The growth in internatonal air traffic means there is increasing pressure on the aircraft industry to respond to environmental concerns by developing low-emssion technology . **Dr Gunter Wilfert** of the NEWAC project argues that improved aero engine design has a large part to play

Innovative engines can make aircraft cleaner

Global air traffic is forecast to expand at an average annual rate of five per cent in the next 20 years. This high level of growth makes it even more urgent that we address the question of the environmental consequences of air traffic. Europe's aviation industry faces a massive challenge in satisfying demand whilst ensuring that air travel is economically viable, safe and environmentally friendly. It is clear that alternative engine configurations need to be researched if we are to achieve a significant, long-term reduction in pollution.

Large sums of money have recently been committed in Europe to reducing the negative environmental effects of aircraft use, and research is already developing technologies which can improve the performance of engine components. However, the limitations of the existing technologies mean that the industry cannot reach the goals set in the Vision 2020 report made by the Advisory Council of Aeronautical Research in Europe (ACARE). New engine core configurations with heat management and active systems, as well as advanced combustor technology, have to be investigated to reduce CO_2 and NO_X emissions.

The NEWAC (New Aero Engine Core Concepts) project is a new European-level programme, under the leadership of MTU Aero Engines, in which major European engine manufacturers, assisted by universities, research institutes and enterprises will focus on new core engine concepts. NEWAC will develop and validate novel core engine technologies to further close the gap between the current emissions and the ACARE targets. NEWAC has an overall budget of €71 mn, of which €40 mn are provided by the EC.

The main result of NEWAC will be fully validated, novel technologies enabling a 6 per cent reduction in CO_2 emissions and a simultaneous 16 per cent reduction in NO_X. All the new configurations investigated under NEWAC will be compared, assessed and ranked according to their benefits and the contributions they make to the global project targets. Detailed specifications will be provided for all innovative core configurations. As a result, NEWAC will be able to identify environmentally friendly, economic propulsion solutions through advanced technology.

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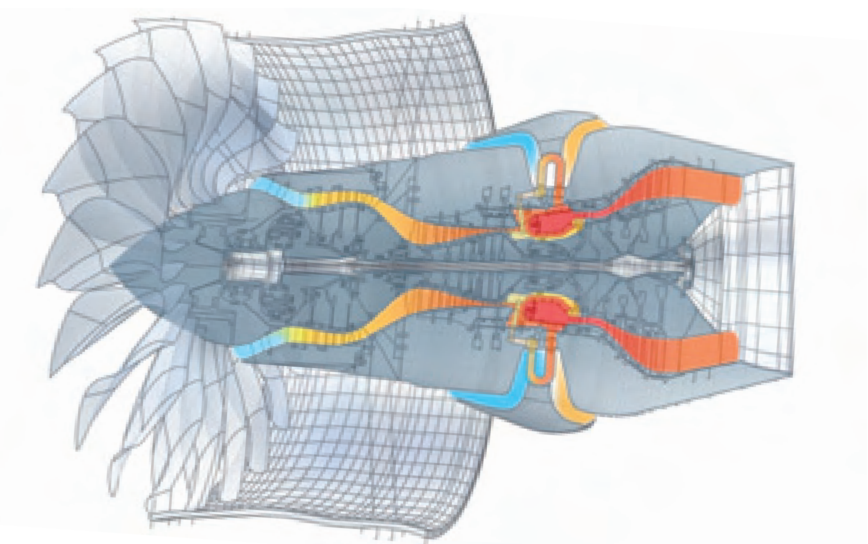

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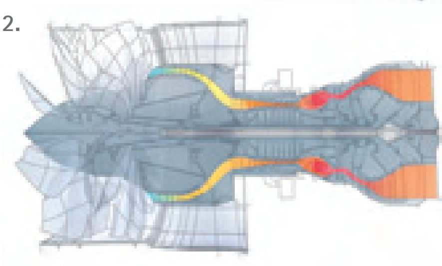

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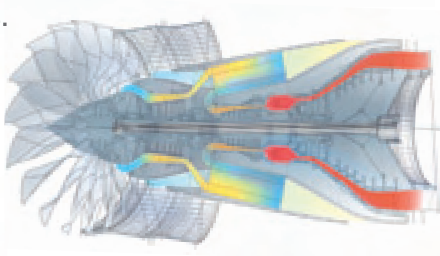

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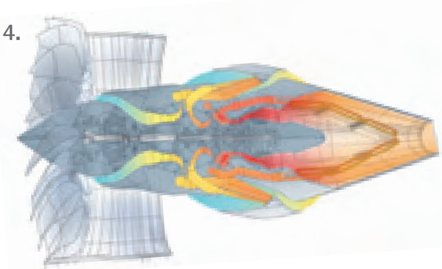


1). Active Core 2). Flow Controlled Core 3). Intercooled Core 4). Intercooled Recuperative Core

NEWAC – The Project

Previous technology programmes have already identified concepts and technologies to achieve the ambitious environmental targets set by ACARE. Innovative core configurations will be developed and validated in NEWAC with the aim of significantly reducing CO_2 and NO_X emissions. These concepts will use heat management, improved combustion, active systems and improved core components. NEWAC will design and manufacture these innovative components and perform tests to validate the critical technologies. The following four core concepts will be investigated:

- **Active Core** applicable to a geared turbo fan (GTF) using a PERM combustor.
- **Flow Controlled Core** using a PERM or LDI combustor applied to conventional or new engine architectures.
- **Intercooled Core** for a high OPR engine concept based on a three shaft direct drive turbo fan (DDTF) with an LDI combustor.
- **Intercooled Recuperative Core** for the intercooled recuperative aero engine concept (IRA) operated at low OPR and using a LPP combustor concept.

The approaches towards large-scale NO_X emission reduction schemes with the most potential are based on lean premixing combustion technology. Three different lean combustion concepts, operating at different overall pressure ratios, will be investigated under NEWAC.

1. Active Core: Active systems offer the chance of adapting the core engine to the operating condition of each mission and, therefore, have the potential to optimise component and cycle behaviour. The most promising active systems for core engine applications will be investigated and compared with passive alternatives:

- Active cooling air cooling system for reduced cooling air consumption
- Active and semi-active clearance control system for the rear HPC stages
- Active surge control system for the front HPC stages

The candidates with the highest overall potential will be developed and validated in a final core test. A Partially Evaporating Rapid Mixing (PERM) combustor is the system best suited to the active core engine and will be investigated under NEWAC.

2. Flow Controlled Core: Flow control technologies offer new opportunities to achieve an increase in high pressure compressor efficiency, additional surge margin and reduced in service deterioration and can be applied to a contra rotating turbofan (CRTF). These technologies are:

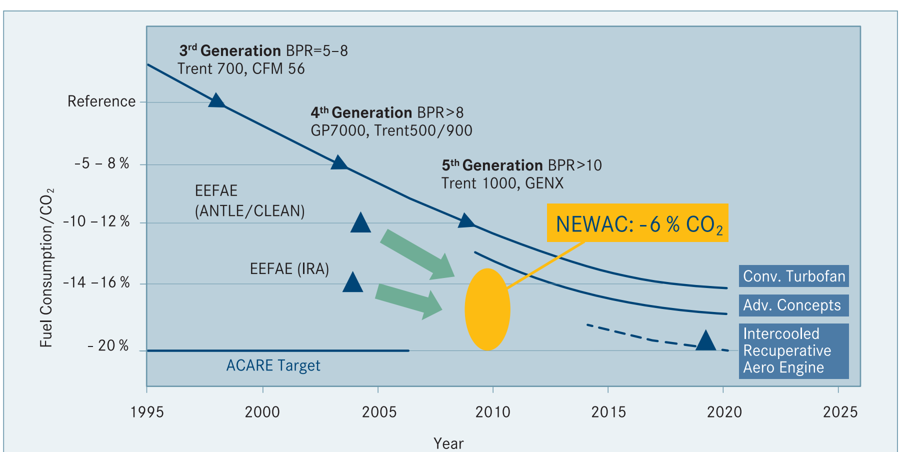
- Tip flow control technologies including tip injection and aspiration
- Advanced 3D aerodynamics and air aspiration applied on stator, hub or blade
- Blade/casing rub management for tight tip clearance
- Flow stability control optimised for engine integration

The flow control technologies will be investigated by analysis, elementary tests and validated in a compressor rig test. Both the Lean Direct Injection (LDI) combustor and the PERM combustor will prove to be highly useful for the purposes of this application.

3. Intercooled Core: The introduction of an intercooler to a core configuration allows for a very high overall pressure ratio (OPR). It reduces the compression work for such cycles and improves fuel burn. Key technologies for the intercooled core concept will be investigated in detail: the intercooler, along with the associated ducting and specific high pressure compressor (HPC) technologies, are needed to provide increased operability for the higher OPR and added intercooler and ducting volumes in the compression system. These HPC technologies will be validated by rig tests. An advanced Lean Direct Injection (LDI) combustor based on the EU-Technology Programme EEFAE-ANTLE will also be investigated, as it is the most appropriate for the intercooled core cycle at high OPR.

4. Intercooled Recuperative Core: This concept exploits the heat of the engine exhaust gas and maximises the heat pick-up capacity of the combustor inlet air by intercooling in front of the high pressure compressor. The results of the EEFAE-CLEAN technology programme showed there was potential for improvement in the optimisation of the recuperator arrangement. This could be done by introducing an innovative duct design and investigating a radial compressor in a new design regime. Finally, an advanced Lean Premixed Prevaporised (LPP) combustor, a design which is well suited for the intercooled recuperative cycle with its low overall pressure ratio, will support further NO_X reduction.

Innovative core configurations will be developed and validated in NEWAC with the aim of significantly reducing CO_2 and NO_X emissions

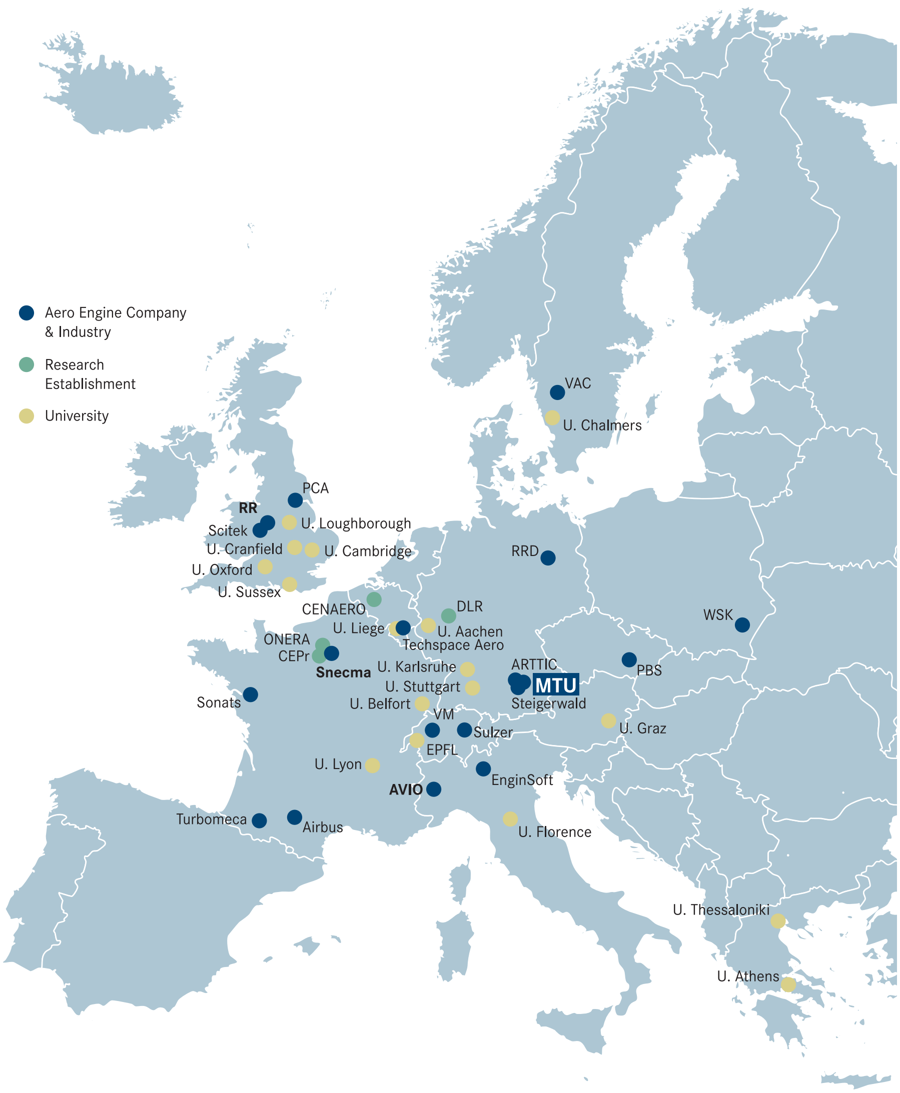


Improvement of CO_2

In summary

There is much pressure on the areo engine industry in particular for new solutions to air pollution.

The movement toward a 'green' engine has been a long time coming with environmental concerns a major priority on



NEWAC has 40 partners throughout Europe

the public's agenda. Although this industry is perceived as one of the most polluting industries around people are not willing to give up their international travel despite their desire for eco-friendly solutions.

The global phenomenon of budget airlines has become a highly popular choice for travellers with budgets in mind and tourism has become a number one economy driver since it has become both competitive and attractive. For this reason the next focus must be on changing the engines rather than trying to change the culture or reverse progress in a service that is in such high public demand.

NEWAC has some highly ambitious goals, goals that cannnot be accomplished by incremental improvements of existing technologies. Totally new core technologies like heat management and active systems have to be investigated and introduced to achieve these objectives. This demands a high level of innovation.

NEWAC is looking to reduce emissions by six per cent CO2 reduction and 16 per cent NOX. This will be in context of the ACARE goals to reduce CO2 emissions by 20 per cent and NOX emissions by 80 per cent by the year 2020.

The project's timetable is fast moving and working demonstrations could be ready in as little as two year time.

NEWAC will validate the new technologies in rigs or core engine demonstrators between 2008 and 2010.

This will enable the engine manufacturer to introduce these innovative technologies in the next generation of aero engines which will make it to market around the years 2013-2015.★

At a glance

The project

NEWAC unites 40 partners from 11 European countries. European leading engine industry, the engine industry supply chain, key European research institutes and SMEs with specific expertise will jointly develop new aero engine core technology under the € 71 mn programme of which € 40 mn are provided by the EC.

Strategy

All new configurations investigated in NEWAC will be specified in detail, compared, assessed and ranked regarding their benefits and contributions to the global project targets.

NEWAC draws on the conclusions of the completed CLEAN and ANTLE programmes. It also complements VITAL, another technology programme under the EU's Sixth Research Framework Programme.

The main result of NEWAC will be fully validated novel technologies which will lead to a 6% reduction in CO_2 emissions and a further 16% reduction in NO_x.

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NEWAC new aero engine core concepts