INNOVATION POWERING SAFRAN

Stéphane CUEILLE, Chief Technology Officer
Technology, key to our competitiveness

R&T plan

BUSINESSES

PROPULSION

EQUIPMENT

INTERIORS

KEY DRIVERS

Greener

Connected and Autonomous

New Usage

Passenger Experience

Productivity & Digital Services

TECHNOLOGIES

4.0
A growing investment in R&T and Innovation

SAFRAN

RT&I

€460M*

~3,000 FTE | 900 patents / year

Self-funded R&T and Innovation (€M)

* Self-funded R&T 2018 – including Zodiac Aerospace (€30M)
SAFRAN R&T and Innovation: state of the art organization and processes

R&T roadmaps

- 40 Safran roadmaps

Products

Innovation

Methods & Tools

Technologies

Shared resources

- 600 Corporate Scientists

SAFRAN TECH R&T CENTER

SAFRAN ANALYTICS

INTELLECTUAL PROPERTY CENTER OF EXCELLENCE

Corporate initiatives

- 4 Initiatives On Going

HYBRID PROPULSION

AUTONOMOUS SYSTEMS

ADDITIVE MANUFACTURING

DIGITAL

Ecosystem

- 30 Strategic partnerships

SAFRAN VENTURES

SCIENTIFIC PARTNERSHIPS

TECHNOLOGY PARTNERSHIPS
SAFRAN at the core of energy & propulsion challenges

CO₂ reduction challenge

- Ultra-efficient gas turbine propulsion
- Hybrid propulsion and Electrification
- Use of Low Carbon Fuels

Timeline:
- 2005
- 2010
- 2020e
- 2030e
- 2040e
- 2050e

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High efficiency advanced turbine propulsion

Open Rotor: a key milestone achieved – a true option for the future

The only engine architecture allowing a 15% reduction of fuel consumption and CO\textsubscript{2} emissions compared to the LEAP Engine

- 3D-woven carbon fiber blades
- Specific control system with Pitch Control Mechanism
- Same performance in terms of emitted noise as the LEAP engine
Optimizing energy onboard the aircraft

- Jet Engines
  - Transmission Systems
  - Generators & Motors
  - Power Electronics
  - Wiring
  - Ram Air Turbines
- Electrical Distribution
  - Auxiliary Power Units
  - Fuel Cells
  - Electric Taxiing
SAFRAN pioneering hybrid electric energy & propulsion

A stepped approach
Potential of new usage, lower electrical power, shorter distance

Electrical Power / Voltage

2021
100 kW

2025
500 kW

2025+
1 MW

2030+
> 1,000 V

2040+
< 1,000 V

10 MW

Potential of new usage, lower electrical power, shorter distance

100 kW
500 kW
1 MW
10 MW

E-TAXIING
Bi-turbine Helicopter
Micro-Hybridization

VTOL
Air taxi or Logistic

Commuter
10 Seats

Electrically assisted
Turbofan
for future SMR* Aircraft

40 Seats
Regional?

Distributed Propulsion for 200 Seats Commercial aircraft?

*SMR: short medium range

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Vtol hybrid electric distributed propulsion

Generator

High power density integrated electrical engine

Full scale flight demo 2021 with Bell

First test of a full hybrid propulsive system (June 2018)
Advanced materials & manufacturing processes

Polymer matrix composites

A core capability for product performance and industrial competitiveness

10% weight benefit, enabling advanced propulsion efficiency

Ceramic matrix composites

+200°C & -60% weight: A game-changing class of material

High performance alloys

Turbine airfoil technologies

+20% strength and x2 durability for critical equipments

5-10% engine fuel burn benefit

Advanced non-destructive testing

20% cost reduction and improved process control

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Additive manufacturing: making it a reality

Accelerating transition from R&T to Product insertion across Safran

Certified parts
- Arrano
- LEAP, APUs ...

Ambitious targets for new designs / products
Supported by full scale demonstrators

Engine
- 50 parts to 1
- Cost -15%
- Weight -25%
- Lead time / 6

Equipment

Benefits
- Weight
- Lead time
- Performance
- Supply-chain dependency
- Reduction of assemblies

Additive campus project
- Mutualized R&T and production Center

50 parts to 1
Cost -15%
Weight -25%
Lead time / 6
Digital at the core of our business processes

Manufacturing – Services – R&D
Data Analytics supporting the ramp-up of LEAP

Manufacturing process optimization

Automated Process Data Collection
Data Analytics

Benefits

- First time yield improvement
- Cost reduction
- Optimization of assets

Example

Forging dies life durability multiplied by 2.5
Autonomous systems

Defense Robotics

Drones

Pilot Assistance

Safe and Secure Navigation System

All Weather Optronic Sensor

Certifiable Artificial Intelligence

Embedded Critical Electronics & Software Solution

Safran Tech Autonomous Systems Lab

Joint lab with Automotive Industry
Agile integration & test
Innovation in cabin

Connected cabin

- Passenger experience
- Operations & maintenance
- New revenue generation

ZEO: Safran design studio

- A unique combination of industrial design, advanced concept engineering and a mockup & prototype shop
- An open, collaborative environment dedicated to innovation