Overview

- GTF Aerospace Inc. was founded in 2001 and since then has experienced rapid development.
- The company's success is based on an extensive IP portfolio, combined with comprehensive development and application know-how.
- To date Process and Equipment Development consumed 32,000 PhD. Man hours and over 100,000 Mac. hours of Engineers

Strategy Pillars Aerospace

- Market Leadership in the field of high performance coatings for large OEM, MRO and PMA customers
- Continuing increase in the industrial scalability of our process applications
- Focus on research and development, as well as the protection of IP by patents associated with economic roll-out of our products
- Deliver high quality nanotechnology products on an industrial scale with high customer benefit
In 2002 the Advisory Council for Aeronautical Research in Europe Stated:

We need improved or new engine designs to reduce:

- CO2 emissions by 50%
- NOx emissions by 80%
- Fuel consumption by 20%
- Maintenance costs by 25%

**BIG However** - the possibility of obtaining improved mechanical properties by the conventional methods of cold working, solution hardening, precipitation hardening, etc., has been almost exhausted. Bulk Nano alloys are many years away from industrial relevance.

**Design Gas Path Trends**

- Highly Loaded Axial Compressors – 40 to 1 ratio – Temperatures might increase to 800 C
- High Turbine Operating Temperatures – 200 C increase in Temperature capability
- Enhance fatigue, sulphidation, oxidation and erosion resistance in high temperatures

“To illustrate nanotechnology’s potential on the world, if the aircraft industry had evolved at the same rate as microelectronic industry in the last 25 years, a Boeing 777 today would circle the globe in twenty minutes on five gallons of fuel”. - Dr. Robert Hull (Professor of Nanotechnology, University of Virginia)
Nanocomposite And Nanostructured Coatings SEM

- 1 micron
- Nanocomposite
- Implanted Metal Oxide
- 1.2 micron
- Nanostructure
- Multi Nanolayer MeO/MeN (16)
- Metal Oxide

AFM Features HV0.05 3850 SC 16.2 N
Stainless 0.0762 mm strip

Stainless Laminate

19% Yield Increase

22% Elongation Increase
GTF Nanocomposite And Nanostructure Features

- EB PVD
  Functional Design
  Erosion and Impact Failure

- CIMO
GTF Nanocomposite And Nanostructure Features

- Compressor – Slow Degradation And Superior Surface Finish
- Potential New Inspection Features

- Compressor – Erosion And Corrosion Resistance in Elevated Temperatures
How Fuel Efficiency Deteriorates With Commercial Engine Cycles

Main Causes Of Materials Deterioration
- Erosion
- Flight Loads
- Erosion
- Flight Loads
- Hot Corrosion
- Erosion
- Clearance Loss
- Hot Distortion
- Clearance Loss
- Hot Distortion

Loss In Efficiency

<table>
<thead>
<tr>
<th></th>
<th>Low Pressure Compressor</th>
<th>High Pressure Compression</th>
<th>Low Pressure Turbine</th>
<th>High Pressure Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>0.62%</td>
<td>0.16%</td>
<td>0.10%</td>
<td>0.48%</td>
</tr>
<tr>
<td>3000 Cycles</td>
<td>1.46%</td>
<td>2.94%</td>
<td>0.538%</td>
<td>2.43%</td>
</tr>
<tr>
<td>6000 Cycles</td>
<td>2.61%</td>
<td>9.40%</td>
<td>1.078%</td>
<td>3.81%</td>
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</tbody>
</table>

Huge Fuel Savings Possible
Military Aviation Is Suffering High Maintenance Cost And Poor Assets Availability

- Typical premature compressor damage T700 Helicopter Engine
- Operating Conditions

- Typical premature compressor damage AGT 1500 Tank Engine
- Operating Conditions

Engines are a vacuum cleaner
<table>
<thead>
<tr>
<th>Military Engine Erosion = Poor Readiness/Asset Availability High Maintenance Cost</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>CH53 Helicopter</td>
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<td>M1A Abrams Tank</td>
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<td>NH90 Helicopter</td>
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<tr>
<td>V 22 Osprey Helicopter</td>
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</tbody>
</table>
GTF Brampton Coating Facility

Clean Room Class 10,000

Nanostructure And CAPVD Plasma Sources

Ion Beam Magnetron

PECVD

Sigmatic TQC Software

Surface Preparation Facilities
Research And Commercial Interest

Nanostructures and Nanocomposite Coatings

- Continue New Thermal Barrier Characterization And Validation (TRL5)
- Develop Anticorrosion Coatings – Cadmium Replacement, but Wear and Erosion Properties Enhanced (TRL1) – Al, Si and Ti Oxides
- Thin Strip and Sheet Coatings – Corrosion, Wear Resistance, Self Cleaning
- Investigate Anticorrosion Coatings – Mg Coating Feasibility (TRL1)
- Anti Erosion Coatings – (TRL9)
Interest in Poland

Why Poland?

- Sizable domestic aerospace industry
- GTF plans for Polish NanoCoating Service Centre Aerospace Profiled
- R&D – High Skill Moderate Cost
- EU Incentives
- I was born in Poland 57 years ago

Darek Molenda - President and CEO holds Msc in Engineering. In 1980’s in senior management and consulting engineering positions in various Ontario manufacturing businesses in the area of surface science and organic thermal and radiation curable coatings. Since 1992 in thin film equipment and process development.

In 2001 he founded GTF Aerospace Inc., corporation committed to development and commercialization of nanotech coatings directly targeted to aerospace and aviation industries. He holds the rights in 8 USPTO applications as co inventor and inventor.

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