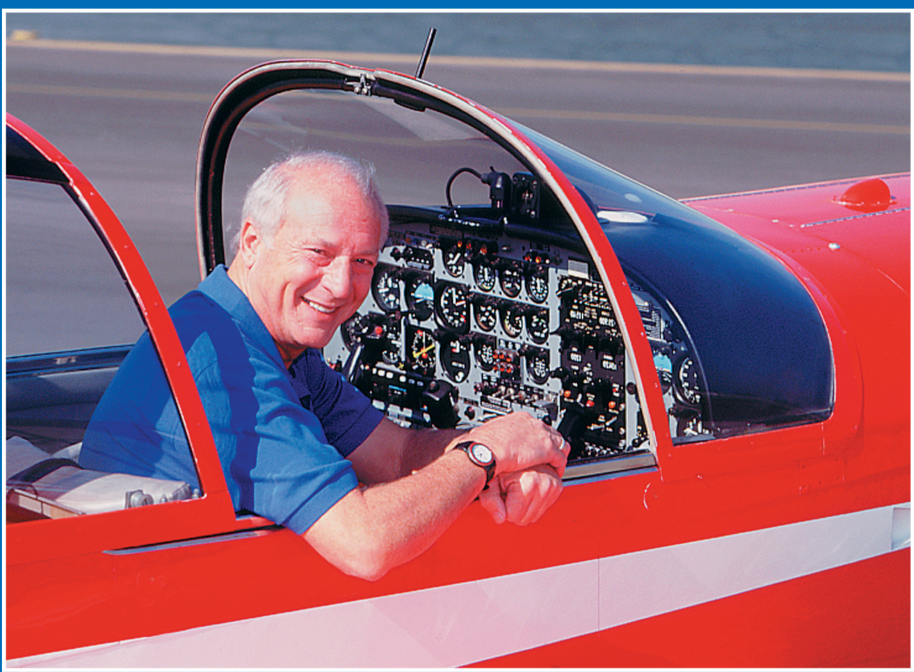
The Proficient Pilot

Volume 2



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Chapter 1 **Power Loading and Wing Loading**

Being a proficient pilot is more than just developing the necessary piloting skills. It also is having some appreciation of the major factors involved in aircraft design because these ultimately determine performance and handling qualities.

When an aircraft is conceived, its designer must mentally wrestle with a variety of variables. These include airframe weight, fuel capacity, range, payload, takeoff and landing speeds, cruise and climb performance, power, manufacturing cost, and operating economy.

Juggling these factors is a frustrating business because optimizing one almost always has a detrimental effect on another. Consequently, a designer must sacrifice certain elements to achieve a goal. The result invariably is a compromise between desire and pragmatism. Not one airplane performs, behaves, and handles the way its designer would have preferred. Creating an acceptable mix of variables is the designer's art and probably is as much intuitive as scientific.

Before finalizing a specific configuration, a lightplane designer makes a performance forecast to verify that priorities have been satisfied. This is done by analyzing certain variables. The most significant of these include power loading, wing loading, aspect ratio, and wetted area.

The first item, power loading, helps determine if an airplane is underpowered or overpowered. Power loading is determined by dividing the maximum allowable takeoff weight by the total rated horsepower of all engines. (In the case of turbofans and turbojets, power loading is expressed as pounds of weight per pound of engine thrust.)

A Mooney 201, for instance, has a maximum gross weight of 2,740 pounds and is powered by a 200-hp engine. Its power loading, therefore, is 13.7 (pounds per horsepower). Figure 1 shows the range of power loadings for different classifications of general aviation airplanes.

Like other design variables, power loading seldom can be used in isolation to make valid performance predictions. Other factors need to be combined with it to obtain meaningful information. Generally, however, low power loading is associated with high performance.

Power loading can be used to determine initial takeoff acceleration. It is, after all, the inverse of the power-to-weight ratio used to calculate the acceleration of drag racers. Everything else being equal, the vehicle with the greatest power-to-weight ratio (or the lowest power loading) has the best acceleration.

Figure 1 shows that a Cessna 152, with a power loading of 15.2, has the highest power loading of the general aviation aircraft. Although it is no surprise that this aircraft has the poorest takeoff acceleration, this is not as negative a characteristic as it might appear. Because the 152 does not require a high liftoff speed, it does not necessarily need more takeoff distance than other singles do. The 36-hp Aeronca C-3 (known as the "Flying Bathtub") had a power loading of 28 pounds per horsepower, but because it had to accelerate only to little more than jogging speed, takeoff distance was not excessive.

Runway length requirements are determined by acceleration and by liftoff speed. If acceleration is constant, takeoff distance increases in proportion to the square of the liftoff speed. This means that every additional knot consumes more distance than the preceding knot. Stretching takeoff distance even farther is aircraft drag, which increases during the roll and reduces acceleration. This explains why manufacturers of STOL (short takeoff and landing) aircraft and modification kits rejoice with every knot that can be trimmed from the liftoff speed. A 5 percent speed reduction reduces takeoff distance by more than 10 percent.

Power loading also indicates how well (or how poorly) engine power can be relied upon to overcome aircraft inertia in flight. Everything else being equal, the airplane with the least power loading is best able to accelerate out of mushing flight and into a safe climb. This is perhaps best illustrated by referring to the power loadings of piston powered twin-engine airplanes.

Notice from Figure 1 that power loadings vary from 11 for a Partenavia Victor to 8.9 for a Beechcraft Duke. (This is a relatively narrow range, indicating that light-twin designs remain within established guidelines.) It is obvious that twins have a substantial power advantage when compared to singles. But look what happens to power loading when a twin loses half of its horsepower: Power loading doubles. It is apparent that the power loading of any twin with an inoperative piston engine exceeds that of a Cessna 152, which helps to explain why a crippled twin has such marginal performance.

Designers obviously prefer low power loadings but usually cannot justify the necessary sacrifices. Adding horsepower increases fuel consumption, inflates operating and manufacturing costs, and can decrease range and use-

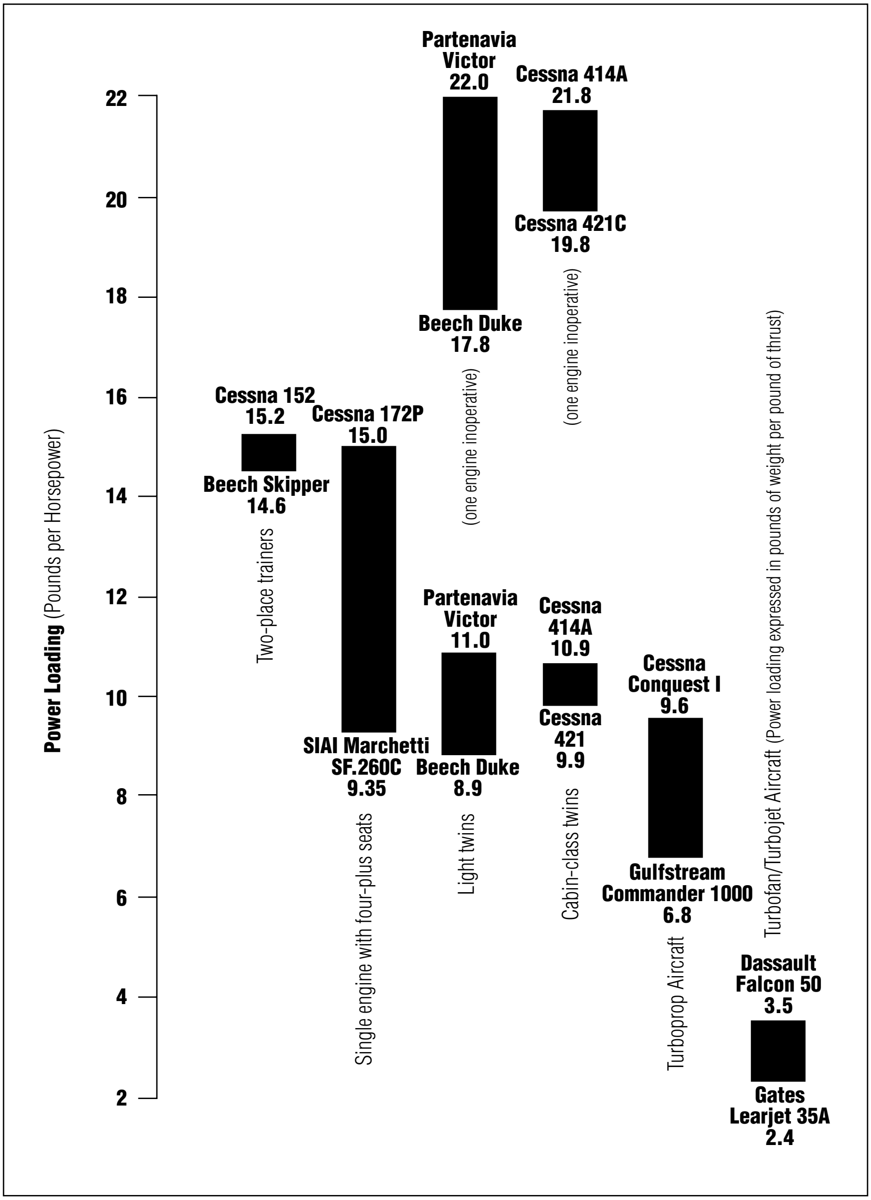

Figure 1. Ranges of power loading for various groupings of airplanes