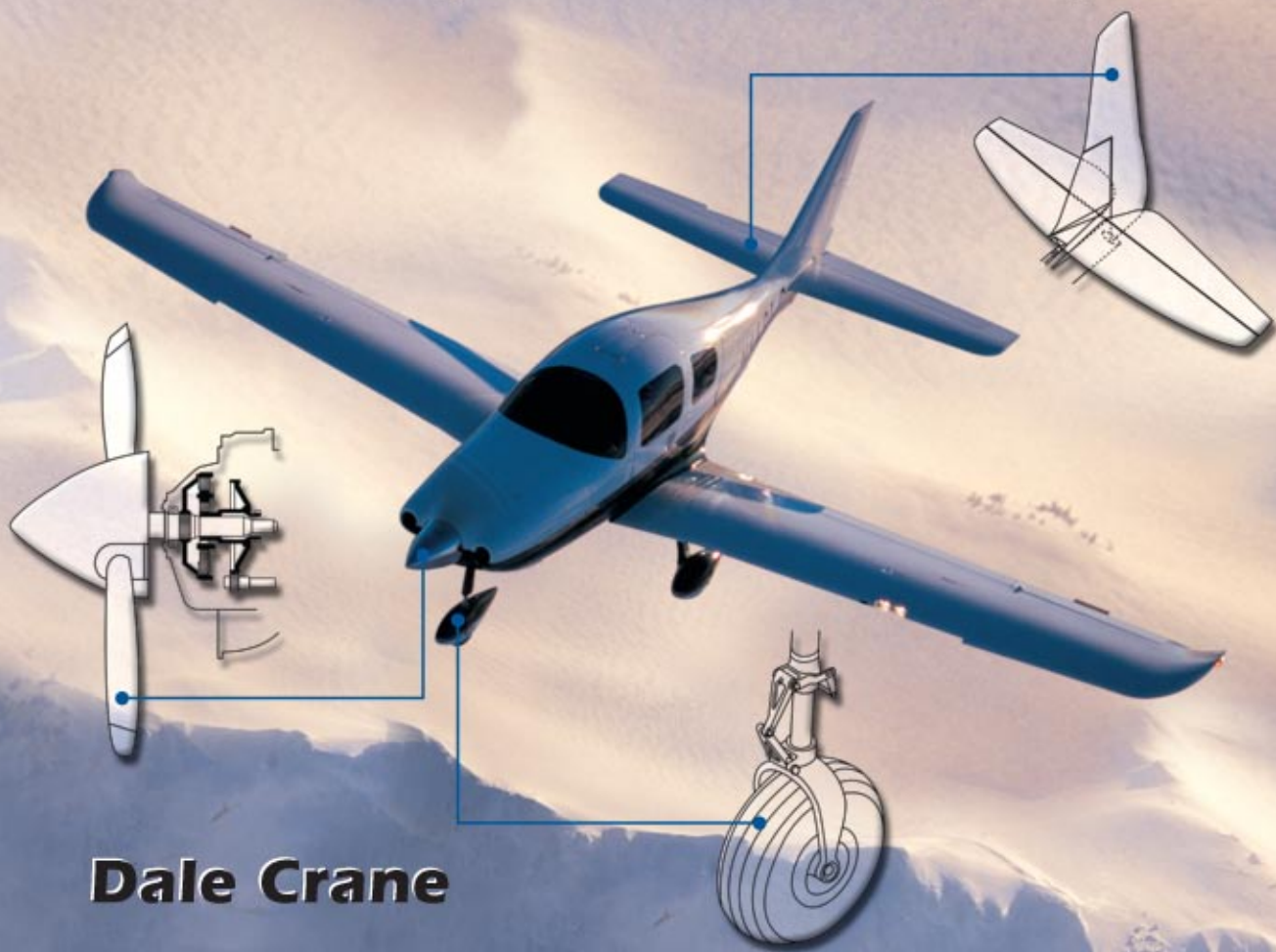




# A Pilot's Guide to Aircraft And Their Systems

The more you know about your  
aircraft systems, the better you fly



**Dale Crane**

*A Pilot's Guide to Aircraft and Their Systems*

by Dale Crane

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Published 2002 by Aviation Supplies & Academics, Inc.

Printed in the United States of America

05 04 03 02 9 8 7 6 5 4 3 2 1

**ASA-ACFT-SYS**

ISBN 1-56027-461-1

Photo credits: p.52, Cessna Aircraft; p.57 and cover, Lancair;  
p.283, TEC Aviation Division.

*Library of Congress Cataloging-in-Publication Data:*

Crane, Dale.

A pilot's guide to aircraft and their systems : the more you know about your aircraft systems, the better you fly / by Dale Crane.

p. cm. — (Focus series book)

Includes index.

ISBN 1-56027-461-1

1. Airplanes. 2. Aeronautical instruments. 3. Aeronautics—Systems engineering. 4. Private flying. I. Title. II. Series.

TL670 .C74 2002  
629.133'34—dc21  
02

2002153716

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## Chapter 1 Forces Acting on an Airplane in Flight

### How Does a Heavier-Than-Air Flying Machine Defy the Law of Gravity?

A heavier-than-air craft flies by obeying a different law; Newton's third law of motion. An airplane flies by creating a downward force on a mass of air that is equal to its own weight. In return, this mass of air produces an upward force on the airplane and supports it.

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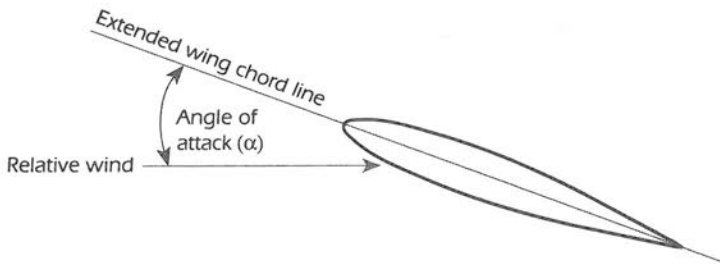
Newton's third law of motion states that every action (or force) gives rise to a reaction (or opposing force) of equal strength but of opposite direction.

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The wing of an airplane has a very special cross sectional shape called an airfoil section. When this airfoil moves through the air the relative wind strikes it at an angle called the angle of attack.

The air in the relative wind strikes the leading edge of the airfoil and some flows over the top and some across the bottom. The air flowing over the top finds the surface dropping away from it, and, in the same way you speed up as you run down a hill, the air speeds up. According to Bernoulli's principle, when the air speeds up, its pressure drops and the low pressure above the wing pulls the air down to the surface and as it leaves the wing it is deflected downward.

**Bernoulli's principle.** When the total energy in a column of moving fluid remains constant, any increase in the kinetic energy of the fluid (its velocity) results in a corresponding decrease in its potential energy (its pressure).



**Figure 1.** The angle of attack is the acute angle between the chord line of an airfoil and the relative wind.

The air flowing below the wing finds the surface rising into its path. This slows down the air and its pressure increases. As the air leaves the airfoil it is deflected downward.

When the weight of the air deflected downward equals the weight of the airplane, the air supports the airplane.

#### **Factors affecting lift**

- Physical characteristics
  - airfoil shape
  - airfoil area
- Air density
  - air temperature
  - barometric pressure
- Pilot controlled
  - airspeed
  - angle of attack

Five things affect the amount of air deflected downward:

1. Shape of the airfoil
2. Angle of attack
3. Area of the airfoil
4. Density of the air
5. Speed of the air

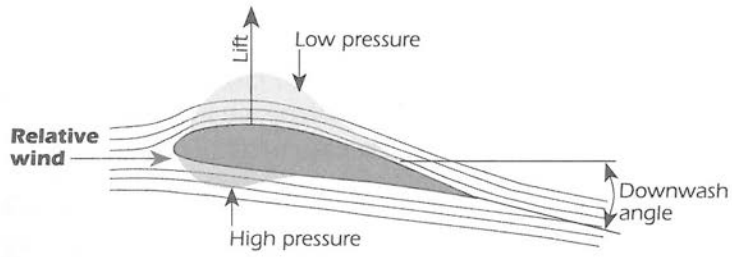
The shape and area of the airfoil are physical characteristics of the airplane. The density of the air is determined by the outside air temperature. The altitude, the speed of the air, and the angle of attack are controlled by the pilot.

#### **Five Forces**

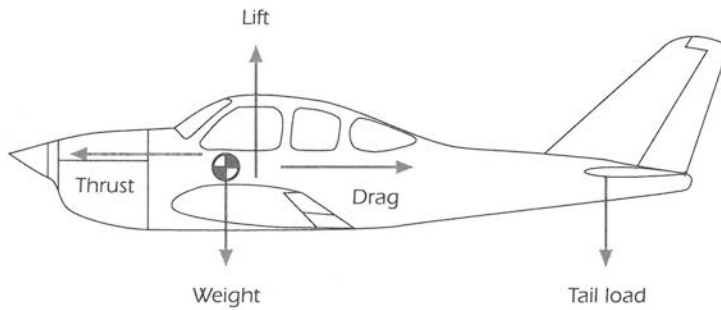
The five forces are in equilibrium during straight and level unaccelerated flight.

In straight and level flight at a constant airspeed and altitude five forces are in balance on an airplane:

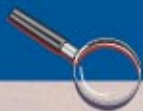
1. Thrust, acting forward, is caused by the propeller moving air rearward.
2. Lift, acting perpendicular to the relative wind, is caused by the wing deflecting air downward.
3. Weight of the aircraft, caused by gravity, acts toward the center of the Earth.
4. Drag, acting in the direction opposite to thrust, is caused by the resistance of the air as the aircraft moves through it.
5. Tail load is a downward aerodynamic force produced by the horizontal tail deflecting air upward. The amount of tail load is determined by the airspeed and it is used for longitudinal stability.



**Figure 2.** The shape of the airfoil causes the air through which it is passing to be deflected downward.



**Figure 3.** In straight and level, unaccelerated flight, the five forces are balanced.



# A Pilot's Guide to Aircraft And Their Systems

The more you know about your  
aircraft systems, the better you fly

by Dale Crane

Early aviators had to be both mechanic and pilot...early airplanes and engines were less than completely dependable. In a forced landing situation, they had to find and fix the problem themselves in order to get the airplane back into the air—fortunately their airplanes were not complex in their systems, nor complicated to fix. In the more than half a century since World War II, aircraft have become a vital component of our transportation system, developed and finely tuned to become the fast, efficient, dependable, and safe machines they are today. But technological advances have brought additional complexities that demand the aircraft be operated in *exactly* the way the designer intended. To do this, pilots must understand what each handle or knob controls and what he or she can expect from each system.

*A Pilot's Guide to Aircraft and Their Systems* furnishes pilots and armchair aviators with explanation and insight into *what* the aircraft, powerplant, and each of the systems *do*, and does so in language they can identify with. Understanding their aircrafts' systems will help pilots enjoy their flying more, and make them safer and more efficient aviators.

**Other books by Dale Crane, published by ASA:**

- Aviation Maintenance Technician Series:  
General/Airframe/Powerplant
- Dictionary of Aeronautical Terms
- Fast-Track Series Test Guides for General, Airframe,  
and Powerplant FAA Knowledge Tests
- Aviation Maintenance Technician Oral & Practical  
Exam Guide
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