rolls-royce.com

# Future of flight

31-40 minutes

---

## Doing more with less

The aerospace industry leads the world in embracing technology and efficiency challenges. Targets for environmental improvements are tougher than ever and need to be met in a marketplace where fuel costs are in flux and competition is fierce.

Overview

The aerospace industry leads the world in embracing technology and efficiency challenges. Targets for environmental improvements are tougher than ever and need to be met in a marketplace where fuel costs are in flux and competition is fierce.

## Doing more with less

### The challenges facing the aerospace industry

We're a key partner in ACARE (Advisory Council for Aeronautics Research and Innovation in Europe) which has set itself ambitious technology goals for 2050. ACARE's vision for the future, Flightpath 2050, lays out clear environmental technology goals for aircraft relative to a year 2000 benchmark. Achieving these will take contributions from aircraft and engine technology, as well as improvements in airline operations and air traffic management.

Reduce noise pollution by

65%

Minimise turnaround times to meet consumer expectations

as our contribution to the overall

75%

reduction goal

Achieving a 75% reduction in fuel burn is equivalent to cutting 275 miles per USG or

1Litre

per 100km, per passenger

## Doing more with less

Reduce $NO_x$

$NO_x$ emissions during landing and take-off have been regulated for many years to help manage local air quality around airports. The standards have become more aggressive over time, and they'll keep getting tougher. We're continuing to invest in low emissions technology to meet the Flightpath 2050 targets.

Noise reduction of a large twin-engine aircraft by

15dB

Making its noise equivalent to a **Learjet 45,** which weighs 25x less and has 20x less thrust.

In 2030

6 bn

are expected to travel

That's an increase of

60%

or almost 2.4 billion
people

We've crafted seven variations of our world-leading aero engine family since the launch of our first Trent engine over two decades ago. Each one is a feat of precision engineering, perfectly designed to meet the needs and challenges of the market it operates in. Today, our Trent XWB is the most efficient aero engine ever created. Evolving from this world-class lineage, the Advance and UltraFan will redefine the world of jet engines.

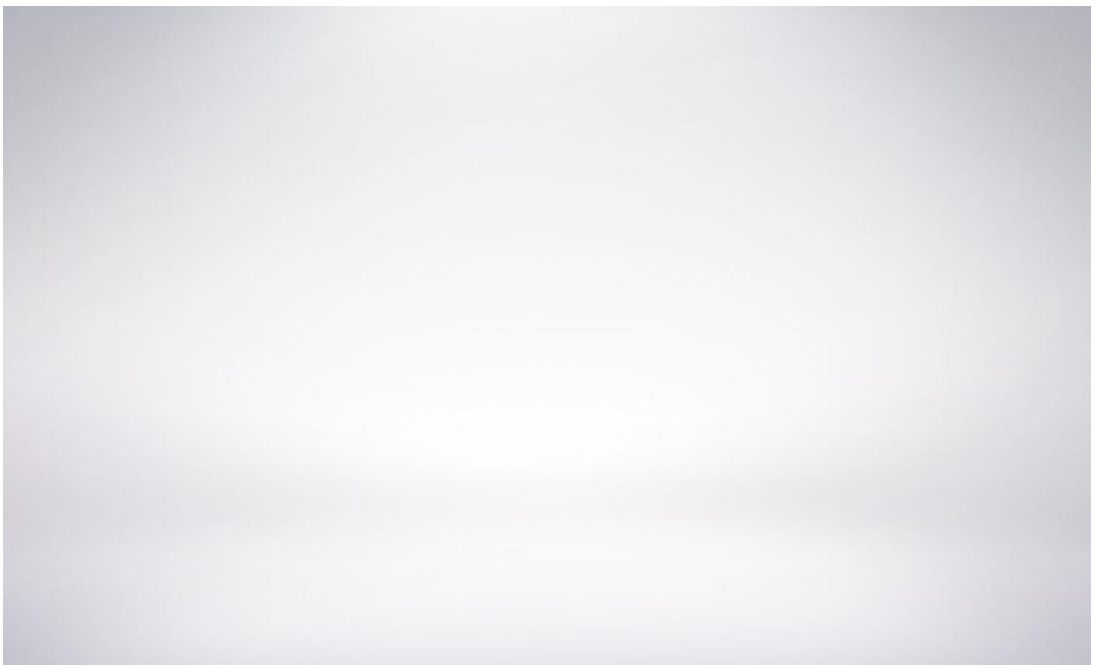
**A family of distinction**

The success of our world-leading Trent engines has grown from continuous investment and our commitment to progressing on perfection at every opportunity. Nowhere is our dedication to meeting customers' needs and delivering better power for a changing world more apparent than in the Trent family.

**A ground-breaking solution**

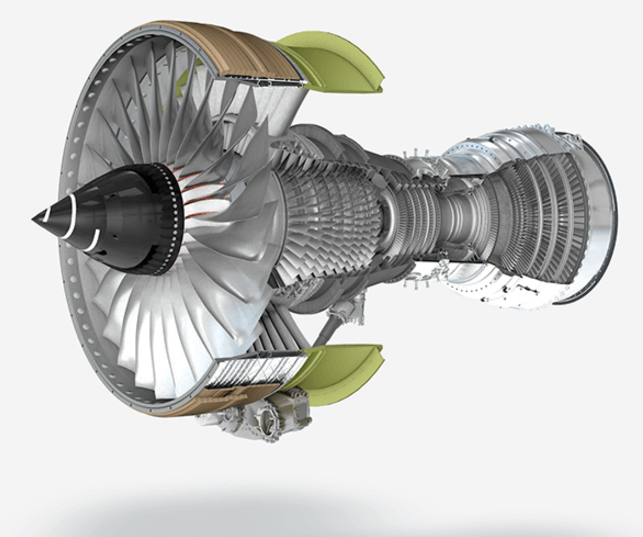
By reengineering performance and efficiency, the Advance and UltraFan engines have the power to overcome the challenges facing the aerospace industry and shape the future of aerospace.

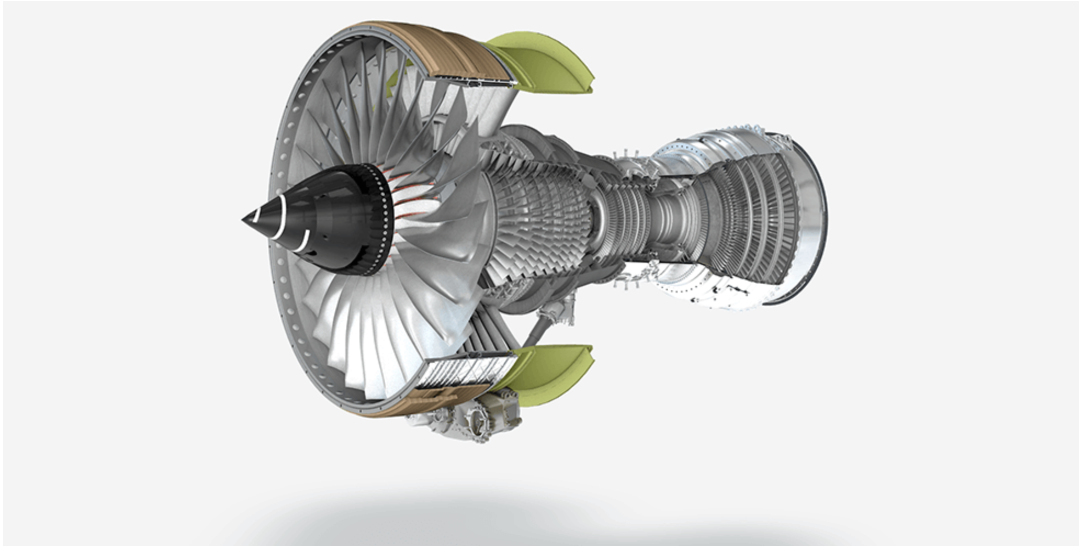
A ground-breaking solution

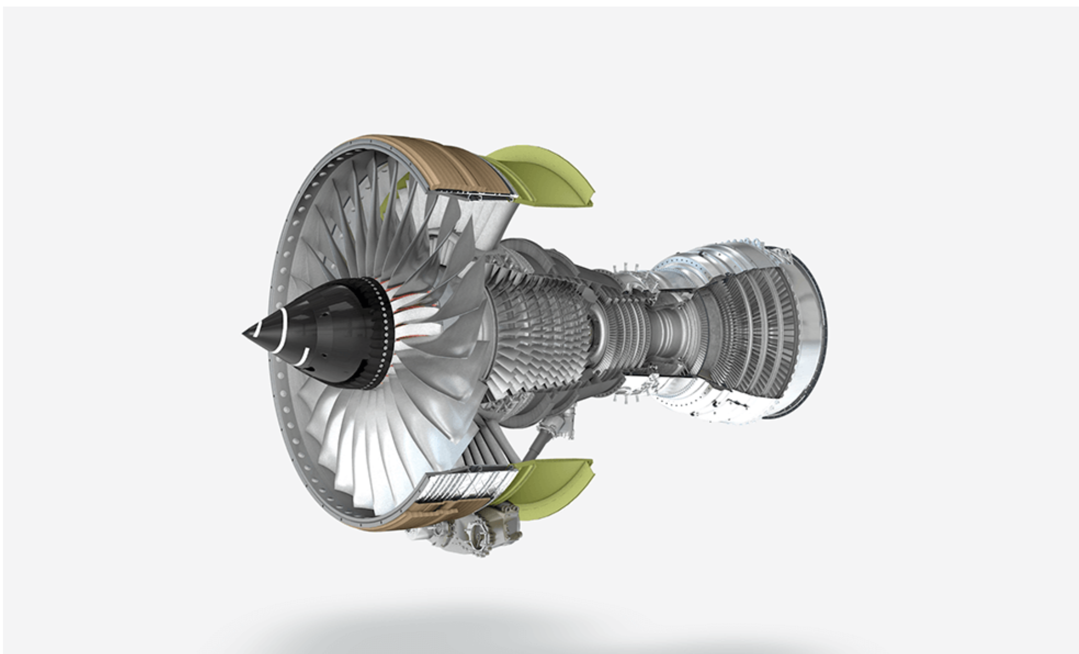


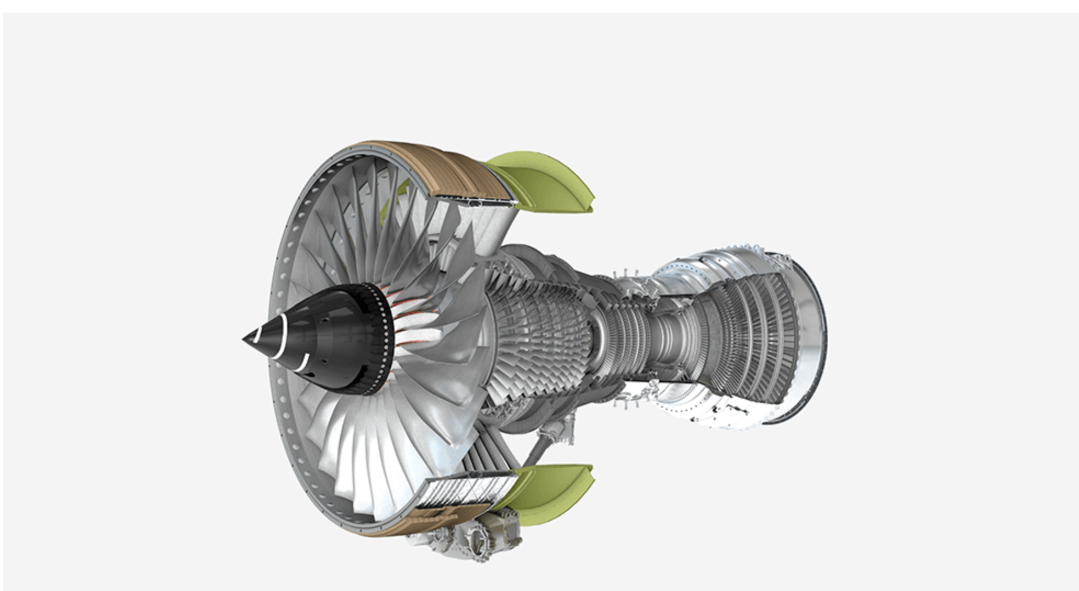
Take the journey from Trent 700 to UltraFan and discover how we’re shaping the future of flight.

Enter our world >





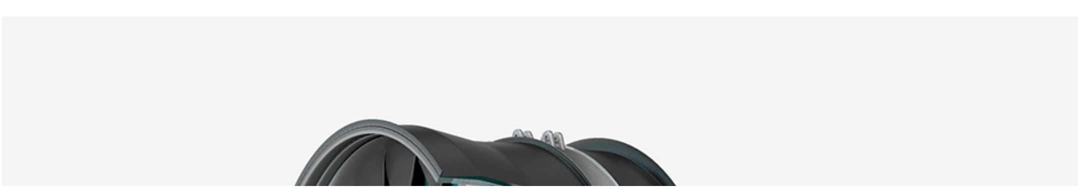


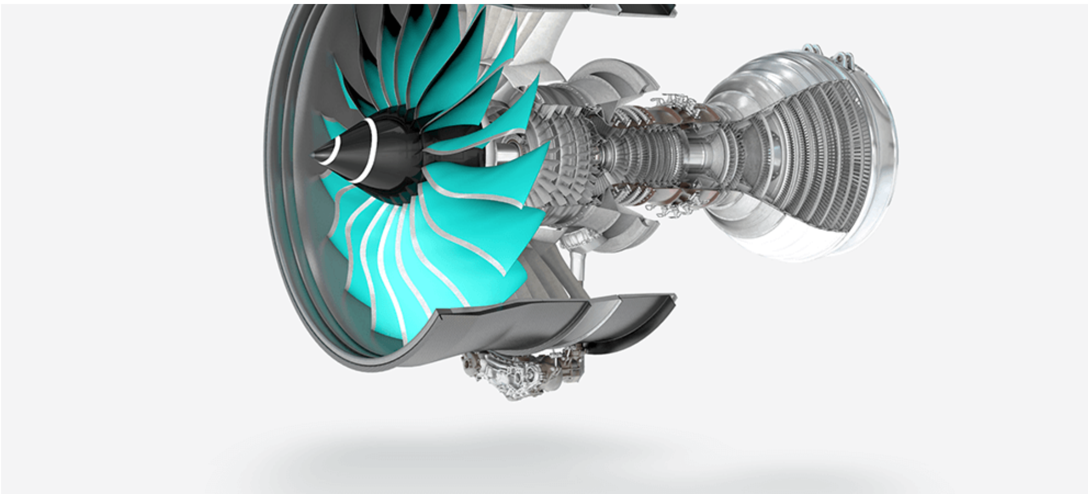


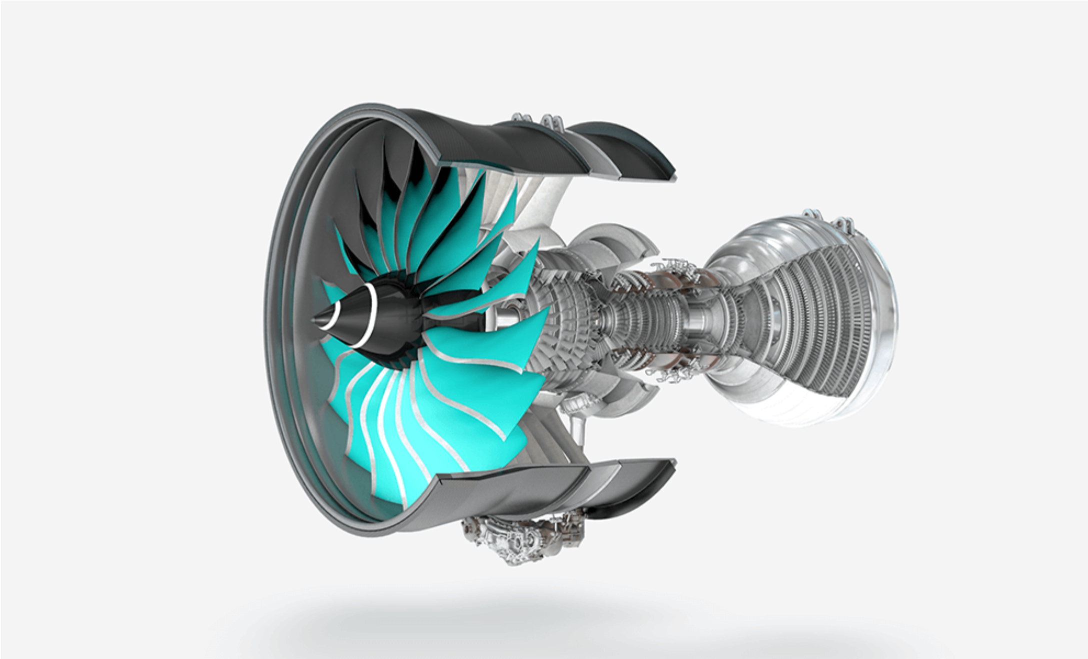
Lightweight CTi fan system

Lightweight high-efficiency compressors and turbines

Advance core architecture







### Lightweight CTi fan system

The lightweight CTi wide-chord fan blades use the latest low speed swept fan technology for even higher efficiency and lower noise. This is combined with a composite fan case to offer a weight saving of around 1,500lbs on a typical twin engine aircraft.

### Lightweight high-efficiency compressors and turbines

Compared to the Trent XWB, Advance has more stages in the high-pressure compressor and turbine, and fewer in the intermediate-pressure spool. This increases the efficiency and reduces the weight of the engine.

### Low-NOx combustor

The addition of a lean-burn combustor reduces NOx emissions at the higher pressure ratio to increase engine performance and minimise losses. It also reduces smoke and particulate emissions.

Advanced components

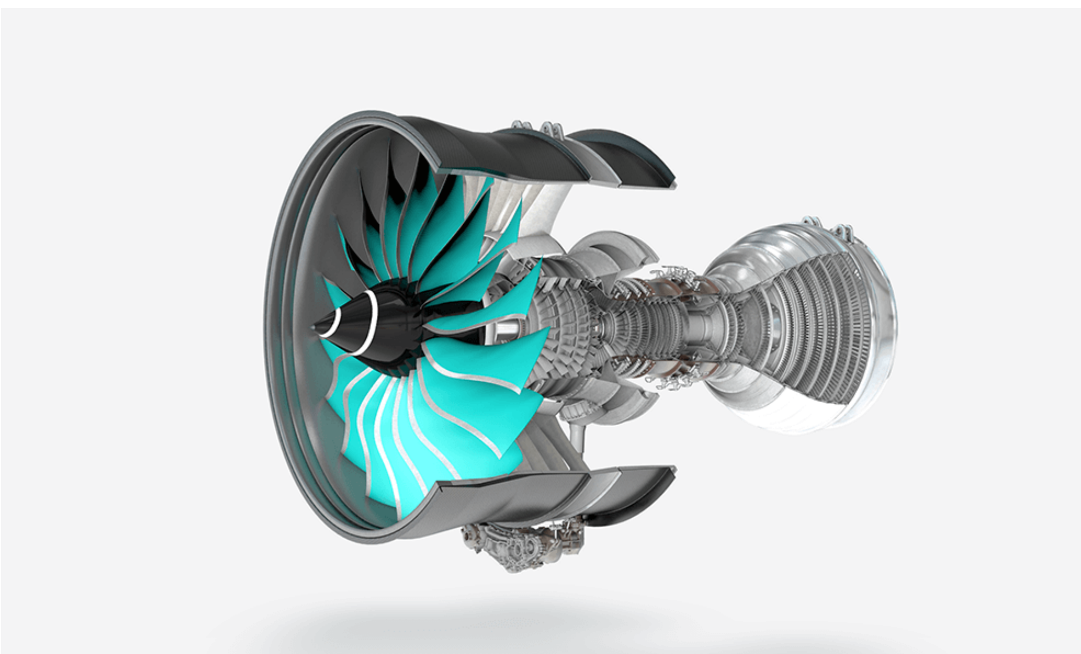
Numerous advanced components including dynamic sealing, advance high-overall pressure ratio cycle, adaptive cooling system and advanced turbine cooling and materials work together to increase engine performance and minimise losses.

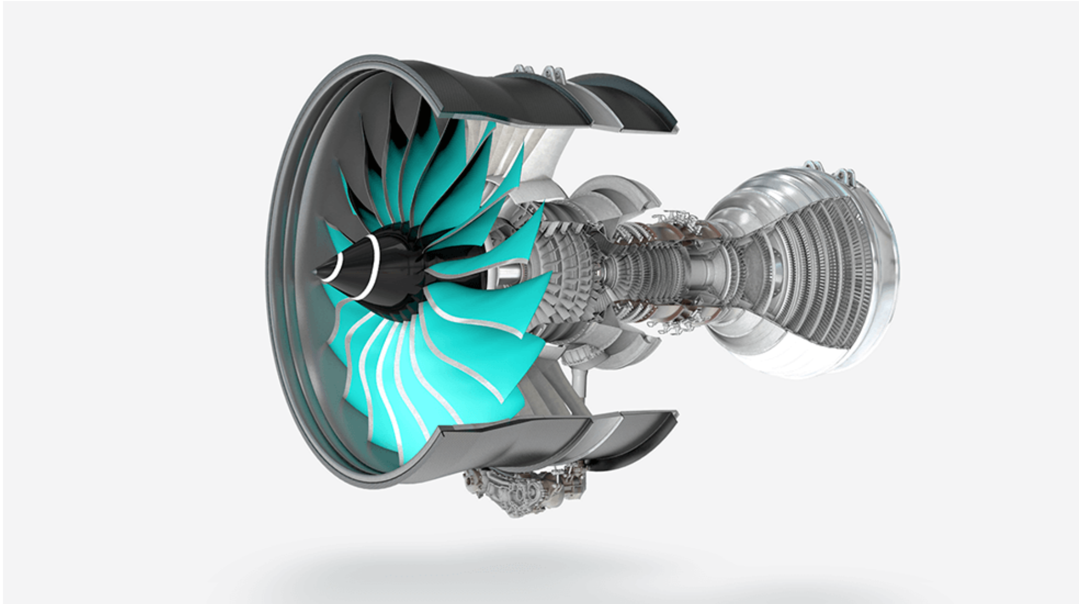
Advance core features

The new core architecture features smart adaptive systems, high-torque density shafts and hybrid ceramic bearings.

Advance core architecture

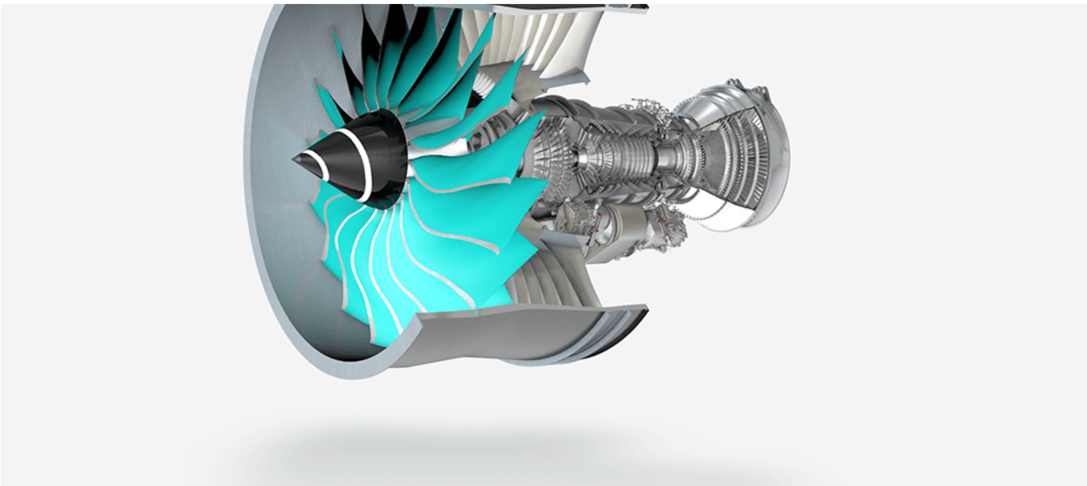
The Advance core architecture redistributes the workload between the intermediate and high-pressure shafts, resulting in higher efficiency, fewer parts and lower weight.

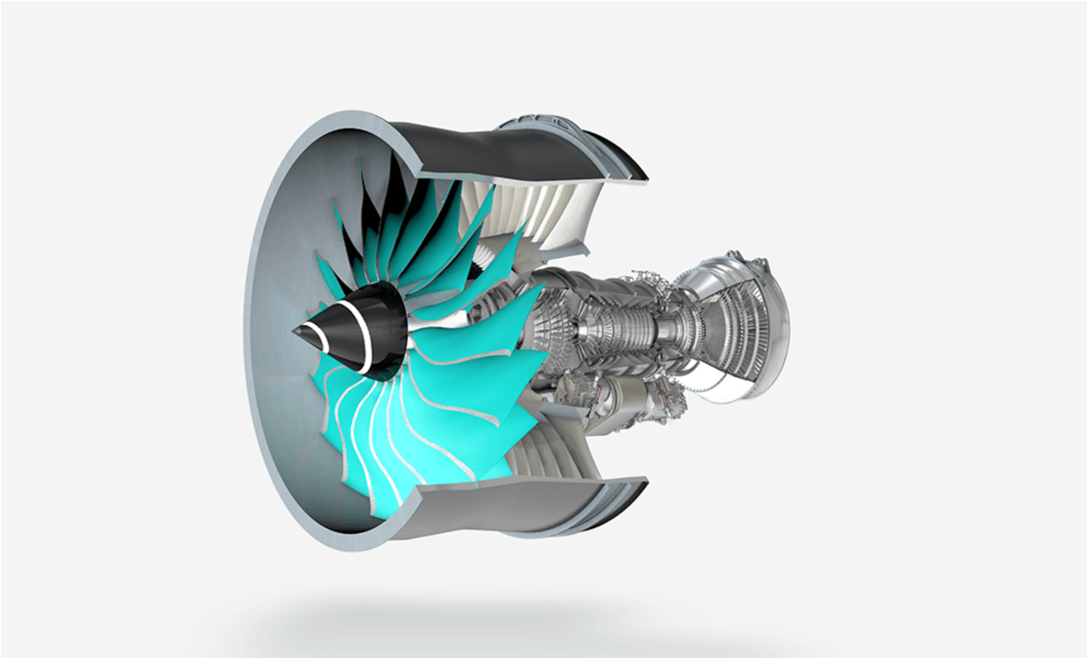




Multi-stage IP turbine system

Next generation components





## Power gearbox

To accommodate the higher overall pressure ratio of 70:1 and bypass ratio of 15:1 (which results from advances made to the Advance core architecture) we've introduced a power gearbox between the low-speed CTi composite fan and the intermediate pressure turbine; the gearbox in a fixed pitch UltraFan allows the Turbine to run faster (than an ungeared LPT) which makes it smaller, lighter and more compact and therefore more efficient.

## Advanced CTi fan system

A further innovation concept of the UltraFan would be to make the fan blade pitch variable in all phases of flight; this removes the need for a thrust reverser and enables a truly slim-line nacelle system which minimises drag.

## Multi-stage IP turbine system

By wrapping a new low-pressure system around the Advance core, the LP turbine is removed and both the geared fan and the IP compressor are driven by the IP turbine. Performance of the IP turbine is improved by having more stages and higher aspect ratio titanium-aluminium blades which are lighter and ceramic matrix composite nozzles which can withstand higher temperatures than previous components.

Next generation components

Broader application of ceramic matrix composites for nozzles and shrouds, next-generation high-strength nickel alloys, compressors with bladed disks and metal-matrix-composite rings and advanced hybrid ceramic bearings all combine to withstand higher temperatures and help to push the pressure ratio to our highest ever of 70:1.

Advanced cooling system

The advanced cooling system and introduction of cooled cooling air means the UltraFan can run at higher power without overheating.

Which engine would you like to view?

X

Overall pressure ratio

What:

Increased pressure ratio of 60:1 – almost double that of the Trent 700 – means a more efficient engine as more heat energy is converted to thrust

Benefit:

Less fuel needed to travel equivalent distances

Bypass ratio

What:

The increased bypass ratio of 11:1 – more than double that of the Trent 700 – increases fuel efficiency as the engine can generate thrust more efficiently by pushing more air flow out in a slower jet

Benefit:

Less fuel needed to travel equivalent distances

Fuel burn

What:

Minimum 20% improvement in fuel burn from the engine weight and efficiency improvements, leading to a lighter more efficient aircraft

Benefit:

Less fuel needed to travel equivalent distances

Weight saving

What:

750lb weight saving per engine resulting from lightweight CTi fan system

Benefit:

Weight saving of 1500lb on a twin engine aircraft, equivalent to 7-8 passengers travelling weight free; means less fuel is needed to power the aircraft

Operating cost

Fuel burn

What:

Minimum 20% improvement in fuel burn meaning a more efficient use of fuel

Benefit:

Less fuel needed to power the aircraft equivalent distances resulting in lower emissions

$CO_2$ reduction

What:

Minimum 20% reduction in $CO_2$ emissions

Benefit:

Equivalent journeys using Advance engines are less environmentally harmful

$NO_x$ reduction

What:

A lean burn combustor will eliminate fuel rich hot regions in the combustor during engine high power operation

Benefit:

Significantly reduces $NO_x$ and other emissions (e.g. smoke particulates), both in and around airports and at altitude

Environmental impact

Bypass ratio

What:

The increased bypass ratio of 11:1 – more than double that of the Trent 700 – as the engine produces a slower jet of air

Benefit:

Perceived engine noise reduction in comparison to the Trent 700

Noise pollution

Advanced materials

What:

Greater application of advanced materials and innovative high-temperature materials

Benefit:

Component engine parts can travel further and be exposed to higher temperatures for longer before needing to be replaced or serviced

Turnaround time

Overall pressure ratio

What:

Increased pressure ratio of 70:1 – double that of the Trent 700 – means a more efficient engine as more heat energy is converted to thrust

Benefit:

Less fuel needed to travel equivalent distances

Bypass ratio

What:

The increased bypass ratio of 15:1 – more than three times that of the Trent 700 – increased fuel efficiency as greater thrust is generated by the fan

Benefit:

Less fuel needed to travel equivalent distances

Fuel burn

What:

Minimum 25% improvement in fuel burn from the engine weight and efficiency improvements, leading to a lighter more efficient aircraft

Benefit:

Less fuel needed to travel equivalent distances

Weight saving

What:

750lb weight saving per engine resulting from lightweight CTi fan system

Benefit:

Weight saving of 1500lb on a twin engine aircraft, equivalent to 7-8 passengers travelling weight free; means less fuel is needed to power the aircraft

Operating cost

Fuel burn

What:

Minimum 25% improvement in fuel burn meaning a more efficient use of fuel

Benefit:

Less fuel needed to power the aircraft equivalent distances resulting in lower emissions

$CO_2$ reduction

What:

Minimum 25% reduction in $CO_2$ emissions

Benefit:

Equivalent journeys using Advance engines are less environmentally harmful

$NO_x$ reduction

What:

A lean burn combustor will eliminate fuel rich hot regions in the combustor during high power operation

Benefit:

Significantly reduces $NO_x$ and other emissions such as smoke particulates both in and around airports and at altitude

Environmental impact

Bypass ratio

What:

The increased bypass ratio of 11:1 – more than double that of the Trent 700 – as the engine produces a slower jet of air

Benefit:

Further reduction in the perceived engine noise in comparison to Advance

Noise pollution

Advanced materials

What:

Greater application of advanced materials and innovative high-temperature materials

Benefit:

Component engine parts can travel further and be exposed to higher temperatures for longer before needing to be replaced or serviced leading to quicker turnaround time for consumers

Modular design

What:

By building electrical connections into component parts and creating parts that fit together, we can minimise assembly and service times

Benefit:

Less time required for maintenance means a reduction in servicing time between flights and quicker turnaround times for consumers

Turnaround time

## Related stories