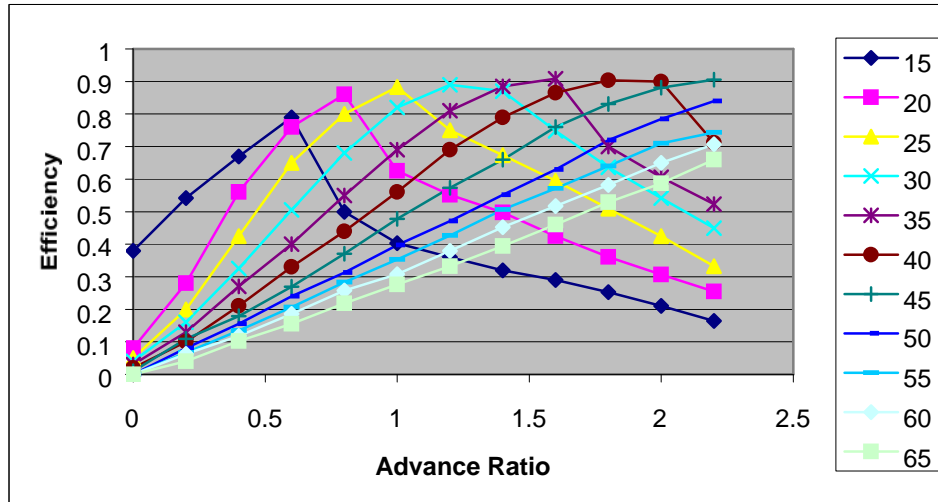# Section 511 Propeller Efficiency

Section 511 contains a 3-D table of coefficients that models prop efficiency as functions of prop pitch and advance ratio. The following chart shows the data found in section 511 for the CFS P51-D. Each of the individual curves is the prop efficiency data for a particular prop pitch setting, and the X-axis is advance ratio.

Section 511 - Propeller Efficiency

Advance ratio

Advance ratio is calculated using the following formula:

Advance Ratio = $\dfrac{\text{Prop Gear Ratio * Airspeed * 88}}{\text{Prop Diameter * Engine RPM}}$ ←airspeed in miles per hour
  ←prop diameter in feet

Thrust Calculation

At speeds above the low speed theory limit, FS calculates thrust using propeller efficiency, engine power, and aircraft velocity as follows:

Thrust = HP * efficiency * 375 / Speed

Thrust – lbs
Speed - mph

Unit conversion notes: 375 = 550 ft-lbs/sec * 3600 sec/hr / 5280 ft/mi

Section 512 Propeller Power Coefficient

Section 512 contains a 3-D table of coefficients that relate propeller power input to prop pitch and advance ratio. These curves are used to select prop pitch based on engine power and aircraft speed. The following chart shows the data contained in Section 512 for the CFS P51-D. The X-axis shows the advance ratio, and each of the curves plotted represents a different prop pitch setting.
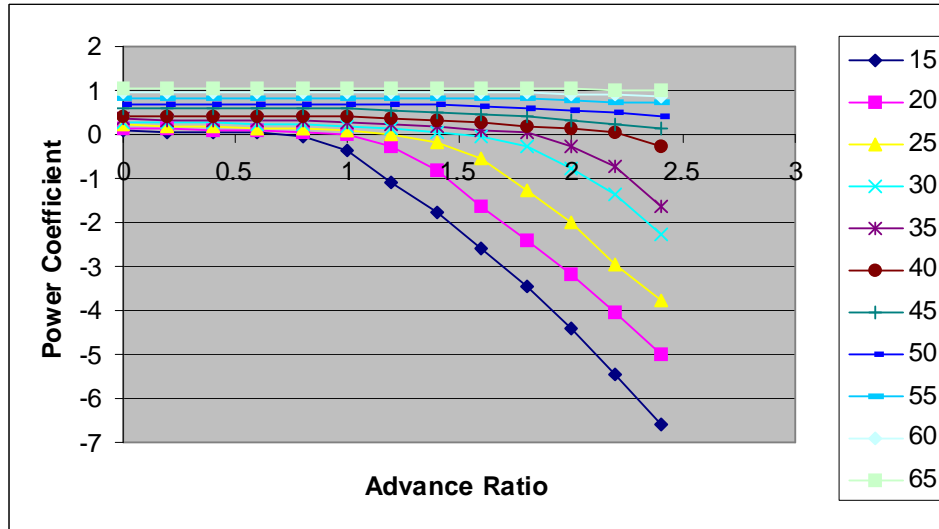
Section 512 - Propeller Power Coefficient

The following equation is used to calculate the power coefficient values in this section:

cf = hp / (rho * rpm^3 * dia^5)

Note: The unit conversions required to use this equation are left as an exercise for the reader.

How the Simulator Uses the Propeller Power Coefficient and Efficiency Tables

Normally, FS calculates engine power and advance ratio first, then selects the prop pitch based on a table look-up in section 512. The selected prop pitch and advance ratio are then used to look up the prop efficiency in section 511. The efficiency is then used to calculate prop thrust.

The algorithm that FS applies to sections 511 and 512 is as follows:

- Calculate engine power based on engine parameters.
- Calculate advance ratio based on aircraft speed, prop diameter, and gear ratio.
- Select a column in section 512 based on advance ratio.
- Scan down selected column in section 512 until engine horsepower matches propeller horsepower coefficient. The point where the values match determines the propeller pitch setting.
- Using the selected propeller pitch and calculated advance ratio, look up the propeller coefficient of efficiency in section 511.
- Use the resulting propeller horsepower and propeller efficiency to calculate propeller thrust.