GKN AEROSPACE

Master Thesis - "Developing a Variable Cycle Engine Model in NPSS"

(30 credits/20 weeks – 1 to 2 students)

About us

GKN Aerospace is the world's leading multi-technology tier 1 aerospace supplier. With 55 manufacturing locations in 15 countries, we serve over 90% of the world's aircraft and engine manufacturers. We design and manufacture innovative smart aerospace systems and components. Our technologies are used in aircraft ranging from the most used civil aircraft to the world's advanced 5th generation fighter aircraft and the Ariane orbital rockets used by ESA.

Project Background

There are two main parameters describing how well a certain aircraft jet engine engine is fulfilling thrust and fuel consumption requirements:

1. Specific thrust: $ST = \frac{F_N}{\dot{m}_{inlet}}$ (m/s)
2. Specific fuel consumption: $SFC = \frac{\dot{m}_{fuel}}{F_N}$ (mg/kN/s)

For military engines it is important to have a high specific thrust to achieve high flight speeds, rapid accelerations and god maneuverability. Since high ST engines normally have high exhaust velocities, the SFC will be high at part power settings for lower flight speeds. Engines designed for good fuel economy at moderate to low flight speeds do often show significantly lower exhaust velocity figures and are often designed as multispool turbofan engines with a bypass stream. Using traditional engine architectures, performance and efficiency are in conflict, so an engine is usually designed to best meet requirements for its primary mission. The Variable Cycle Engine (VCE) or Adaptive Cycle Engine (ACE), has become actual in recent years due to the sometimes conflicting requirement on thrust and fuel efficiency.

While the concept of a variable cycle engine is not new, recent advances in engine architecture technology suggest that adding a second bypass stream to a traditional turbofan can provide significant benefits. This "third stream" (the core flow being the primary stream and the inner bypass being the second stream) airflow can be independently modulated so that engine airflow demand can be matched with the available inlet flow at a variety of operating points, thereby reducing spillage drag.

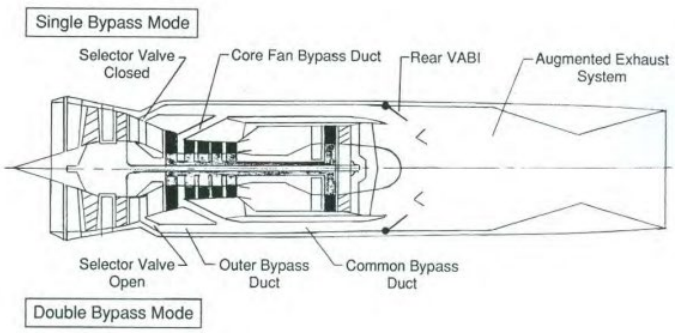

Figure 1: GE YF120, example of a VCE with a variable bypass third air stream

NPSS (Numerical Propulsion System Simulation), which will be used to develop the VCE model in this thesis project, is an advanced object-oriented, non-linear thermodynamic modeling environment used by the aerospace industry for modeling turbomachinery, air-breathing propulsion systems, liquid rocket engines, engine control systems, and system model integration.

Assignment Description

The purpose and aim of this Master Thesis is to develop an NPSS model representing a variable cycle engine with a variable bypass third stream. Furthermore, the NPSS model should also be used to assess the performance benefit of the third air stream.

Milestones and content

The following project milestones are suggested:

1. A literature study to identify similar work reported and to acquire understanding of the topic and how methods may be implemented.
2. Develop and simulate a three-stream variable cycle engine with a variable bypass in NPSS
3. Simulation of the VCE within the operating envelope and a pre-defined mission and evaluation of performance
4. Comparison to conventional engine architecture and assessment of variable bypass performance benefits
5. Development and optimisation of a control schedule for modulating the variable bypass third air stream
6. Thesis report including background, description of tasks, targets and methods, suggestions for future work, list of scripts etc. created during work

Qualifications

- Bachelor/Master's in Applied Mechanics, Engineering Physics or other relevant field
- Basic knowledge in gas turbine theory preferred
- Object-oriented programming skills meriting but not required

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