

**Project 2.2.3 Turbine Engine Design**

Introduction

Turbine engines provide a tremendous amount of thrust for an aircraft. Takeoff requires the maximum thrust available to accelerate the aircraft from rest to takeoff speed before the end the runway. During cruise the engines must overcome drag throughout the flight. Engine designers must balance the thrust needs with fuel economy. Inefficient engines mean that more fuel must be carried and more fuel is used than needed. Both result in a cost increase for the airline operator or a military.

In this activity you will use the software simulator you learned in the last activity to design a turbine engine to meet several design constraints.

Equipment

* Computer with access to EngineSim software
* Engineering notebook

Procedure

Using the information you gathered during the previous activity and what you have learned about aerodynamics, propulsion, and propulsion systems, design an engine that will be the most fuel-efficient engine in your class. Explore the available choices for how the program works below the simulation parameters on the same webpage. The simulation can work in two modes so be careful you are working in the correct mode.

 1.      You can choose from four different types of engines:

a.      A simple turbojet

b.      A jet with afterburner

c.      A turbofan engine or

d.      A ramjet

Selections are made on the graphics window by clicking on the engine name. The chosen engine is shown in yellow.

 2.      Flight Conditions include the following:

a.      Mach number,

b.      Airspeed,

c.      Altitude,

d.      Pressure

e.      Temperature and

f.        Throttle and afterburner settings

There are several different combinations of these variables available for input using the choice button on the input panel. The pressure and temperature are computed as functions of the altitude by using a Standard Day atmospheric model.

 3.      Design variables for each engine component can also be varied. The components and variables include

a.      The Inlet (pressure recovery)

b.      Fan (pressure ratio, efficiency, and bypass ratio)

c.      Compressor (CPR, compressor efficiency)

d.      Burner (fuel, maximum temperature, efficiency, pressure ratio)

e.      Turbine (turbine efficiency) and

f.        Nozzle (maximum temperature, efficiency, A8/A2)

As you choose a different component the part of the engine being affected is highlighted in the graphic by changing from its default color to yellow. If you change the Output Display to Pictures, you can view an actual photograph and description of each engine part.

 4.      Engine Size can be specified by either the frontal area or the diameter. As the engine size changes, the grid background changes in proportion to the size. The distance between any two-grid lines is 1 foot.

5.      Choose the best units for doing your calculations. Be sure to confer with your partner.

6.      Choose the proper materials you will use to design your engine and list them in your engineer’s notebook.

7.      In your engineer’s notebook, be sure to record the following:

a.      Average weight of the engine that you design:

b.      Thrust to weight ratio of the engine:

c.      Temperature: periodically, record the temperature throughout the engine design against the material limits. If you exceed a limit, a flashing warning will occur in the schematic. Record any errors or changes you must make.

8.      Select the graphical output that will allow you to display and describe the engine parts including graphs of the variations of the value of pressure and temperature at various stations through the engine. You will need to make a print screen for your report. Topics that should be included in your report are the following:

1. Engine net thrust
2. Fuel flow rate
3. Engine air flow rate
4. Engine weight
5. Thrust to weight ratio
6. Specific fuel consumption
7. Fuel-to-air ratio
8. Engine pressure ratio (EPR)
9. Engine temperature ratio (ETR)
10. Gross thrust
11. Ram drag.
12. Nozzle pressure ratio (NPR)
13. Engine thermal efficiency
14. Nozzle exit velocity (V exit)
15. Free stream dynamic pressure (q0)
16. Specific impulse (ISP)
17. Nozzle exit pressure (Pexit)
18. Fan nozzle exit pressure (P fan exit)
19. Compressor face Mach number (M2)
20. Variation of total pressure and temperature through the engine
21. Overall engine efficiency

9.  Prepare a report using the Written Report Template that depicts your research and results.

10. Submit your report to your teacher.

**Conclusion**

1. Explain how the engine type impacts performance?
2. Identify and explain the factors you would consider while designing an aircraft to fly efficiently at an altitude of 30,000 – 40,000 ft.