Systematic Method for Engine Performance Modelling at KLM ES

MSc Assignment for …., Propulsion & Power (FPP), Faculty of Aerospace Engineering

Introduction

KLM Engine Services (ES) is part of Air France Industries KLM Engineering & Maintenance Group, overhauling approximately 200 aircraft engines annually. The overhaul shop visit ends with a standardized performance test, to assess compliance to certification rules and customer contracts, before it is released for operation on-wing. At two different locations, the following turbofan engine types are tested:

- CFM56-7B KLM E&M Testcell / Schiphol-Oost
- CF6-80E1 KLM E&M Testcell / Schiphol-Oost
- CF6-80C2 KLM E&M Testcell / Schiphol-Oost
- GEnx-1B Zephyr Testcell / Charles de Gaulle Airport, Paris
- CFMI LEAP-1A & -1B (in gradual introduction)

Over the years KLM ES Engineering has used GSP (Gas turbine Simulation Program) as a supporting tool to analyze and evaluate engine performance data. Gas Path Analysis (GPA) techniques are used to translate engine performance data into component condition information. For optimal performance analysis accuracy, parameter inputs from all gas path sensors at the various engine stations are required. With new engine types such as the GEnx and the LEAP, the OEM does no longer provide the ability to install the additional sensors at the various engine stations, hence data input is limited, resulting in reduced potential to accurately analyze performance. However, the missing information can be compensated for by using accurate and detailed system performance models, which provide relationships between measured and unmeasured parameters. Furthermore, KLM ES has access to test cell and (continuous) in-flight engine performance data.

Key objectives

- To develop a systematic method for next-generation engine performance modelling in GSP.
- Reverse engineer key design parameters and create a design point model for a specific engine case study (GEnx-1B)
- Validate the design point model using literature and available information on existing engine models at KLM ES.
- Identify and document limitations and bottlenecks of performance modelling with the existing (test cell/on-wing) parameter set.
- Assess the potential of using the performance modelling method for engine test cell and on-wing performance analysis and diagnostics.

Assignment

Your work will include the following elements:

1) Introduction to current KLM performance and condition monitoring practice and relation to the maintenance concept.
2) Introduction to GSP (test analysis and gas path analysis models) as applied to KLM engines.
3) A literature study on current trends in gas turbine design and how to validate engine performance models.
4) Assessment of the model quality and uncertainty when modelling with a limited number of known parameters, based on literature of current engine design standards.
5) Development of a GSP design point modelling method that is applicable to the GEnx-1B as well as the LEAP in the future.
6) If time, a preliminary start to component map reverse engineering and off-design modelling.

Report

Results of the work must be reported in English, with a copy of this assignment and an executive summary.

Coaching

The work will be performed in close collaboration with KLM Engine Services (Juan Regueiro, Tim Rootliep)

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Professor,	Delft University supervisor,	Supervisors at KLM
Prof. dr. ir. P. Colonna	Dr. ir. W.P.J. Visser	Juan Regueiro, Tim Rootliep