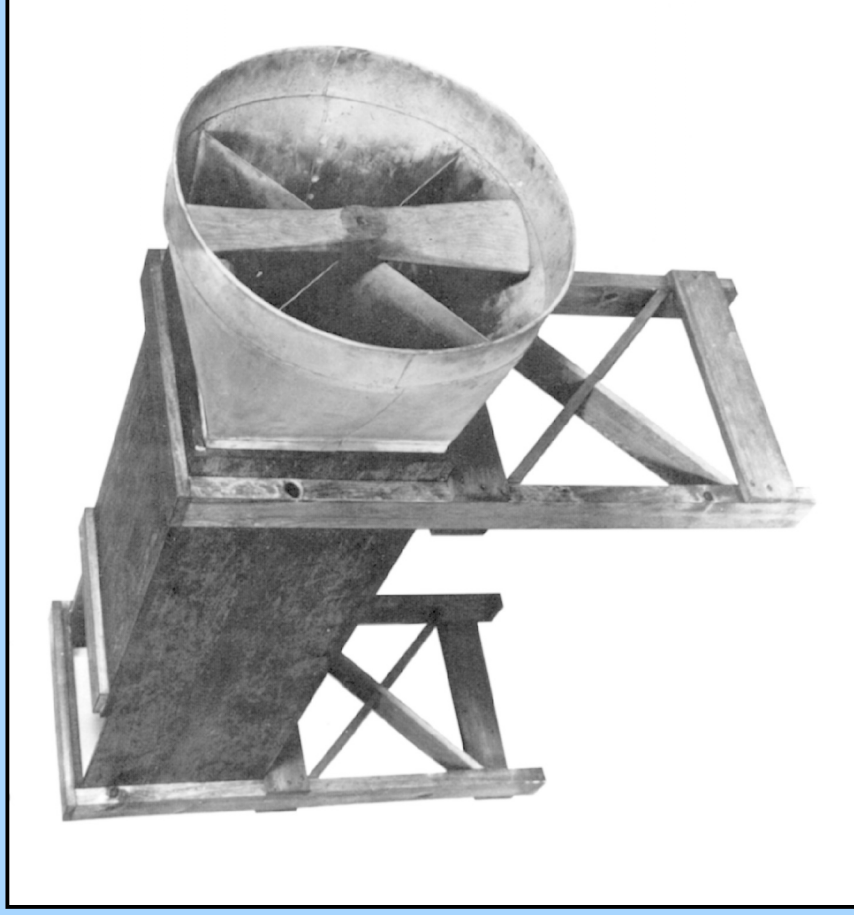
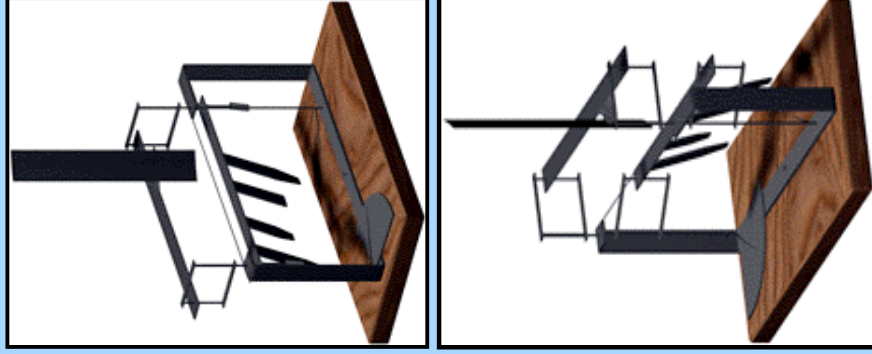
Dayton Experiments

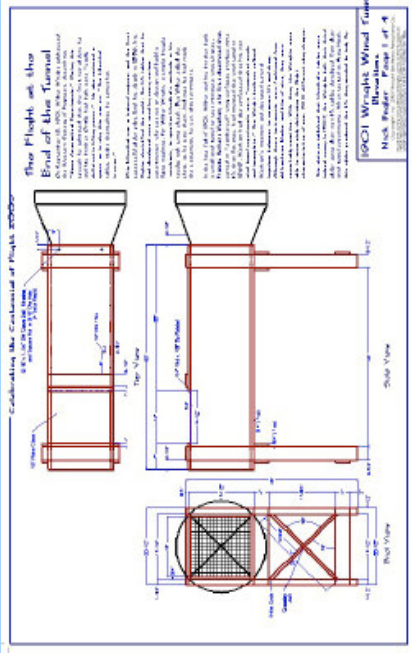
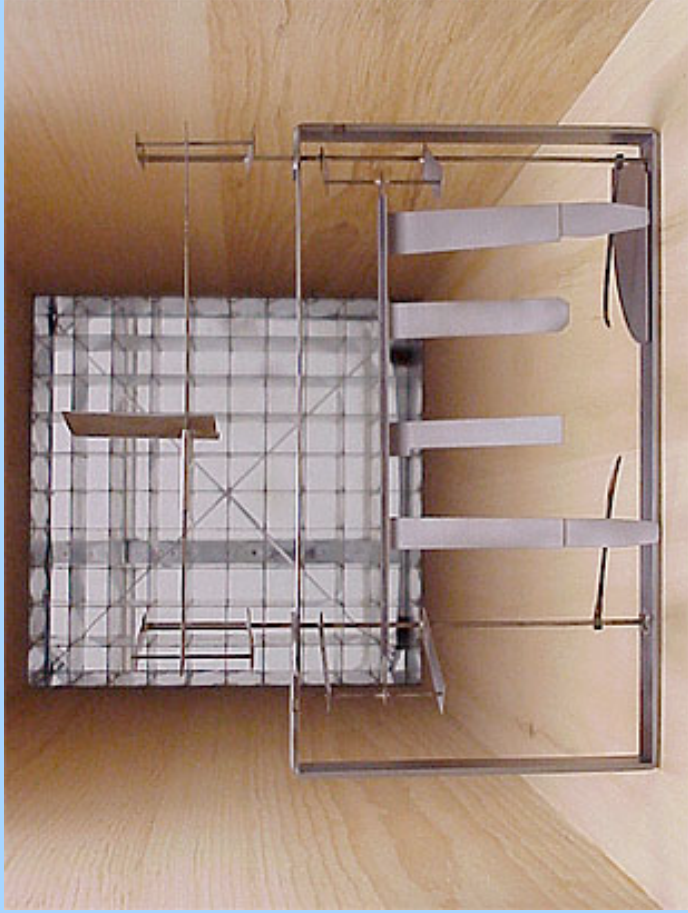
October 1901



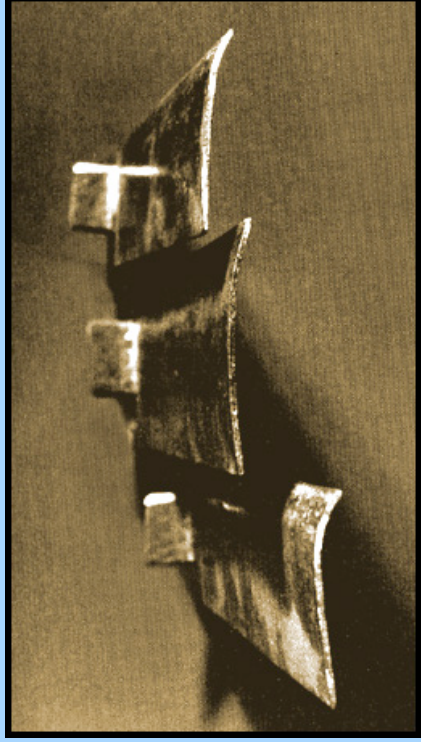
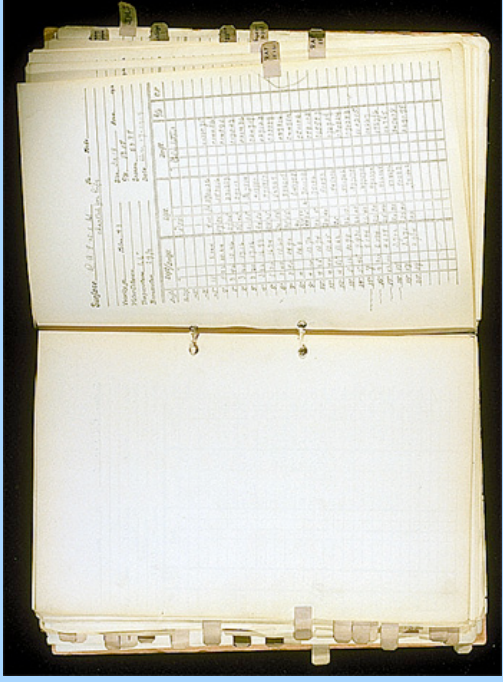
1901 Wind Tunnel

16 inch square section x 6 feet





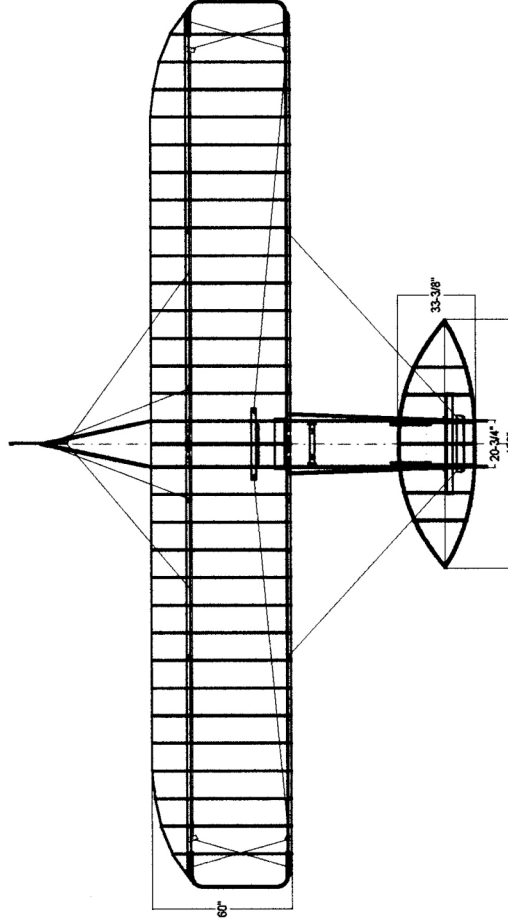
1901 Wright Wind Tunnel Results



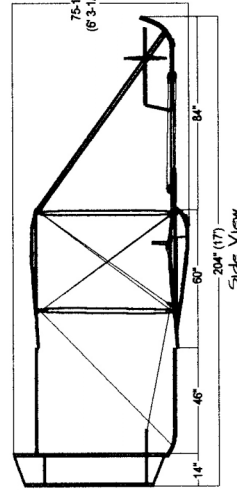
1902 Wright Glider

Specifications

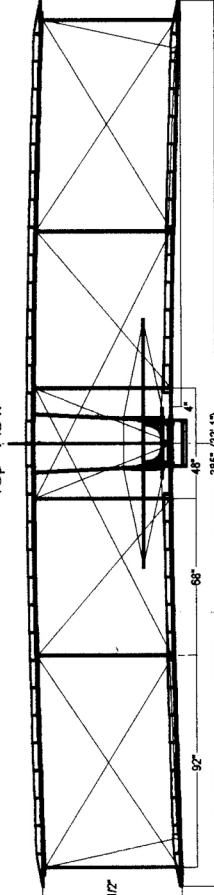
Wingspan: 32 feet, 1 inch
 Chord: 5 feet
 Camber: 1/20 to 1/24
 Anhedral: 4 inches
 Wing Area: 305 square feet
 Elevator Area: 15 square feet
 Rudder area: 5.7 square feet
 Overall Length: 17 feet
 Overall Height: 6 feet, 3 inches
 Gap between wings: 5 feet
 Weight: 112 pounds
 Number of flights: Approximately 2000
 Longest distance flown: 622 feet
 Longest time in flight: 1 minute, 12 seconds
 Frame materials: Spruce, ash, waxed linen cord
 Hardware: Mild steel, boxwood (for pulleys)
 Rigging: 15-gauge steel wire
 Wing covering: Cotton muslin, 209 thread count



Top View



Side View



Front View

Not for sale or profit; these plans are to be distributed freely and free of charge.

To help celebrate the upcoming Centennial of Flight in 2003, the Wright Brothers Aeroplane Company offers the engineering drawings we developed for the 1902 Wright Glider free. This is a wonderful project not just for those who enjoy building historic aircraft, but also for young people. If you're a teacher or a youth leader, there is no need to purchase the plans. We encourage you to share the plans with your students and to encourage them to use the Wright Brothers. Use these plans and distribute them with our good wishes. However, remember these are copyrighted plans and the copyright holder claims all privileges and protection afforded by law. If you use or distribute these plans, you are bound to these conditions: 1. You may not set or profit from these plans. 2. You cannot charge copying, handling, postage, or shipping fees. If we can contribute hundreds of hours of research, you can look in a title paper and postage. 3. If you find a mistake of these drawings, you are honor-bound to let us know so we can correct it. 4. If you know of or discover better methods or additional suppliers of materials for building this glider, then those we describe are not to be used. 5. We encourage you to make this project a better experience, especially for the young people who participate. 5. You may make single copies but you may not publish these plans in any form, electronic or paper, without written permission of the copyright holder.

1902 Wright Glider
 Elevations
 Nick Engler Page 1 of 20
 Copyright © 2000 Wright Brothers Aeroplane Co.
 1000 Wright Brothers Ave., Dayton, OH 45325
 www.wright-brothers.org

1902 Wright Glider

- Span: 32 feet 1 inch
- Chord: 5 feet
- Gap: 4 feet, 7 inches
- Camber $1/24$
- Wing Area: 305 sq ft
- Horizontal Rudder Area
15 sq ft
- Length 16 feet 1 inch
- Weight 112 lb
- Three configurations

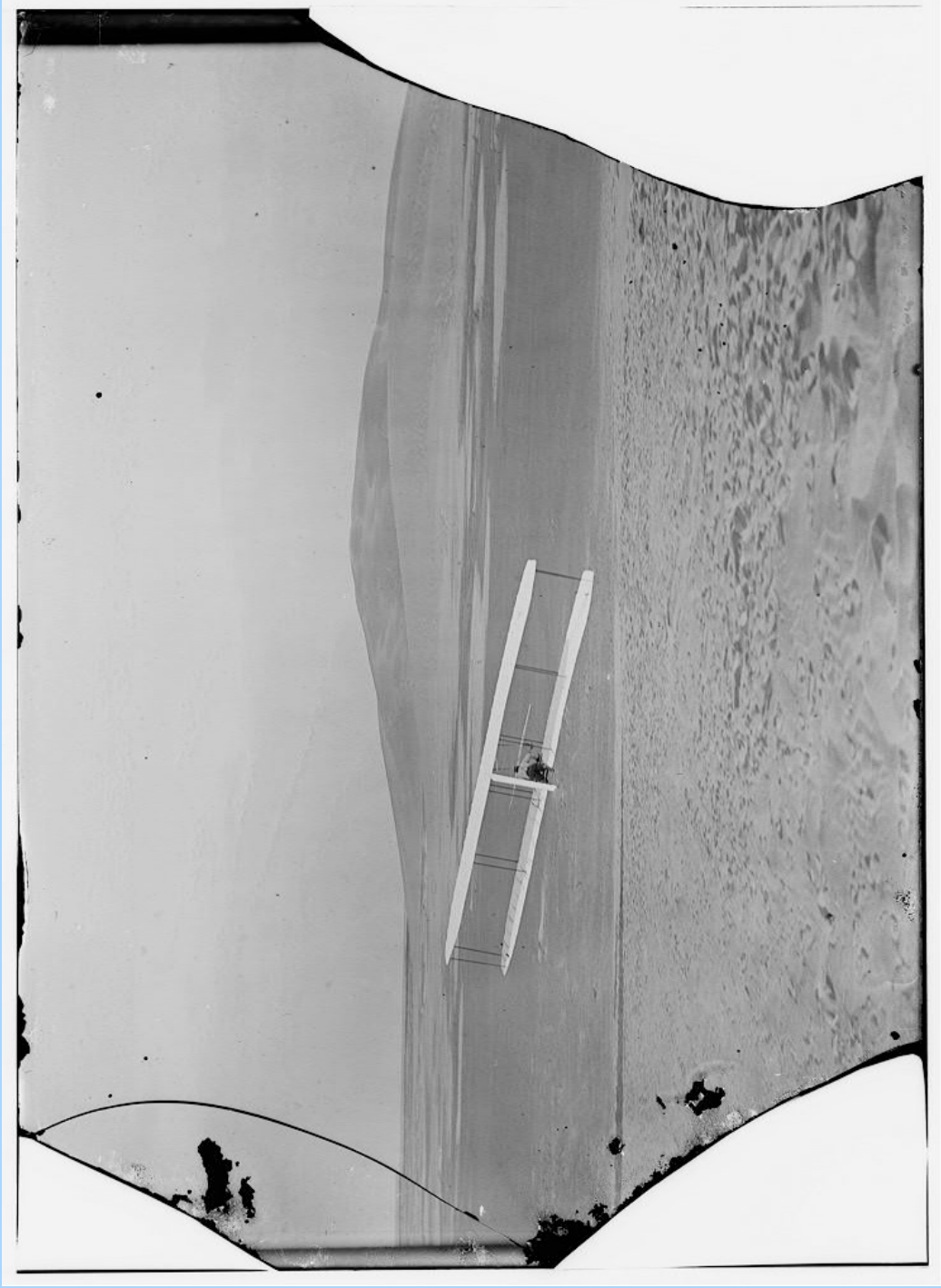


1902 Wright Glider

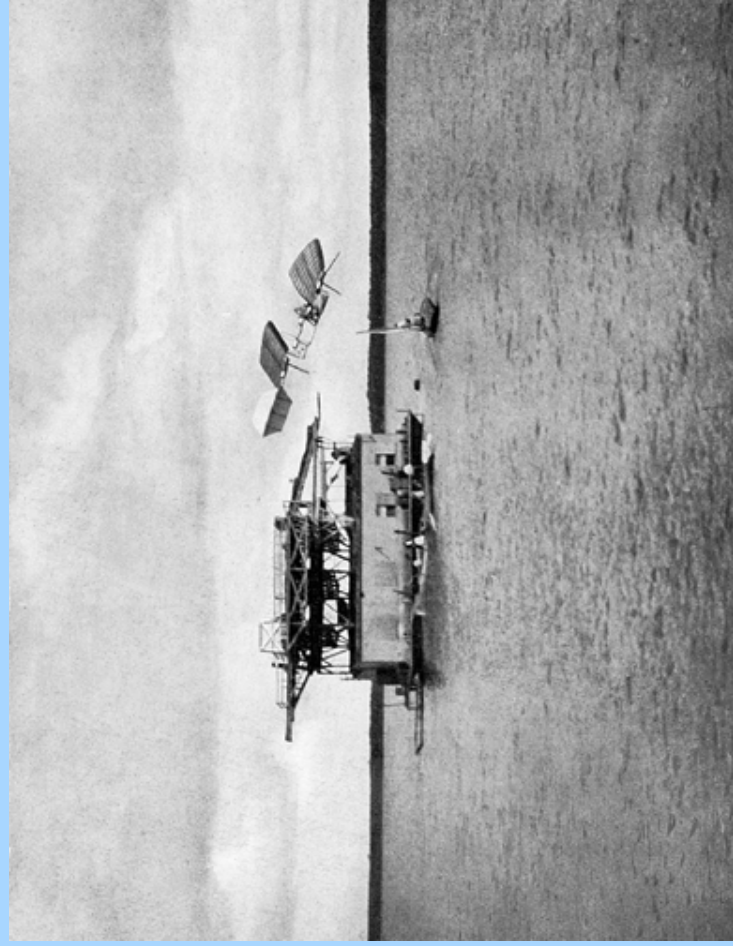


Centennial of Controlled Flight

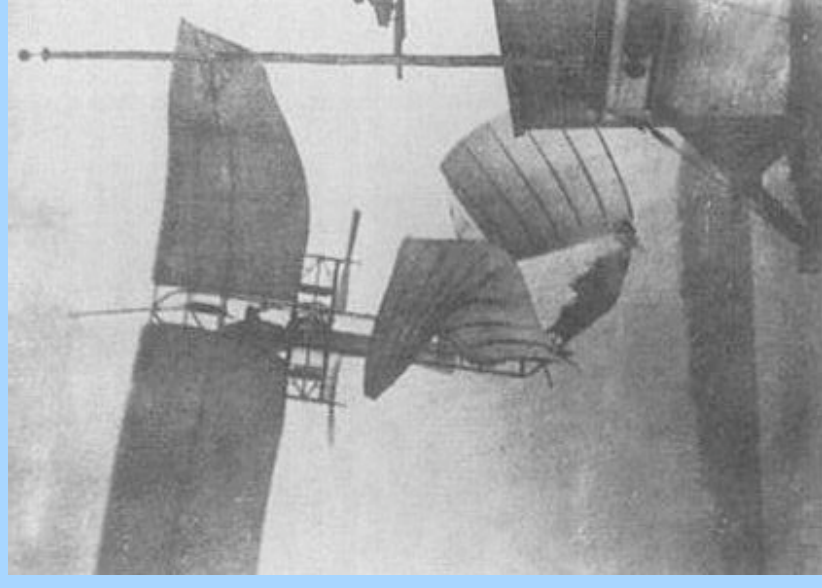
24 October 1902



1903 Langley Aerodrome

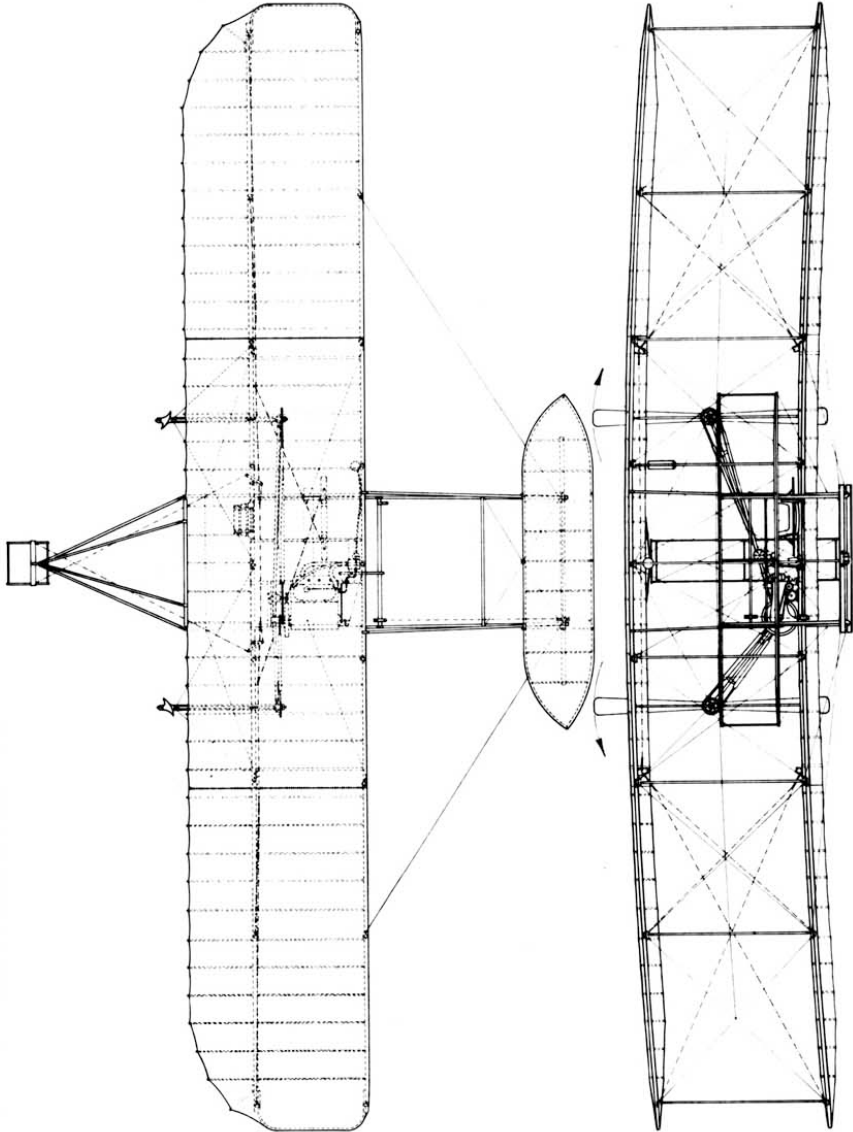


Oct 7, 1903



Dec 8, 1903

1903 Wright Flyer



SPECIFICATIONS.

EXTERIOR DIMENSIONS:
 40 FT. 1 IN. OVERALL LENGTH.
 8 FT. 4 IN. HEIGHT OVER WINGS OF PROPELLERS.
 8 FT. 6 IN. HEIGHT OVER WING CAMBER.
 7 FT. 3 IN. WING CHORD.
 37° 35' ANGLE OF INCIDENCE (AVERAGE).
 37° 35' ANGLE OF DITCHING (AVERAGE).

SURFACE AREAS:
 148 SQ. FT. WING AREA, EACH WING.
 148 SQ. FT. FRONT RUDDER AREA, (TWO SURFACES).
 20 SQ. FT. REAR RUDDER AREA, (TWO SURFACES).
 140 SQ. FT. TOTAL SURFACE AREA.

WEIGHT:
 600 LBS. TOTAL WEIGHT WITHOUT PILOT.
 140 LBS. WEIGHT OF ENGINE AND ACCESSORIES.
 140 LBS. PILOT WEIGHT, (WILBUR WRIGHT).

ENGINE:
 4 CYLINDER, 4 CYCLE, VERTICAL GASOLINE TYPE,
 12 HORSE POWER AT 1100 REV. PER MINUTE.
 170 LBS. WEIGHT COMPLETE WITH MAGNETO AND ACCESSORIES.

ENGINE IGNITION: MAGNETO MARKED, MAGNETO BREAK SPARK.

ENGINE STARTING: ENGINE STARTED WITH DRY BATTERIES, THEN SWITCHED TO MAGNETO.

ENGINE LUBRICATION: OIL SLASH, ACTIVATED BY THE CRANKSHAFT.

ENGINE COOLING:
 FUEL WITH WINDMILL WATER CIRCULATION THRU RADIATOR.

FUEL TANK: GRAVITY FEED THRU RUBBER TUBING FROM 6 GALLON CAPACITY TANK MOUNTED ON UPPER END OF WING FRONT STRUT.

LOADING:
 142 LBS. PER SQUARE FOOT WING AREA.
 142 LBS. PER ENGINE HORSE POWER.

PROPELLERS:
 TWO PROPELLERS, POSITIVE DIRECTION OF ROTATION, CHAIN DRIVEN, ROLLER CHAINS, (INCH PITCH, 3/8 IN. DIA. X 5/8 IN. WIDTH ROLLERS).
 SPROCKETS, 2 1/2 IN. DIA. X 3/4 IN. THICK ON PROPELLER SHAFTS.
 2700 R.P.M. APPROX. ENGINE SPEED IN FLIGHT.
 3300 R.P.M. APPROX. PROPELLER SPEED IN FLIGHT.

—KITTY HAWK AEROPLANE—

CONCEIVED AND BUILT AT DAYTON, OHIO, AND SUCCESSFULLY FLOWN BY ORVILLE AND WILBUR WRIGHT, DECEMBER 17, 1903, AT KITTY HAWK, NORTH CAROLINA.

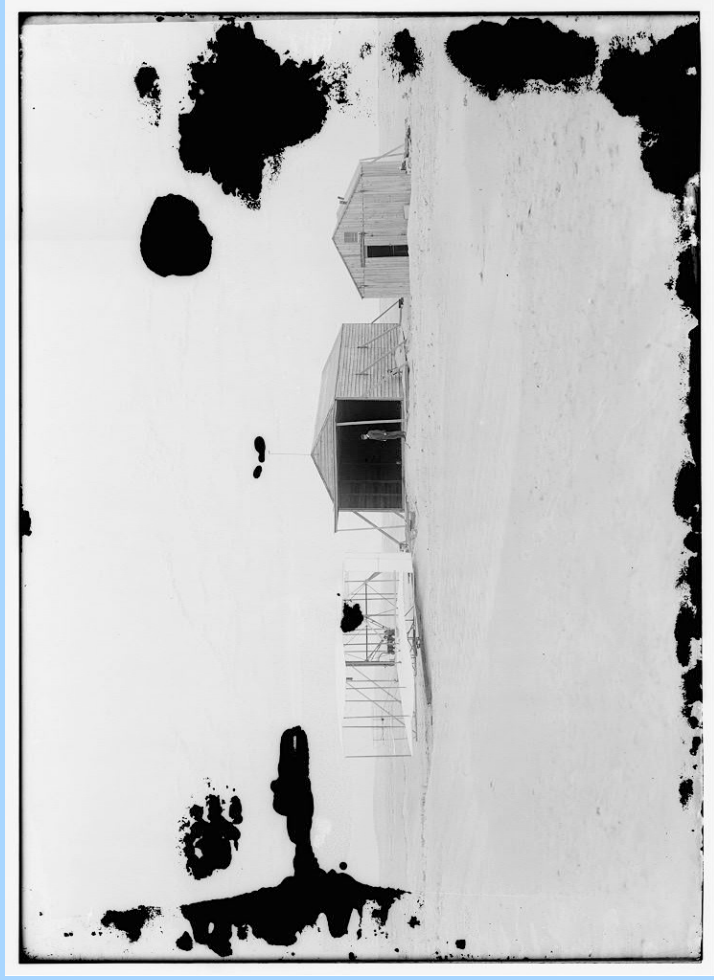
LOUIS F. CHRISTMAN, DELINEATOR

DRAWING CONTRIBUTED BY EDUCATIONAL AND MUSICAL ARTS, INC., DAYTON, OHIO.

DRAWING NO. 2-1

1903 Wright Flyer

- Span: 40 feet 4 inch
- Chord: 6 feet 6 inches
- Gap: 6 feet 2 inches
- Camber 1/20
- Wing Area: 510 sq ft
- Horizontal Rudder Area 48 sq ft
- Vertical Rudder 21 sq ft
- Length 21 feet 1 inch
- Weight 605 lb



1903 Wright Flyer

December 14, 1903



Wilbur wins the coin toss, and...

1903 Wright Flyer

December 14, 1903



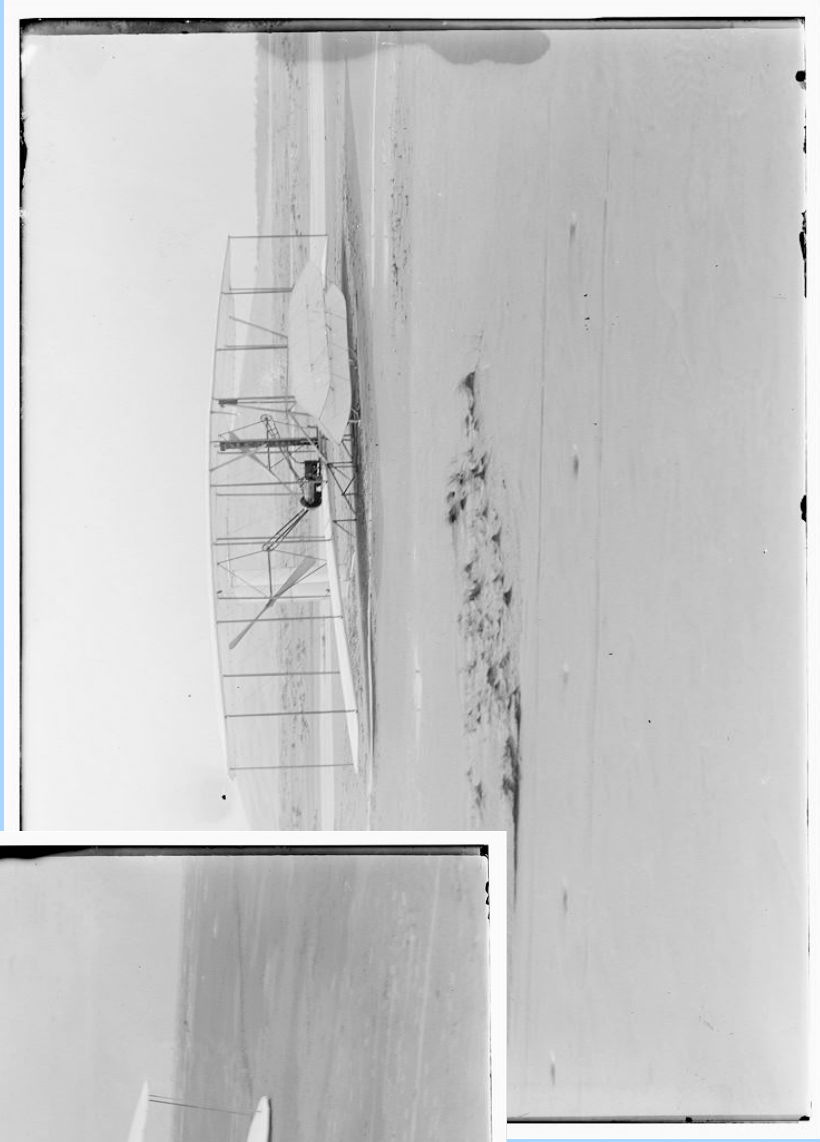
Oops!

1903 Wright Flyer

December 17, 1903



1903 Wright Flyer



They tell the world...

Form No. 108

THE WESTERN UNION TELEGRAPH COMPANY.
23,000 OFFICES IN AMERICA. INCORPORATED CABLE SERVICE TO ALL THE WORLD.

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This is an UNREPEATED MESSAGE, and is delivered by request of the sender, under the conditions named above.

ROBERT G. CLOWRY, President and General Manager.

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176 C KA GS 33 Paid. Via Norfolk Va

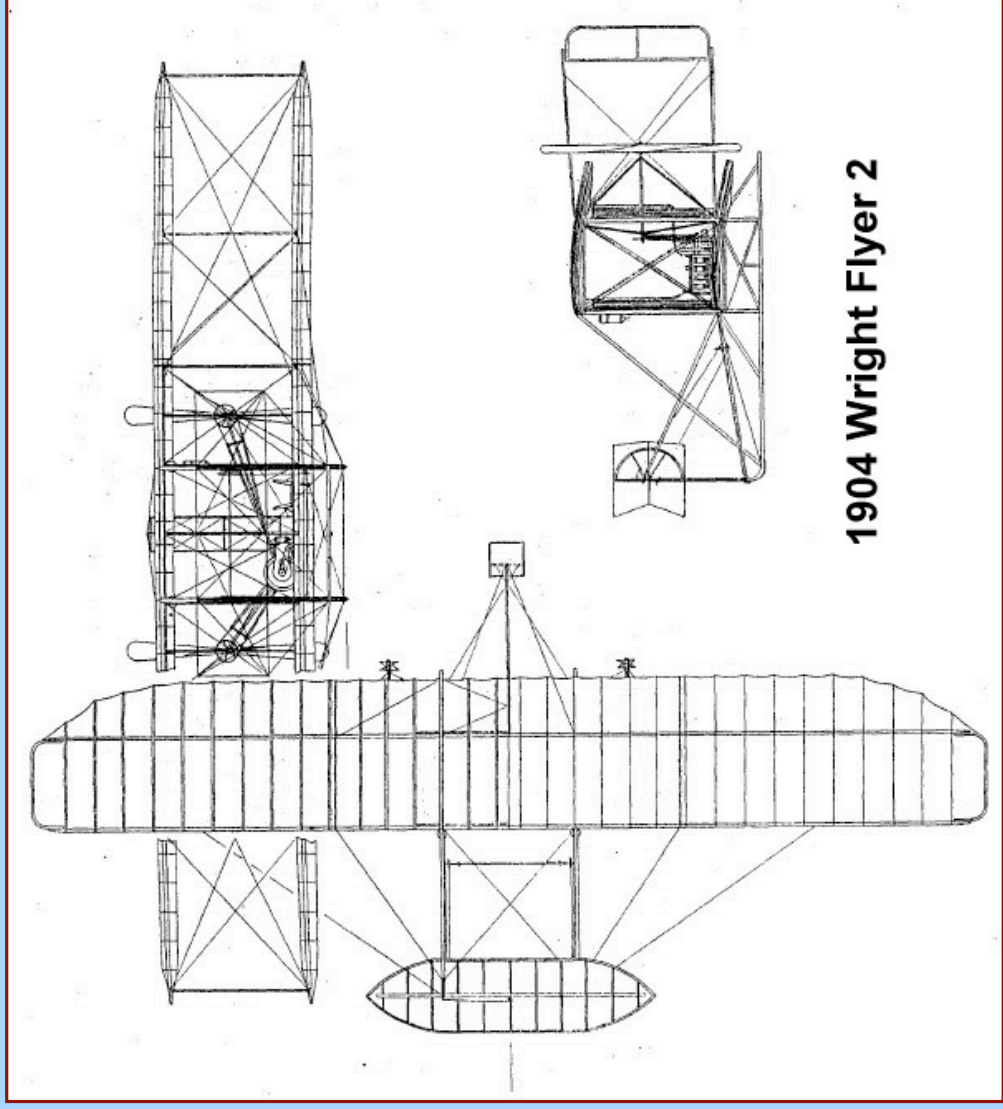
Kitty Hawk N C Dec 17

Bishop M Wright

7 Hawthorne St

Success four flights thursday morning all against twenty one mile
wind started from level with engine power alone average speed
through air thirty one miles longest 57 seconds inform Press
home ~~Christmas~~ Christmas . Orevelle Wright 525P

1904 Wright Flyer



1904 Wright Flyer 2

1904 Huffman Prairie Ohio

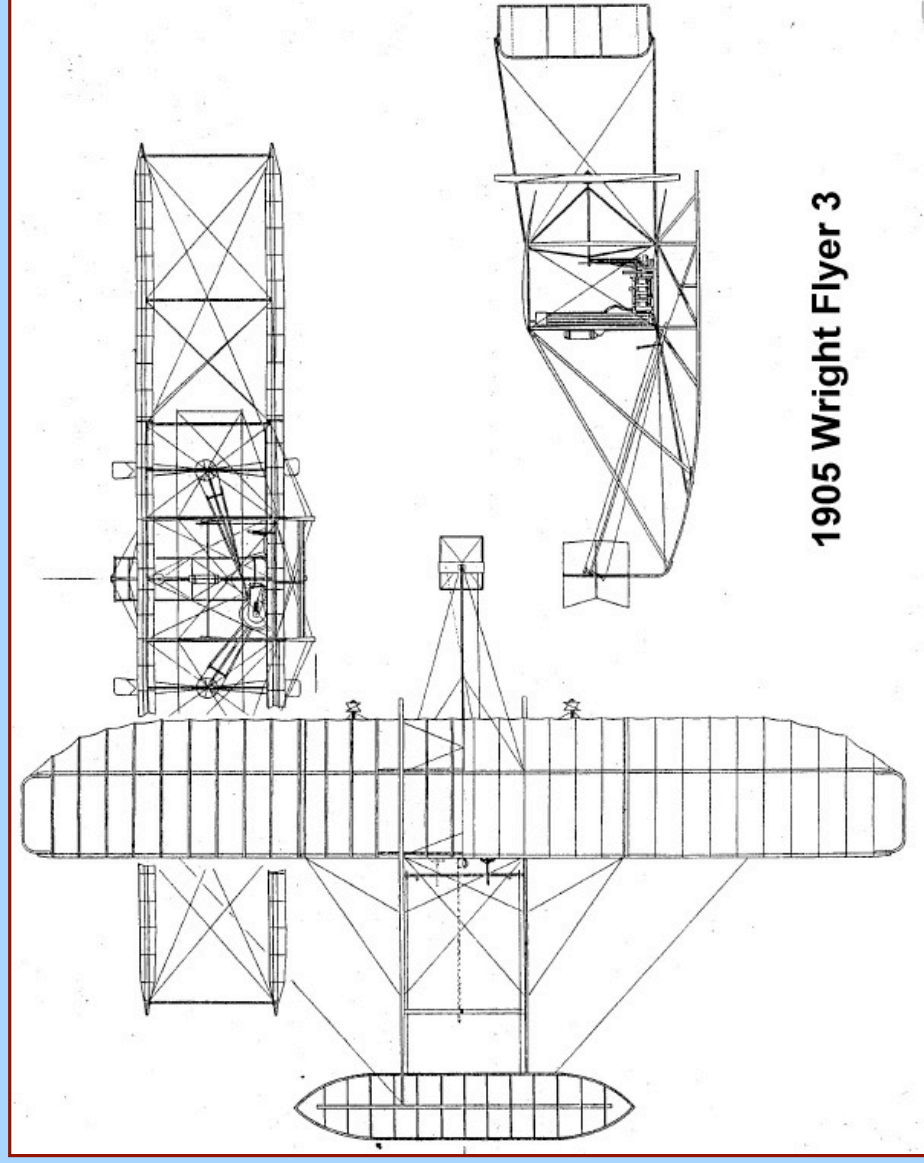
September 20, 1904 First Complete Circle in an Airplane



1904 Wright Flyer III



1905 Wright Flyer



1905 Wright Flyer 3

1905 Huffman Prairie OH

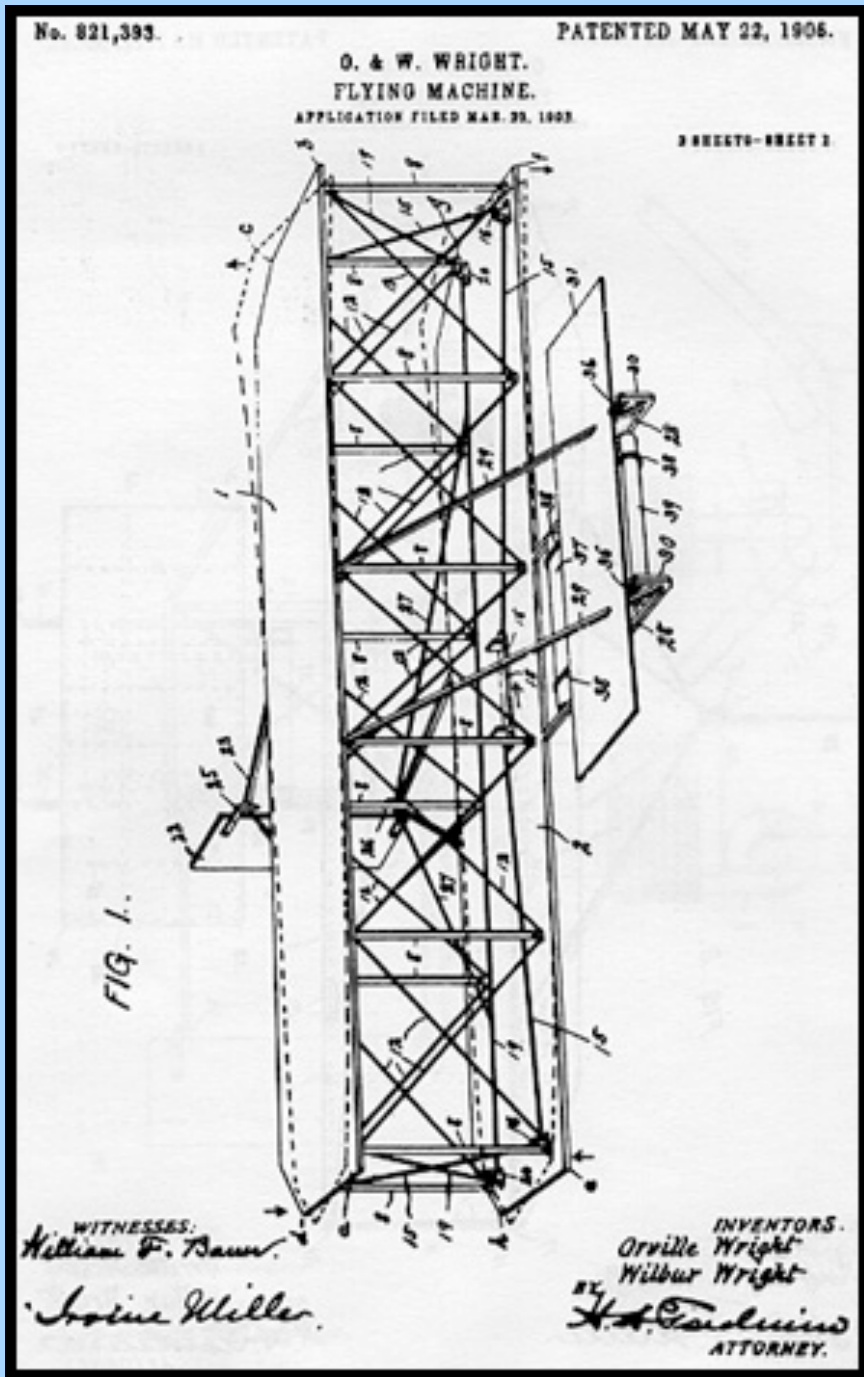
Oct 4, 1905 Extended Flight in an Airplane (38 minutes)



Wright Flying Machine Patent

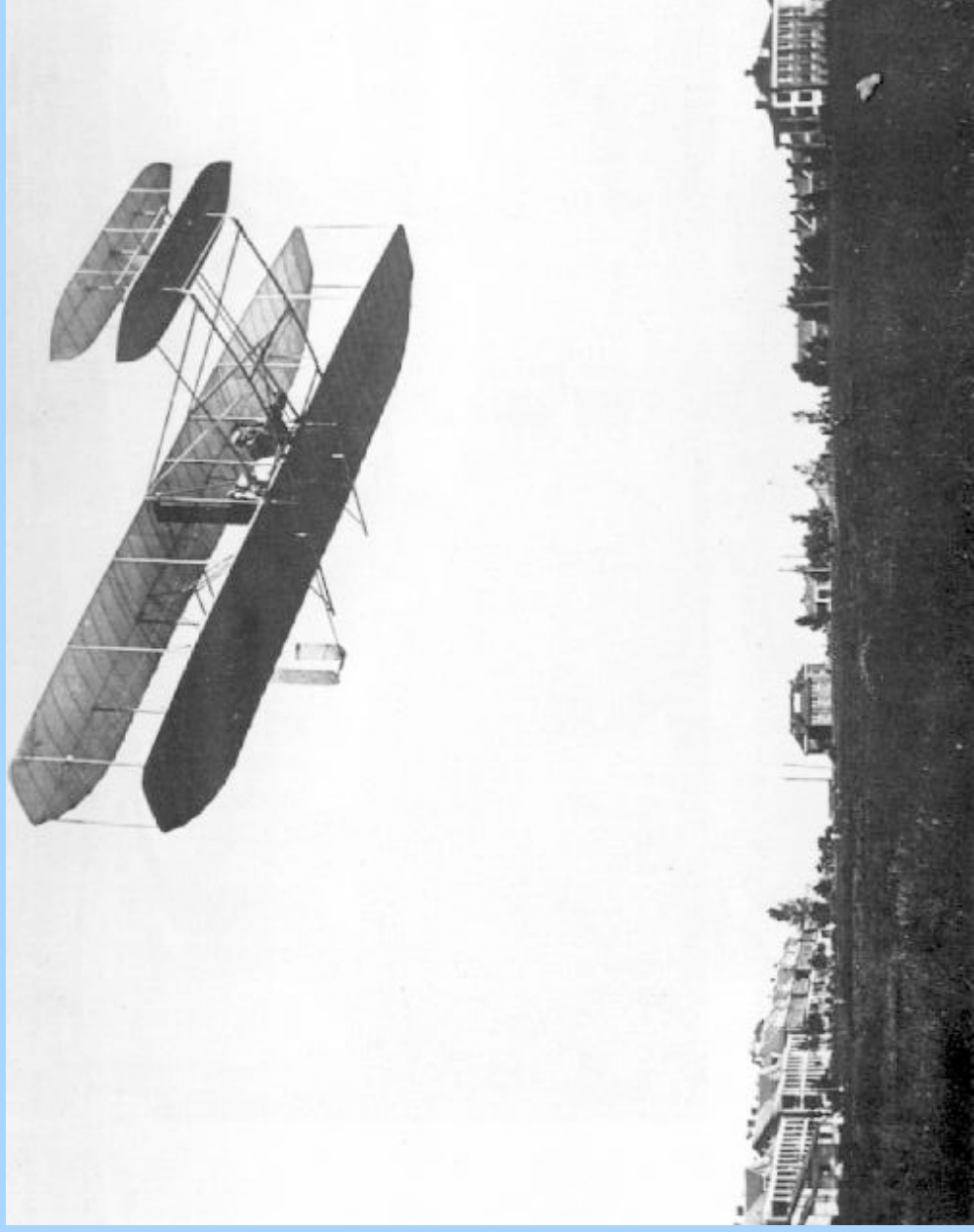
#821, 393

May 22, 1906



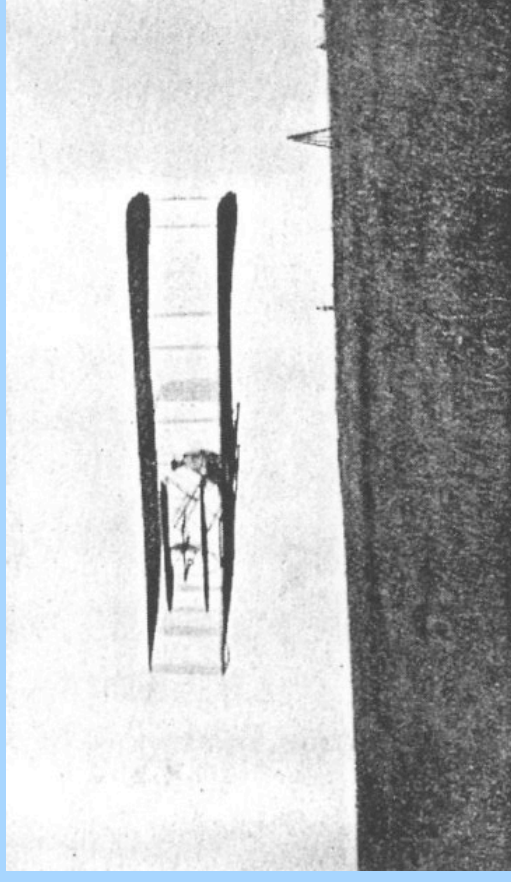
1908-1909 France & Virginia

Public trials of the first practical airplane



1909 Clarke-Wright Glider

- Built as a trainer to Wright specs



1911 Wright Glider

- Built for autopilot experiments
- Set duration record (9 min 45 sec)



The Rest is History...

- 1904 Flights of 5+ minutes duration
- 1905 Flights to 38 minutes duration
- 1906 - 1907 Commercialization
- 1908 - 1909 Flight Demonstrations
 - Wilbur in France, Italy and Germany
 - Orville in United States

- 1909 The Wright Company is established
 - Clarke-Wright glider in England
 - Established Flying School in Alabama, OH

- 1911 Glider Experiments with autopilot

- Orville serves on NACA board from 1920 to 1948



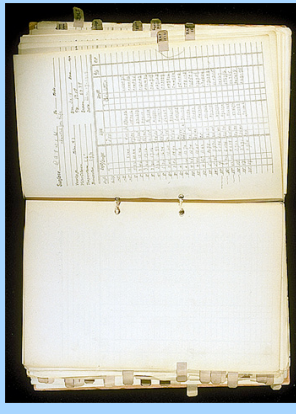
NACA Board, 1938

What Does Flight Research Accomplish?

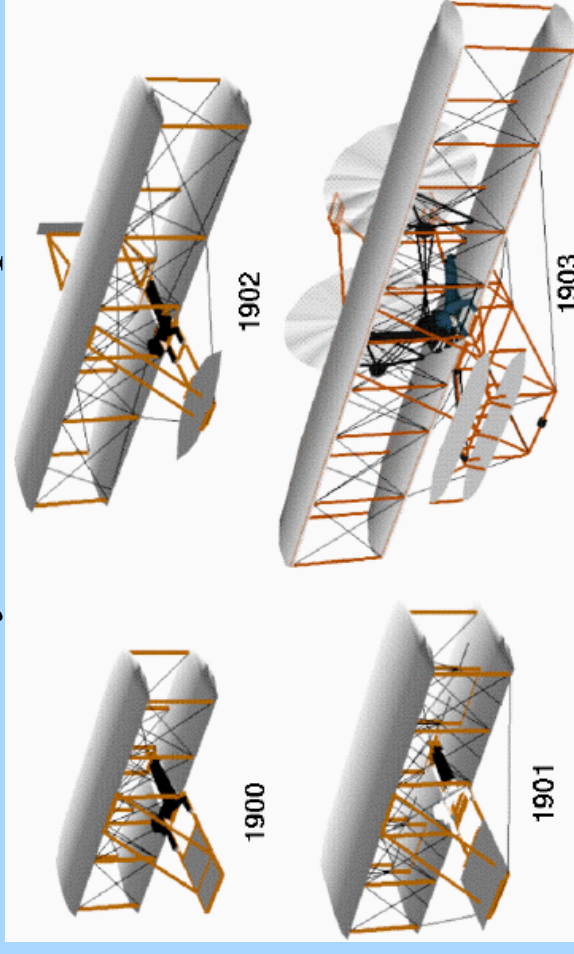
- Separates the Real from the Imagined
- Uncovers the Unexpected and the Overlooked
- Forces the Realistic Integration of the Pilot
- Forces the Development of Reliable Prediction and Test Processes
- Requires Every Problem to Be Addressed
- Promotes Technology Transfer
- Builds a Core Technical Team

Flight Research Lessons Learned

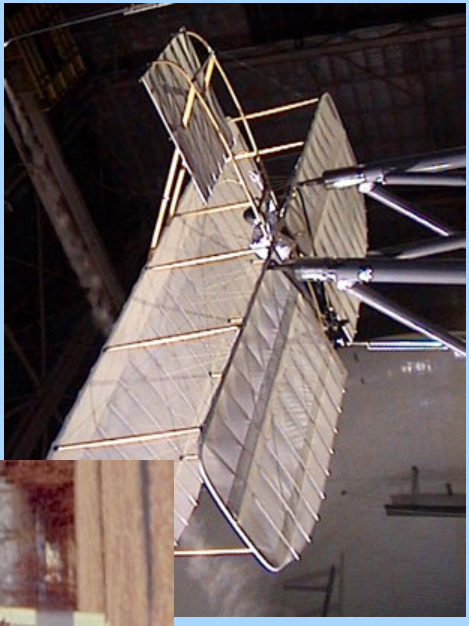
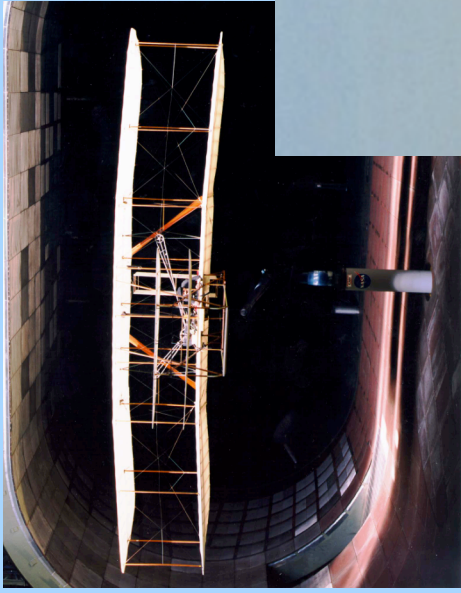
Then...Still Apply Today



- Make sure you really understand the problem
- Do a literature search and read and talk
- Plan carefully...and record as much as possible
- Identify and measure your most important parameters
- Plan for the unexpected...and expect differences
- Test over a large envelope but not necessarily a full envelope
- Fly early, as much as possible
 - more visibility
 - more attention to “Real” problems
 - much more credibility
 - faster technology transfer
- *Get a simulation going ASAP*



Understanding the Wright's Accomplishments Through Evaluation



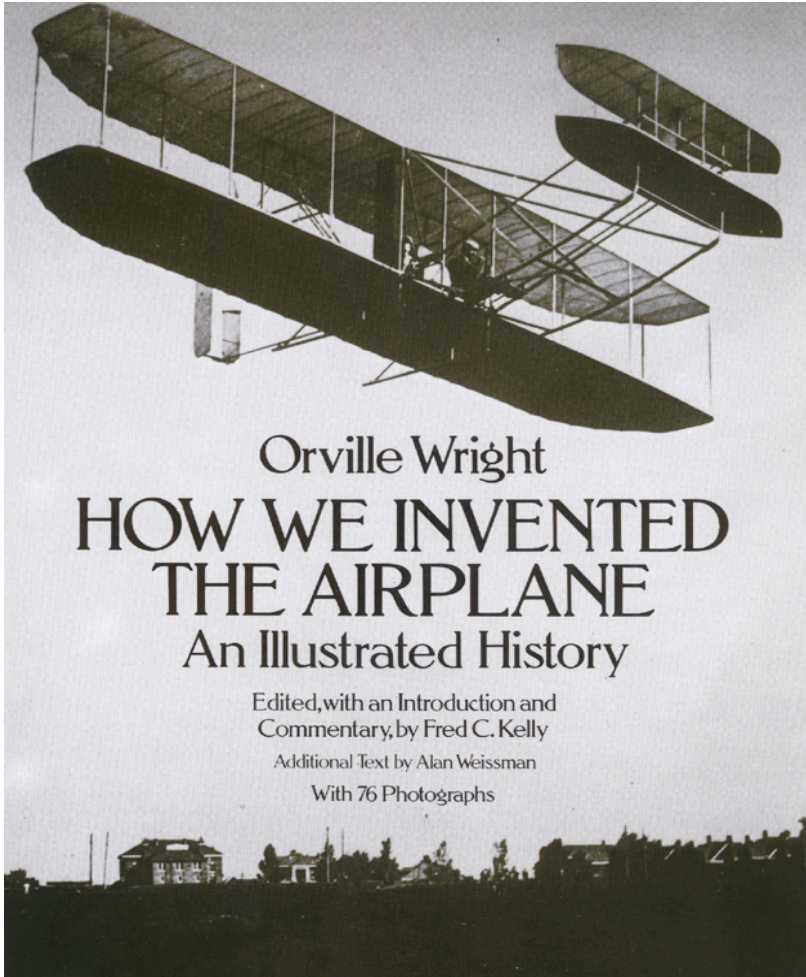
Wright Flyers Today



1903 Wright Flyer I
National Air & Space Museum

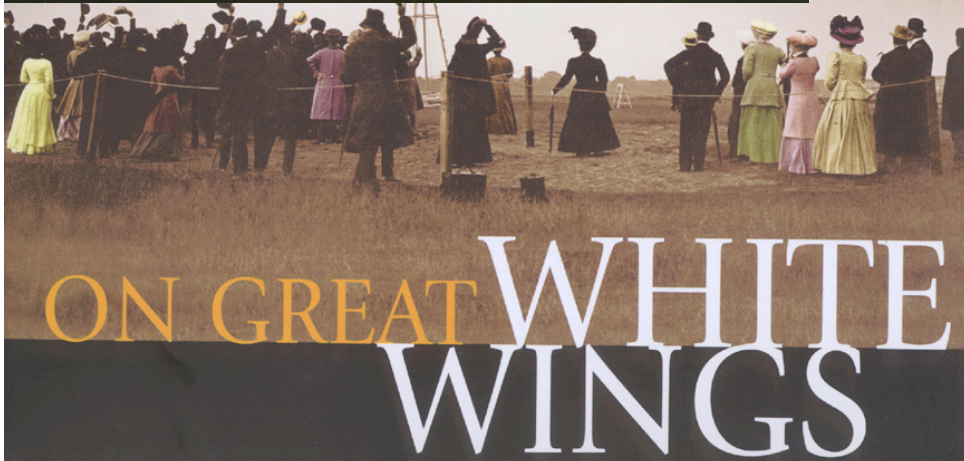


1905 Wright Flyer III
Carillon Hall




Orville Wright
**HOW WE INVENTED
 THE AIRPLANE**
 An Illustrated History

Edited, with an Introduction and
 Commentary, by Fred C. Kelly
 Additional Text by Alan Weissman
 With 76 Photographs



ON GREAT **WHITE
 WINGS**

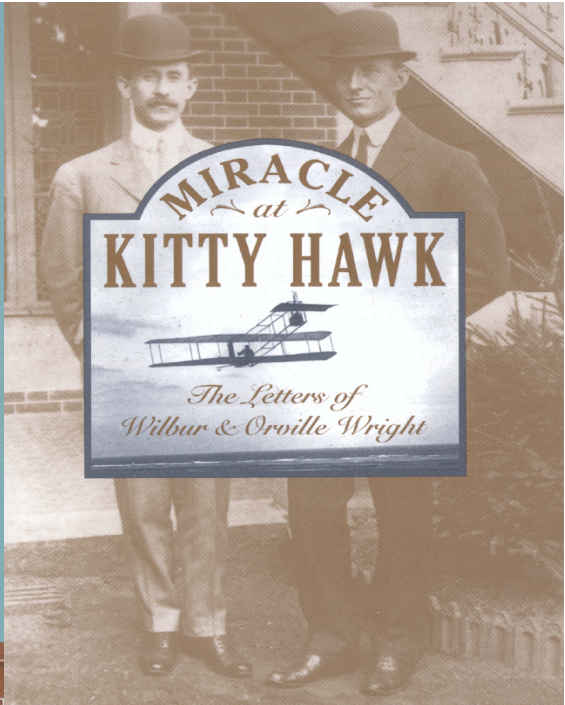
New in paperback



*A
 Dream
 of Wings*

Americans
 and the Airplane,
 1875–1905


Tom D. Crouch



EDITED BY FRED C. KELLY

*The PIONEER
 of FLIGHT*

A Documentary History



PHIL SCOTT



**WILBUR
 AND
 ORVILLE**
 A BIOGRAPHY OF THE
 WRIGHT BROTHERS

Fred Howard



THE
A Life of
Wilbur and
Orville Wright

BISHOP'S BOYS

Tom Crouch

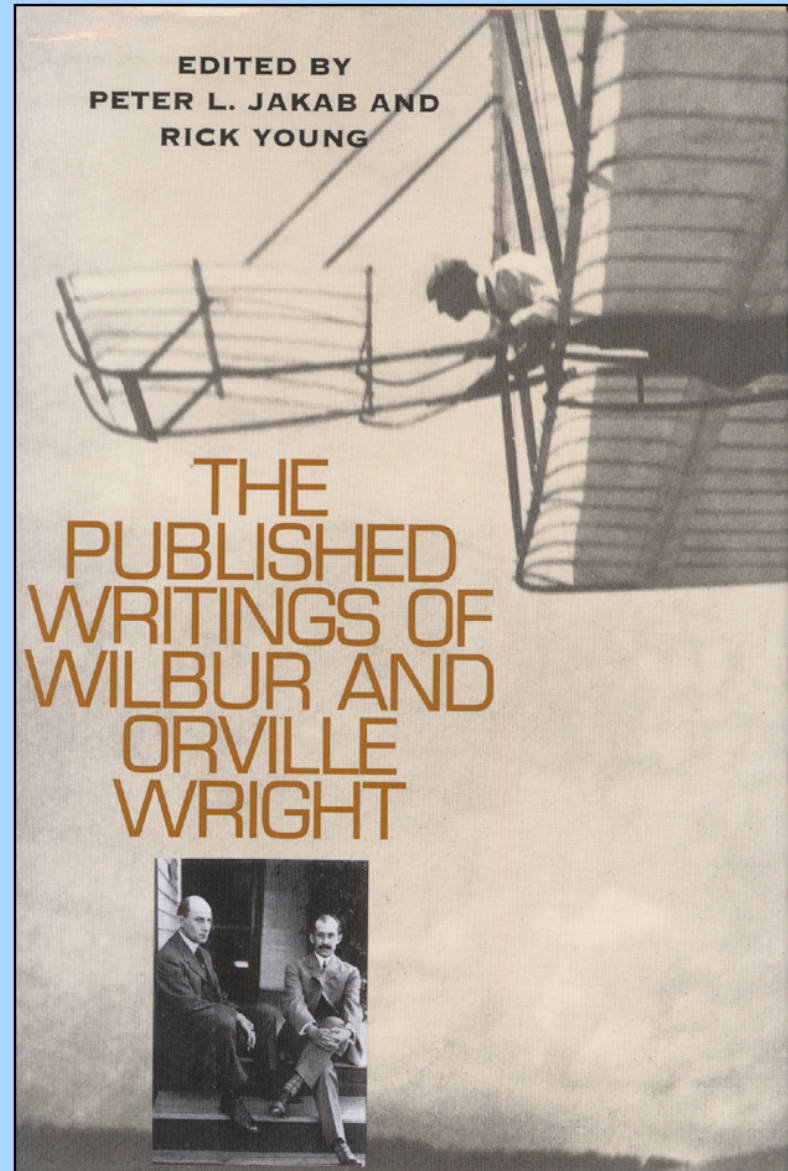
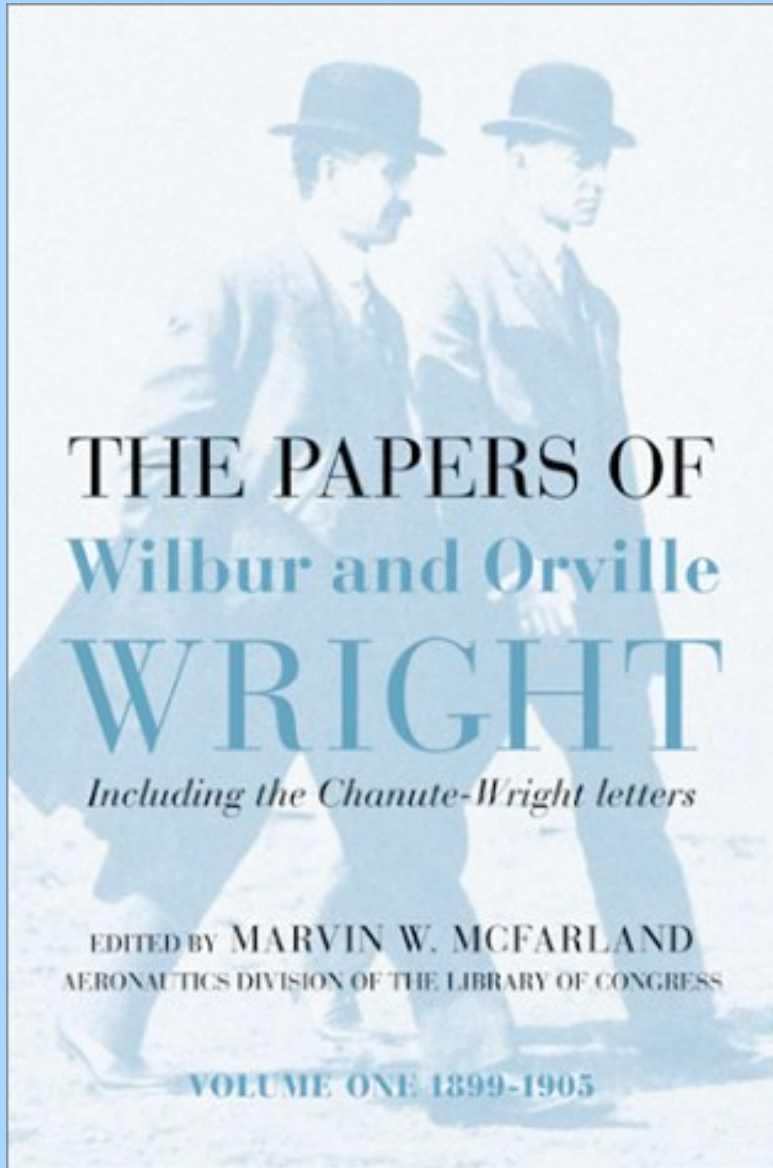


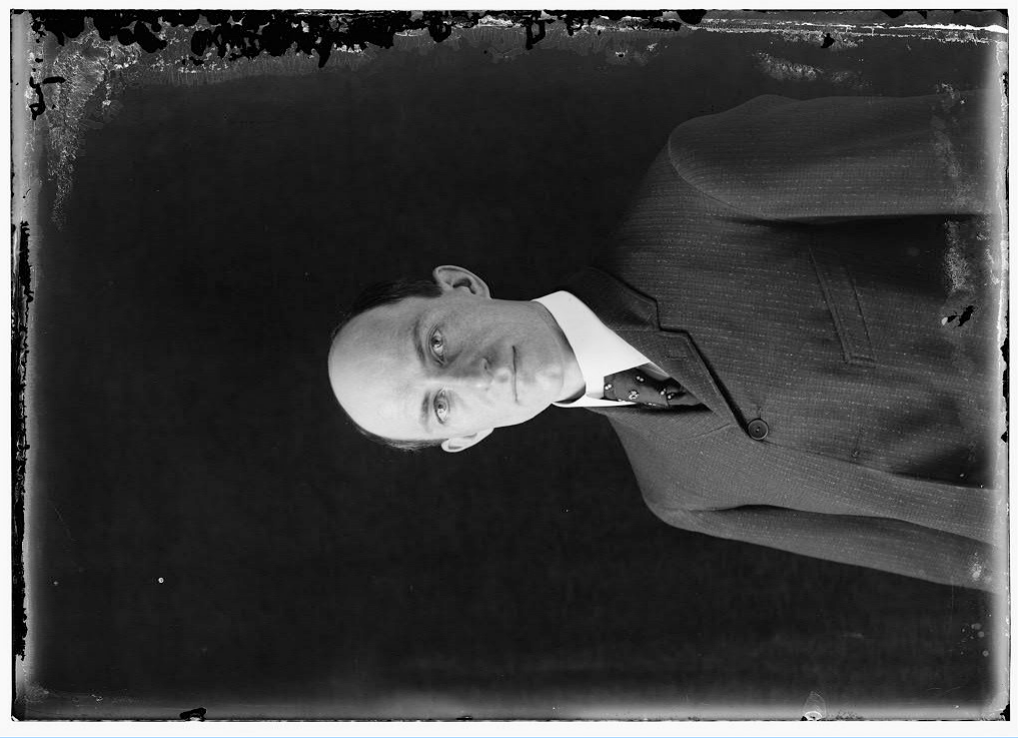
VISIONS OF A FLYING MACHINE

The Wright Brothers and the
Process of Invention

Peter L. Jakab







Wilbur Wright.



Orville Wright.

Orville's Camera: 1902 to 1905

