NEWAC SP1 Editorial – Whole Engine Integration: Andrew Rolt (Rolls-Royce plc)

What's New?

The big news in sub-project SP1 is that we welcome Pascal Coat from Snecma to the management team as the new work package WP1.1 leader. Pascal joins me (as SP1 leader), Stefan Donnerhack from MTU (as WP1.2 leader) and Konstantinos Kyprianidis from Cranfield University (as the acting WP1.3 leader) in the existing management team. He takes over from his colleague Marine Andreoletti who is moving on to other projects.

I would like to take this opportunity to thank Marine and the rest of the management team for all the support they have given over the last few years, and for their help with this editorial.

Introduction to SP1

To give more background information on the SP1 activities I will start with figure 1, which shows the thirteen NEWAC partners engaged in the three work packages. I will then describe the purpose of each work package and show how they are complementary activities that give an improved understanding of the potential of the new technologies being researched in the NEWAC programme.

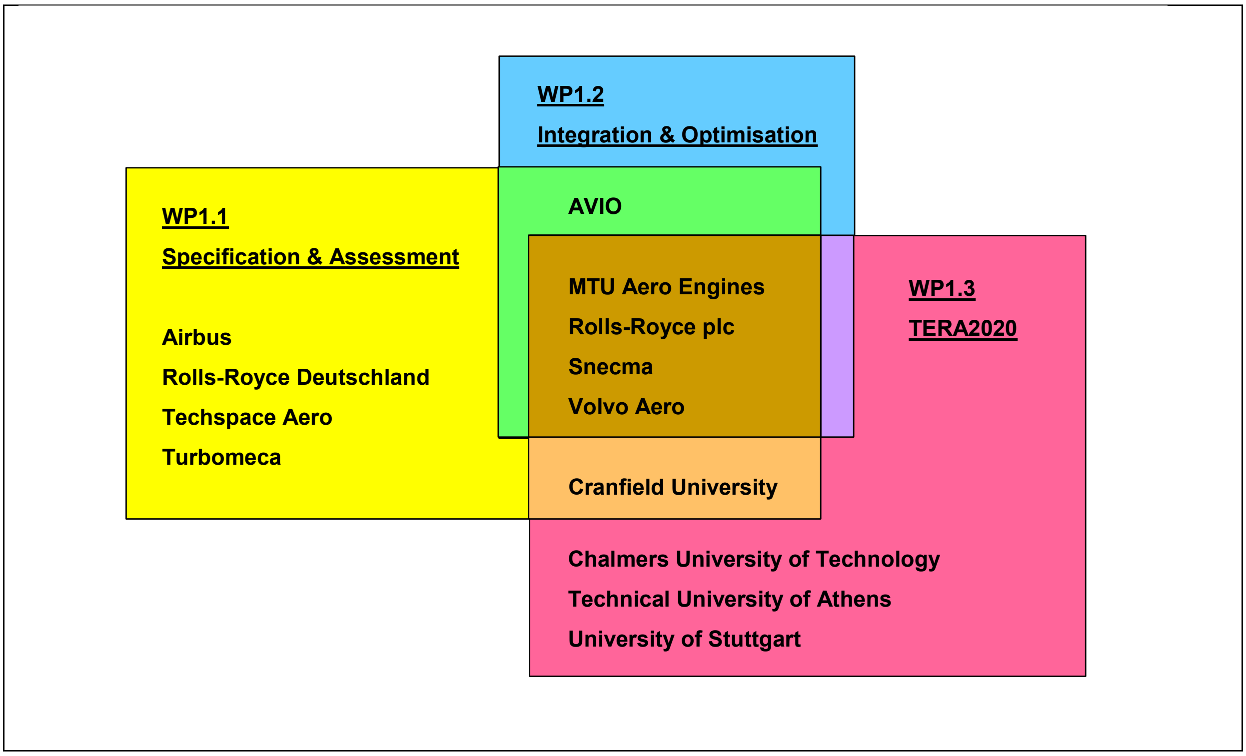

Figure 1 – Partners and Work Packages in NEWAC SP1.

The NEWAC programme as a whole sets out to raise technology readiness levels for the four advanced engine core concepts shown in figure 2. It does this by demonstrating key enabling technologies and measuring their performance effects in representative rig tests. NEWAC SP1 puts these new engine technologies into context by defining typical engine applications and by setting design requirements and targets for rig testing. Whole engine designs and assessments are then needed to properly evaluate the full potential of each new technology. The technologies are regularly reassessed at whole engine level to see how well the original design targets are being met and how well the new technologies would benefit different engine applications.

We have worked up separate engine designs for long-range and short-range aircraft. This is because technologies that improve thermal efficiency, but also increase engine weight, may for example only be cost-effective on the longer-range aircraft. The designs are assessed in various ways, including new methods originally developed in the VITAL programme.

SP1 also investigates whether better use can be made of the new technologies by re-optimising the engine designs or by combining the technologies in different ways.

We have learned much about the practical integration of the new technologies from these studies.

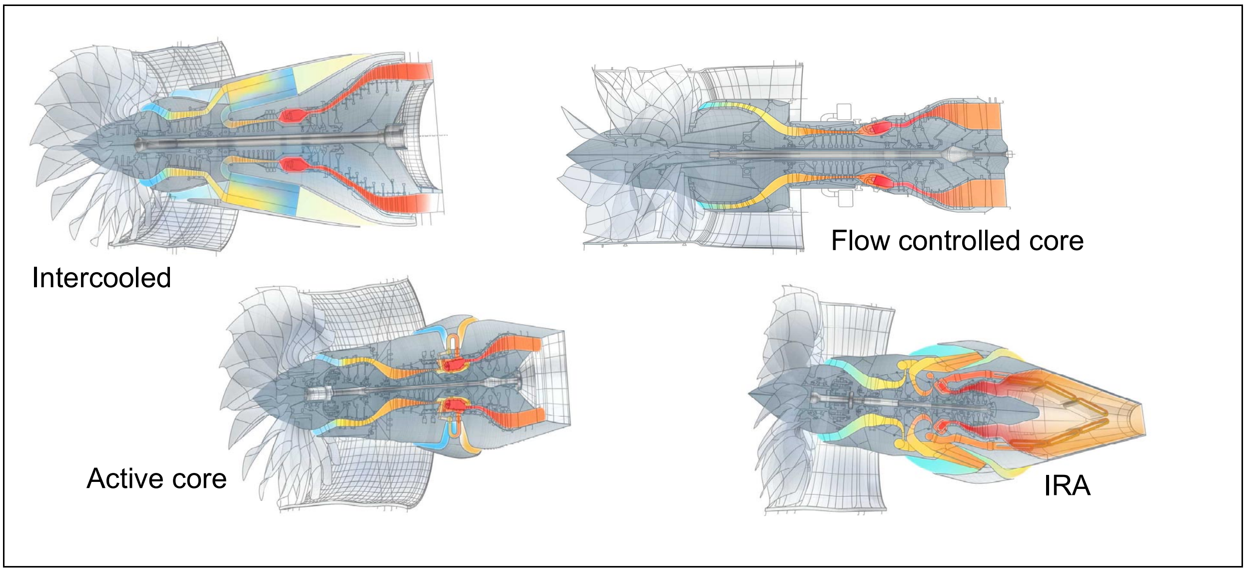

Figure 2 – The Four Original NEWAC Advanced Cycle Concepts

Work Package 1.1 – Specification and Assessment

This work-package covers SP1 coordination, and whole engine specification and assessment.

In reality this activity started in the proposal phase of the NEWAC project, in which three leading engine manufacturers – Rolls-Royce, Snecma and MTU – defined the four main NEWAC engine architectural concepts and set the original CO_2 and NOx reduction targets. Then, with the formal launch of NEWAC in 2006, the high-level objectives from ACARE and the original NEWAC proposal were flowed down to engine, module and component level, and detailed performance and geometry specifications consistent with those objectives were provided to the other subprojects.

In work package 1.1, throughout the duration of the project, we are monitoring the technical progress of the other subprojects for the consistency of their test results and analyses with our specifications and thus with the overall NEWAC objectives. The technologies are collectively re-assessed annually and the physical and functional models are refined after each major milestone of the other subprojects (PDR, CDR, tests etc.) A final assessment of the NEWAC technologies and results will be made at the end of the project. Technologies from other recent European research projects, such as VITAL, will be incorporated to establish the overall level of achievement versus the ACARE goals, and advice will be given on further improvements and the technologies that merit whole engine demonstration.

Work package 1.1 also provides inputs and technical advice to the team of European universities developing the TERA2020 code and engine models in NEWAC work package 1.3.

Work Package 1.2 – Integration and Optimisation

We have established this work package on integration and optimization in SP1 in order to explore further engine solution options with the potential for even better environmental performance than the initial NEWAC powerplants. The goal defined for this activity is to show novel ways of combining technologies and modules to meet fully the ACARE targets, even in the case that results from some individual NEWAC technologies do not reach their initial objectives.

For this purpose the work package WP1.2 working core team, comprising Rolls-Royce, SNECMA and MTU, has decided to go forward with three new engine candidates, each of them being a combination of an advanced VITAL low pressure spool system with an advanced NEWAC core. We then allow for the integration of suitable and complementary technologies from all the NEWAC and VITAL sub-programmes and other available technology sources.

Since these studies rely on achievements delivered as final test results, the work is concentrated into the final part of the NEWAC project. However, our preliminary view is that 'mixing and matching' additional technologies in novel ways is very promising, and should provide further benefits relative to the initial NEWAC powerplants. We are also confident that the optimization studies will contribute to a better understanding of the physical background (potential and limitations) of the technologies selected for integration at system level.

Work package 1.2 also now coordinates independent reviews and assessments of the TERA2020 results from work package 1.3.

Work Package 1.3 – TERA2020.

A new tool, TERA2020, originally created in the VITAL programme, has been developed further in NEWAC work package 1.3 to investigate the economic and environmental impact of the new technologies and to undertake sensitivity and optimisation studies around the original NEWAC engine configurations and specifications. This is enabling us to explore benefits of the innovative NEWAC technologies at the aircraft system level, using a somewhat different approach that is complementary to the assessments carried out in work package 1.1.

TERA2020 (Techno-economic, Environmental and Risk Assessment for 2020) is a software tool and system that spans aero engine conceptual design and preliminary design. It addresses the major component designs and system level performance for whole aircraft applications, and by using a sophisticated explicit algorithm and a modular structure it helps to automate part of the aero engine preliminary design process. In the NEWAC programme this tool has been developed by a team of universities led by Cranfield University and including Stuttgart University, Chalmers University of Technology, and the National Technical University of Athens. The team is formally supported by Rolls-Royce, SNECMA, MTU and Volvo. Avio and Rolls-Royce have also contributed to the combustor and emissions modelling.

Disciplines considered by TERA2020 include: engine performance, engine weight and dimensions, aircraft weight and aerodynamics, engine emissions and environmental impact, engine and airframe noise, production cost, maintenance cost and direct operating costs.

TERA2020 in VITAL was limited to low pressure component technology assessment, but NEWAC has extended this capability by introducing a range of core component designs (i.e. intercooling, intercooling and recuperation, improved compressor aero design and blade tip rub management, aspirated compressor systems, active control of compressor surge and tip clearance, and active control of a cooled cooling air system) and advanced technology combustion system technologies (i.e. lean premixed pre-vaporised, partially evaporated rapid mixing, and lean direct injection).

The addition of open rotor modelling capability and assessment in the EU Framework 7 DREAM programme will further extend the applications of the TERA2020 system.

SP1 Overall Assessment and Dissemination

The next NEWAC SP1 Specification and Assessment Review will be held in May 2010 and key results will be disseminated at the NEWAC Public Workshop to be held in Munich on 30 June to 1 July. More details of this event will be announced soon on the NEWAC website. I shall also be presenting a NEWAC SP1 paper on 21 September 2010 at the ICAS Conference in Nice.

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