IMPROVING THE ACCURACY OF 1D AIRCRAFT SYSTEM SIMULATIONS BY INTEGRATING ENGINE CYCLE PERFORMANCE DATA FROM NPSS (NUMERICAL PROPULSION SYSTEM SIMULATION)

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ABSTRACT

System level simulations for aircraft are an essential part of the design and modification of the aircraft. The closely coupled interactions of these systems makes analyzing an individual system in isolation difficult. When considering the thermal fluid systems on an aircraft such as the fuel system or the air management system their performance can be directly linked to the performance of the engine. The operational envelope of the engines have a direct impact on the transient performance of these other systems since they are the boundary conditions for the thermal fluid systems.

The challenge becomes how to integrate accurate transient boundary conditions from the engine into the 1D CFD fluid system models without degrading the performance of the model and maintaining the flexibility to consider both operational envelope as well as the off-design or system failure scenarios.

This has been achieved by coupling the engine performance cycle models developed in NPSS (Numerical Propulsion System Simulation) with Flowmaster. NPSS is an object oriented, multi-physics, engineering design and simulation environment which enables development, collaboration and seamless integration of system models. Primary application areas for NPSS include engine performance models for aircraft propulsion, thermodynamic system analysis such as Rankine and Brayton cycles, and various rocket propulsion cycles.[1] It has its origins in NASA and is governed by a consortium of aerospace companies including Boeing, General Electric, Teledyne, Pratt &Whitney and many

others. The management of the code has been given to Southwest Research Institute (SwRI).

The coupling allows the engineer to change the operational conditions of the engine or engines and study the impact on different aspects of the thermal fluid systems performance including:

- Fuel Systems
  - Fuel demand
  - Fuel tank inerting performance (nitrogen enrichment)
  - Fuel cross feed operations
- Air Management Systems
  - Aircraft pressurization
  - Deicing system performance
  - Environmental control impacts
  - Bleed air system performance

Examples of these NPSS-Flowmaster coupled systems are shown and the increased level of fidelity the results that can be achieved through the multi-system interactions. This increased fidelity allows for further frontloading of the design process and takes systems a step closer to virtual engineering. The focus is on an engineering approach to the coupling and the observed accuracy improvements. Individual steps involved to create, analyze and evaluate the coupled system are presented.