Airfinance Journal Roundtable Summit

The Future of Engine Technology

Scott Welsh
Services Marketing Manager
GE Aviation
## Expanded GE Aviation portfolio...

('07 Rev $, in billions)

<table>
<thead>
<tr>
<th>Engines &amp; Services</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial Engines</strong></td>
<td>$4.6&lt;br&gt;[a]</td>
<td></td>
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<tr>
<td><strong>Commercial Engine Services</strong></td>
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<tr>
<td><strong>Military Engines &amp; Services</strong></td>
<td>$3.5</td>
<td></td>
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<tr>
<td><strong>Digital Systems</strong></td>
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<td>$1.3</td>
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<tr>
<td><strong>Electrical Power</strong></td>
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<tr>
<td><strong>Mechanical Systems</strong></td>
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<tr>
<td><strong>Unison Engine Components</strong></td>
<td></td>
<td>$0.6</td>
</tr>
</tbody>
</table>

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(a- Includes GE's 50% of CFM 50/50 JV between GE and Snecma
GE Proprietary Information

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*GE Aviation
Airfinance Journal Summit*
Integrating engines and systems to deliver greater customer value

Examples:
- Enhanced Airborne Flight Recorder
- Nose Gear Steering System
- Common Core System
- Landing Gear Actuation System
- Highlift Actuation System
- Remote Data Concentrators
Delivering reliability every day ...

Every two seconds a GE or CFM powered aircraft is taking off somewhere around the world.

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
Installed base growing ... 8% CAGR

Engines in service

CFM, CFM56, and the CFM logo are trademarks of CFM International, a 50/50 joint company between Snecma and General Electric Company
... and beyond industry expectations

- GE and CFM engines ... 700 million flight hours and growing

- Increasing departures ... decreasing events
Future industry trends
Aviation - a global economic driver

Contributions
- $3 trillion
- 8% of World GDP
- 29 million global jobs

A robust industry
- 30MM departures
- 2.2B passengers
- $600B backlog
Fuel prices continue to rise – the growth segment of operating cost

Jet Fuel / bbl

$35

'00 '01 '02 '03

Cash AROC

Others 59% Fuel 12%

Mx 5% Labor 24%

Source: IATA
GE Proprietary Information
Fuel prices continue to rise – the growth segment of operating cost

Cash AROC

Jet Fuel / bbl

- '00: $35
- '08 YTD: $119

Source: IATA
GE Proprietary Information

Others 59%
Fuel 12%
Mx 5%
Labor 24%

Others 45%
Fuel 28%
Mx 5%
Labor 22%
Fuel prices, plus future **emissions charge** accelerating operating cost growth

![Graph showing the increase in Jet Fuel from $35 to $119 over the years, with a breakdown of costs by category: Fuel, Labor, Others, and Mx.](image)

**Cash AROC**

- '00: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '01: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '02: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '03: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '04: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '05: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '06: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '07: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '08 YTD: Others 59%, Fuel 12%, Labor 24%, Mx 5%
- '09E: Others 32%, Fuel 40%, Labor 20%, Mx 5%
- '10E: Others 32%, Fuel 40%, Labor 20%, Mx 5%
- '11E: Others 32%, Fuel 40%, Labor 20%, Mx 5%
- '12E: Others 32%, Fuel 40%, Labor 20%, Mx 5%

**Emissions**

- '00: 5%
- '01: 5%
- '02: 5%
- '03: 5%
- '04: 5%
- '05: 5%
- '06: 5%
- '07: 5%
- '08 YTD: 5%
- '09E: 5%
- '10E: 5%
- '11E: 5%
- '12E: 5%

Source: IATA

GE Proprietary Information

International Society of Transport Aircraft Trading
Commercial aviation making great efficiency gains

![Graph showing relative fuel consumption improvements from 1950 to 2000. Baseline fuel consumption is indicated. Engine fuel consumption improvements are shown as -40% and -70% compared to baseline. Aircraft improvements are shown as -70% compared to baseline.](image)

GE Aviation
Airfinance Journal Summit
GE Proprietary Information
Traffic growth exceeds progress, increasing aviation emissions.

Source: GE Analysis
GE Proprietary Information
Aviation only 2% of the CO₂ contributor
Air Traffic Control challenges

In the U.S.

- One-quarter flights delayed in ‘07
- $66 cost per minute

In Europe

- Delays across 35 ATCs
- Cost $4.4B in 2007

U.S. Congestion Cost

- 2007: $9B
- 2020: $20B
Performance based navigation – enhancements to existing system

- Reduced workload
- Fuel savings
- Lower noise
- Increased airport capacity

Source: FAA, IATA, GE Aviation Systems

GE Proprietary Information

GE Aviation
Airfinance Journal Summit
Performance based navigation – enhancements to existing system

- Reduced workload
- Fuel savings
- Lower noise
- Increased airport capacity

Source: FAA, IATA, GE Aviation Systems

GE Proprietary Information

Ge Aviation
Airfinance Journal Summit
Future support trends
Global fleet redistribution – a growing support challenge

40% operator increase
- most with 10 aircraft or less

Varied airline technical expertise
- increased reliance on OEM

Alternate material choices
- technical limits on ability to provide support
- potential residual value impact

Growth in passenger airlines

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<th>Year</th>
<th>&lt;10 AC CAGR</th>
<th>≥ 10 AC CAGR</th>
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<td>'02</td>
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<tr>
<td>'06</td>
<td>603</td>
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</table>

<10 AC CAGR = 10%
≥ 10 AC CAGR = 3%
The CFM56-3, 170,000,000 flight hours of support experience

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
The CFM56-3, 170,000,000 flight hours of support experience

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
The CFM56-3, or is it? another growing support challenge

Multiple alternate material providers & configurations
Independent engine survey ... asset value

<table>
<thead>
<tr>
<th>Engine lessors pole</th>
<th>Investor appeal</th>
<th>Remarking potential</th>
<th>Value for money</th>
<th>Residual average value</th>
<th>Average score</th>
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<td>CFM56-7B 737NG</td>
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<td>1.6</td>
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</table>

Source: Airfinance Journal Research

*CFM, CFM56, and the CFM logo are trademarks of CFM International, a 50/50 joint company between Snecma and General Electric Company
Addressing trends with technology
Efficiency **gains** in engine technology

-32% Since 1960

Relative fuel consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>CF6</th>
<th>CFM56-3</th>
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<tbody>
<tr>
<td>1980</td>
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<tr>
<td>Long range application</td>
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<tr>
<td>High cycle application</td>
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</table>

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
TECH Insertion and LEAP are registered trademarks of CFM International
Efficiency gains in engine technology

-32% Since 1960

-5% to -8% Since 1980

Relative fuel consumption

1980 1990 2000

CF6 CFM56-3 CFM56-5/7 GE90

Long range application
High cycle application

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Efficiency **gains** in engine technology

- **-32%** Since 1960
- **-5% to -8%** Since 1980
- **-6% to -15%** Since 1980

**Relative fuel consumption**

- **40%**
- **50%**
- **60%**
- **70%**
- **80%**

**1980**

- CF6
- CFM56-3
- Long range application

**1990**

- CFM56-5/7
- GE90
- High cycle application

**2000**

- TECH Insert™

**2010**

- TECH Insert™
- GEnx

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Efficiency gains in engine technology

-32% Since 1960
-5% to -8% Since 1980
-6% to -15% Since 1980
-15% to -25% Since 2008

Relative fuel consumption
80%
70%
60%
50%
40%

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
TECH Insertion and LEAP are registered trademarks of CFM International

CF6
CFM56-3
CFM56-5/7
GE90
GEnx
LEAP™

Long range application
High cycle application
Cleaner, quieter, faster, affordable

Fuel consumption
Emissions
Noise
Cost of ownership
Reliability

a product of ecomagination™
Commitment to technology investment

GE Aviation R&D investment

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment</th>
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<tr>
<td>'05</td>
<td>$1.1B</td>
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<td>'06</td>
<td>$1.2B</td>
</tr>
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<td>'07</td>
<td>$1.3B</td>
</tr>
</tbody>
</table>

Technology focus areas
- Aerodynamics
- Materials
- Combustion
Major technology enablers - **Aerodynamics**

- **3-D Aero**
- **12:1 Pressure Ratio**
- **23:1**
- **26:1**
- **GE90**
- **GE90**
- **CFM International** is a 50/50 joint venture with Snecma (SAFRAN Group)
- **LEAP**
- **LEAP** is a registered trademark of CFM International
Major technology enablers - Materials

Periodic Table

- GE36 UDF unducted, composite blades
- GE90 composite fan blade
- GE90 composite fan blade and case
- GEnx composite fan blade and case
- High temperature composites (CMCs)

80's
90's
00's
Next
Major technology enablers - Combustion

80’s  90’s  00’s  Next

CFM/GE90 Dual-Annular Combustor (DAC)
Twin-Annular Pre-Swirl
GE90-115B DAC TAPS
GEnx TAPS

CF6 Low Emissions Combustor (LEC)

NOx

CO

CFM International is 50/50 joint venture with Snecma (SAFRAN Group)
LEAP56 is a registered trademark of CFM International
Engine architecture options - Leading-Edge Aviation Propulsion (LEAP)

- Advanced Turbofan
  - Proven design
  - Improved reliability

- Open Rotor
  - Game changing performance
  - Time to mature technologies

CFM International is a 50/50 joint venture with Snecma (SAFRAN Group)
LEAP is a registered trademark of CFM International
GE Aviation – powering the future

- Significant trends affecting the aviation industry
- Continuous investment in technology, for today and in the future
- Committed to the safe redistribution of our fleet, and protecting your asset value
- Focused on exceeding customer expectations - creating clean, quiet, efficient, and affordable products