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VP Materials Purchasing

TITANIUM USA 2018
ITA's 34th annual Conference & Exhibition
Las Vegas, Nevada – October 7-10
In 2018, Safran took control of Zodiac Aerospace, significantly expanding its aircraft equipment activities and reinforcing the core aerospace and defense businesses, and presence on key major programs.

AN INTERNATIONAL HIGH-TECHNOLOGY GROUP

3 CORE BUSINESSES:
Aviation
Space
Defense

WORLD’S No.3 AEROSPACE COMPANY
(excluding aircraft manufacturers)

More than 58,000 EMPLOYEES
(91,000 with Zodiac Aerospace) in
30 COUNTRIES

€16.5 BILLION in revenue
(€21 billion with Zodiac Aerospace, pro forma 2016)

€2.5 BILLION in adjusted recurring operating income

€1.4 BILLION in R&D expenditures, equal to 8% of revenue

850 INITIAL PATENTS filed in 2017
TITANIUM’S EVOLVING ROLE IN MODERN AIRCRAFT ENGINES
CFM, 47 years after...

33,000+ engines delivered

570+ customers worldwide

Every 2”, a CFM-powered aircraft takes off

CFM carries 3M+, passengers daily

99.98% dispatch reliability

900M+ Engine Flight hours

René Ravaud (Snecma) and Gerhard Neumann (GEAE) in the early 70’s
... we are defining history

- **33,000+** total CFM deliveries to date
- **16,000+** LEAP engines on order
- **63** LEAP operators on 430 aircraft 80 by 2020
- **1,000+** engines shipped to date
- **2M+** LEAP engine flight hours
- **96%+** Utilization
- **75%** BUY
- **25%** MAKE
What is CFM’s market?

2017-2036 market forecasts

- Economic growth: +2.8%
- RPK traffic growth: +4.5%
- Global fleet growth: X 1.9
- New Aircraft deliveries: 38,900

Planned 20-year deliveries of new aircraft

- Turboprop aircraft: 2,800
- Regional jets: 3,700
- Short-medium range jets: 23,800
- Long range jets: 8,600

Nearly 24,000 new short-medium range A/C
Typical production downturn has not occurred in over 10 years

Aircraft production cycle

Demand % change, RPKs

- Boeing: 7.6 '17, 6.0 '18F, 6.4 '20F
- Airbus: 81.4 '17, 81.4 '18F, 81.5 '20F

Departures

- Millions of
- '17: 36.8, '18F: 38.6, '20F: 41.2

6%+ RPK growth 2018-2020
CFM56 deliveries ramp-down, but shop visit volume still growing... will continue to drive material demand.

2017 deliveries
1,400+

2017 orders continued
400+

Fleet growing
21,000+

Shop visits don’t peak until
~2020+

60% of in-service fleet still hasn’t reached its first shop visit.
What were our promise to the market in 2008

Combining technology, experience and execution

Fuel efficiency
- 15% reduction

NOx
- Up to 50% lower vs. CAEP 6

Noise
- New regulation a/c compliance (chapter 24)

Reliability
- Same as CFM56 ... best in industry

Life cycle maint. cost

Performance and reliability
What we have accomplished ...

- 15% fuel efficiency
- NOx and noise targets
- 96% utilization
- 16,000+ engines ordered and 1,000+ engines delivered
How we have accomplished ...

- Optimized thermodynamic design,
- Higher bypass and compression ratios,
- Advanced 3-D aerodynamic design
- Greater use of lightweight materials.

The materials used to make engine parts play a significant role in environmental performance. Choosing the right ones is very important, because lighter parts help reduce fuel consumption and emissions. And their resistance to high temperatures means we can improve the thermal efficiency of turbomachines.
Greater use of lightweight materials

Composites on Fan blades / Case

+30% of titanium per LEAP engine
Leap-1B compared to CFM56-7 – Safran share

Titanium main parts for LEAP
- Fan Disk and Fan Blade Leading Edge
- Fan Hub Frame and LPC vanes and blades
- Fan Frame Shroud, Strut and Shroud link
- Bearing housing and supports
- Kit Engines: tubes, struts, ...
Use of different type of grade and production route

6.4 for LP static and rotating parts

Ti17 & 6.2.4.2 for rotating parts

TiAl 48-2-2 for LPT blades (last stages)

Casting for numerous small and medium size parts
Fan Hub Frame, LPT blades (TiAl)

Forging for static and rotating parts
Fan Frame shroud, Leading Edge, Fan Disk, Booster spool, Bearing housing
WHAT'S ABOUT THE FUTURE?
Mid term: NMA – New Mid-sized Airplane

- **275 seats**: between 225 and 275 in dual-class configuration
- **5,000 A/C**: market projections from 2,000 to 5,000
- **50,000+ lb of thrust**: from 45,000 to 50,000
- **5,000 Nm** range: from 4,200 to 5,000
- **EIS in 2025**: estimate
- **new routes**: + replacement of old generation

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Mid or long term: Ultra-High Bypass Ratio

Ducted UHBR

Open Rotor

Future concepts overview
Long term: new architecture and integration

Studies on going on several architectures

Future efficiency improvements require more than an engine...
WHAT’S ABOUT THE FUTURE OF TITANIUM?
Weakness and opportunities

Composite materials are catching a bigger share on the engine. 500 lb weight savings on LEAP. Aluminum materials are much cheaper than titanium. By 10 times on plates.

Stakes are for Ti based alloy for higher temperature HPC rotating part. Casting of complex titanium parts is always challenging. AM could be an answer.
Safran expects support from the supply chain to ...

Save weight:
Challenge for the future on rotating parts is to have a Ti based alloy that can replace the 6.2.4.2 without the problems of relaxation at "low temperature" (Dwell Effect) or replace Inconel 718.

Save cost:
Safran uses 2000+ mt of high strength Titanium for its landing gears (UTS ≥ 1200 Mpa), good compromise between mechanical properties (ultimate tensile stress, fatigue), density and easier maintenance (corrosion)...
... but, volumes are declining to the profit of 6.4 or even 300M because of its price

Obtaining titanium powder in production quantities without going through the cost of: Sponge – Ingot – Billet – Bars – Powder.
Bringing back home...

Aerospace is still a growing market (6%+ RPK growth) and Safran has a major share on this story. For the next decades, every working day, Safran will use 20 mt of titanium.

Titanium based alloys have a great future in this industry: lighter parts help reduce fuel consumption & emissions and the resistance to high temperatures means the thermal efficiency of turbomachines can be improved.

Titanium powders could be extensively used by additive manufacturing new technologies, if they reach the market price.
Every day, every part matters