Moog Aircraft Group

Technology and Business Briefing

22 January 2015
Supporting Aerospace in the South West

Welcome to MOOG
Thursday 22nd January 2015

Simon Young
Chief Executive
Introduction

• Fire - exits
  - muster point
• First Aid
• Smoking
• Movement and safe areas
• Toilets
• Security
• Mobile phones
WEAF - Timings

08:45 Coffee and Registration
09:15 Welcome – Jonathan Murday / Simon Young
09:30 NATEP opportunities and programme update - Simon Young
10:00 Moog Company Overview Presentation – Jonathan Murday
10:30 Technology Challenges – Mike Baker / Ian Brooks
11:15 Coffee
11:35 Aircraft programmes – Richard Tamplin
12:00 Tour of Moog (3 groups colour coded)
13:15 Networking Lunch
14:00 Doing business with Moog – Stephen Fallon
14:30 Event Close
WEAF Briefing - Objective

- To expose the supply chain to the technology needs of the Moog business in order to allow those suppliers to determine their investment and engagement with Moog.
Moog Aircraft Group

NATEP

Simon Young - WEAF
NATIONAL AEROSPACE TECHNOLOGY EXPLOITATION PROGRAMME (NATEP)
Lifting Off with Technology - NATEP

Invest £40M in Aerospace Technology development
• Including £23M government funding from AMSCI

Committed over 4 years

To create and safeguard jobs...
• 1,200 jobs through 100 projects

To support technology development throughout the supply chain
## NATEP Timetable

<table>
<thead>
<tr>
<th>Timetable</th>
<th>Call 2</th>
<th>Call 3</th>
<th>Call 4</th>
<th>Call 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full application</td>
<td>23rd May 2014</td>
<td>7th November 2014</td>
<td>3rd March 2015</td>
<td>30th July 2015</td>
</tr>
<tr>
<td>Panel review / presentation</td>
<td>19th June 2014</td>
<td>25th November 2014</td>
<td>Mid March 2015</td>
<td>Early September 2015</td>
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</table>

### Diagram:

- **2013**
  - **CALL 1**
  - **CALL 2**
  - **CALL 3**
  - **CALL 4**
  - **CALL 5**

- **2014**
  - **CALL 1**
  - **CALL 2**
  - **CALL 3**
  - **CALL 4**
  - **CALL 5**

- **2015**
  - **CALL 1**
  - **CALL 2**
  - **CALL 3**
  - **CALL 4**
  - **CALL 5**

**Legend:**
- Outline Proposal
- Full Proposal
- Grant Award

**NATEP : An AGP Programme**

www.aerospace4growth.org.uk

www.natep.org.uk

www.NATEP.org.uk
### Call 4 Proposals

<table>
<thead>
<tr>
<th>Region</th>
<th>Number received</th>
<th>Number with bye to Full Proposal from Calls 2&amp;3</th>
</tr>
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<tbody>
<tr>
<td>FAC</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>MAA</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>NWAA</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>WEAF</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Wales</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>74</strong></td>
<td><strong>6</strong></td>
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</table>

### Projections

<table>
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<tr>
<th>Current calls 1,2&amp;3 total</th>
<th>Projected Call 4 total</th>
<th>After Call 4 projected total</th>
<th>Estimate Call 5</th>
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</thead>
<tbody>
<tr>
<td>15</td>
<td>6</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>12</td>
<td>27</td>
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<td>7</td>
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<td>14</td>
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<tr>
<td>8</td>
<td>14</td>
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<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>40</td>
<td>88</td>
<td>32</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>80</strong></td>
<td><strong>120</strong></td>
<td></td>
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</table>
SW aerospace cluster working together to realise the national aerospace agenda

Advanced Engineering and Technology
Targeted advanced Engineering and Technology capability

High Value Aerospace and Manufacturing Skills
Additional educational capability integrated with National strategies

Supply Chain Development and Enterprise
Additional capability to promote collaborative working and supply chain vitality

What is it?
- Begin with the end in mind

A Strategic approach to long term SW Aerospace capability development
Foundation Technology Themes

- Advanced assembly and automation
- Advanced composites application & integration
- Wing integration and optimisation
- Wing and engines systems integration
- Net shape manufacturing

Foundation technologies
Upcoming WEAF Events

• 28th January – Bribery Act Masterclass: BAESystems networking

• 3rd February – SME Skills for the Future

• 12th February – Better Business through Microscopy

• 25th February – WEAF Annual Conference

All details on agendas, pricing and venues available at www.weaf.co.uk/events
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West of England Aerospace Forum
and South West Energy Forum
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Clevedon,
North Somerset BS21 6UP

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Moog Aircraft Group

Company overview
Jonathan Murday – Director Business Development and Programmes
Moog Aircraft Group – WEAF Briefing
22 January 2015

Moog Proprietary and/or Confidential Data
• Founded in 1951 by Bill Moog
• Medium-size, multinational
  – $2.65B sales in FY’14
  – 100+ locations in 27 countries
  – Over 11,000 employees
• Traded on the New York Stock Exchange (MOG-A)
• People-oriented environment with emphasis on individual responsibility
• Reputation for high quality and technical excellence
### Reporting - Five Operating Segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>FY ’14 Sales</th>
<th>% of Total</th>
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</thead>
<tbody>
<tr>
<td><strong>Aircraft</strong></td>
<td>$1140 MM</td>
<td>43%</td>
</tr>
<tr>
<td><strong>Space &amp; Defense</strong></td>
<td>$398 MM</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td>$583 MM</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Components</strong></td>
<td>$424 MM</td>
<td>16%</td>
</tr>
<tr>
<td><strong>Medical</strong></td>
<td>$106 MM</td>
<td>4%</td>
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</tbody>
</table>

#### Segments Overview

- **Aircraft**
  - Military Aircraft
  - Commercial Aircraft
  - OEM and Aftermarket

- **Space & Defense**
  - Space
  - Defense
  - Security & Surveillance

- **Industrial**
  - Energy
  - Industrial Automation
  - Simulation and Test

- **Components**
  - Slip Rings & Motors
  - Market Focus Overlaps
    - Aircraft
    - Space / Defense
    - Industrial
    - Marine
    - Medical

- **Medical**
  - IV Pumps
  - Enteral Pumps
  - Administration Sets
  - Sensors
  - Handpieces

*2014 revenue range of $2.65 MM*
## Significant Presence on Major Platforms

### Military

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>System Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-35</td>
<td>Primary flight control actuation system, High-lift actuation system</td>
</tr>
<tr>
<td>V-22</td>
<td>Complete primary flight control actuation system, Active vibration suppression controls</td>
</tr>
<tr>
<td>Black Hawk/Seahawk</td>
<td>Pitch-trim actuation system, Vibration control actuation system</td>
</tr>
</tbody>
</table>

### Commercial

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>System Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>787</td>
<td>Complete primary flight control actuation system, Complete high-lift actuation system</td>
</tr>
<tr>
<td>A350 XWB</td>
<td>Complete primary flight control actuation system, Trailing edge flap controls</td>
</tr>
<tr>
<td>COMAC C919</td>
<td>High-lift actuation system</td>
</tr>
</tbody>
</table>
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22 January 2015

Moog Proprietary and/or Confidential Data

Aircraft Group Offering

• Integrated Flight Control Systems
  – Primary & Secondary Flight Control Systems
  – High Lift Systems
  – Maneuvering Leading Edge Systems

• Critical Control Applications
  – Engine Controls
  – Active Vibration Control
  – Weapons Bay Door Drive
  – Navigation & Guidance
  – Specialty Control Actuation

• Critical Control Products
  – Flight Control Computers & Software
  – Cockpit Controls
  – Control Electronics & Power Drives
  – Actuators – All Technologies
  – Sensors
  – Related Components
• Integrated Flight Control Systems
  – Actuation, Electronics & Software
  – Hydraulic, EM & EHA Technology
  – Design, Qualify & Certify

• Engine Controls & Specialty Actuation
  – Products & Component Solutions

• Leadership position on world’s next generation of commercial transports & business jets
UK interests of Moog

- 5 main operating sites
- Turnover > £240M for all subsidiaries
- ~ 1200 personnel
- >70% exported
- Engineering and manufacturing Ops
- Aerospace, Defence and Industrial
- Over £200M of investment in UK in last 5 years

Aerospace – Civil, Military, Engine Controls, R&O

- Located Tewkesbury, Wolverhampton & Luton
- Potential for continued inward investment
Aircraft Control Components (ACC) Sector

- Engine Controls
- Flight Control Valves
- Braking & Steering Controls
- Pneumatics

Locations:
- Tewkesbury
- Baguio
- East Aurora

Departments:
- Operations
- Engineering
- Business
- Finance
- UK QA & HR
- Operations PE
- PH QA & HR
- Operations EA QA & HR
Tewkesbury product range
Moog Aircraft Group

Aircraft Programmes
Richard Tamplin – Chief Engineer
Flight Controls – Commercial Aircraft

- 787
- 777
- 767
- 757
- 747
- 737
- A380
- A350
- A340
- A330
- A320
- A319
- Citation X
- Hawker 4000
- Challenger 604
- Challenger 300
- G650
- G550
- G450
- G250

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Moog Proprietary and/or Confidential Data
Boeing 787 Primary Flight Controls

- Elevator: Quantity = 4
- Rudder: Quantity = 3
- Stabilizer with Controllers (2): Quantity = 1
- Aileron: Quantity = 4
- Flaperon: Quantity = 4
- SREU: Quantity = 10
- REU: Quantity = 15
- Spoiler Surface Resolver: Quantity = 14
- EM Spoiler & Controller: Quantity = 4
- Outboard Spoiler: Quantity = 6
- Inboard Spoiler: Quantity = 4
Boeing 787 High Lift System

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Moog Proprietary and/or Confidential Data
Embraer 190EV – Complete Flight Control System

- Aileron
  Quantity = 4

- Elevator
  Quantity = 4

- Rudder
  Quantity = 3

- Multi-Function Spoiler
  Quantity = 2

- Air Brake Control Lever
  Quantity = 1

- Flight Control Computer
  Quantity = 3

- Ground Spoiler Control Module
  Quantity = 5

- Ground Spoiler
  Quantity = 4
Flight Controls – Military Aircraft

- F-35
- V-22
- F/A-18 E/F
- X-47B
- B-2
- F-15E
- F-16
- F/A-18C/D
- LCA
- T-50
- JAS Gripen
- F-2
- C-5
- A400M
- C-27
- CX/PX
- UH-60
- Lavi
- IDF
- Typhoon
F-35 B Lift Fan Actuation System

Variable Inlet Guide Vane Linear Actuator
Variable Inlet Guide Vane Control Valve Block
Variable Area Vane Box Nozzle Control Valve Block
Nozzle Cooling Valve Actuator
Transfer Gearbox
Variable Area Vane Box Nozzle Linear Actuator
Variable Area Vane Box Nozzle Rotary Actuator
3 Bearing Swivel Module

*Part location and orientation is approximate
F-35 A/B Primary Flight Control & LEFAS

Horizontal Tail Electronic Control Unit

Leading Edge Flap Electronic Control Unit

Flaperon EHA

Leading Edge Flap Power Drive Unit

Outboard Position Sensor

Asymmetry Brake
F-35 C Primary Flight Control, LEFAS, Wingfold

F-35 C Primary Flight Control, Leading Edge Flap and Wingfold System

Horizontal Tail Electronic Control Unit

Leading Edge Flap Electronic Control Unit

Flap Electronic Control Unit

Flap Electronic Hydraulically Actuated Actuator (EHA)

Rudder Electronic Control Unit

Leading Edge Flap Power Drive Unit

Outboard Position Sensor

Asymmetry Brake

Fold Box

Wingfold Transmission

Note: Locations and extensions are approximate.
V280 JMR Concept Demonstrator

- MAIN ROTOR ACTUATOR
  - X6 (3 servos per)

- RUDDERVATOR
  - X2 (3 servos per)

- FLAPERON
  - X6 (1 servo per)
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Site Tour
Site tour

• 3 Groups – colour coded

• Blue – Andy Yuill
• Red – Nick Hall
• Yellow – Greg Mason

• Three areas of the business – A&T, Fit and null, core machining

• Approx 20 mins per area, then move around
Moog Aircraft Group

Doing Business with Moog

Stephen Fallon – Procurement Manager
Presentation Overview

- Moog’s business shift

- Moog’s new organisation and sourcing strategy

- Strategic supplier expectations

- Sourcing approach

- Supplier development and performance management
Business Shift

• There has been a shift from “Cost Based” pricing to “Market Based” pricing. Our customers determine the selling price.
  
  – Targets are assigned by dividing deliverable hardware into labour and components

• Moog has made a purposeful shift from a Manufacturing Company to a Global Supply Chain Company
  
  – Shift from 80% “make” to 80% “buy”

• Moog is currently transferring business from job shops to innovative best in class low-cost manufacturing companies

• Moog needs innovative low-cost suppliers that we can partner with and who can grow with us
Supply Chain Global Organisation
Supply Chain Global Organisation
Strategic Suppliers

SUPPLIER DIFFERENTIATION

100% On Time Delivery
100% Quality
Safety Stock
Blanket Purchase Orders
Frozen Processes
Dock-to-Stock Supply

Innovation
Strong Engineering Staff
Short Development Time
World Class Manufacturing

Invest in Nonrecurring Cost
Long Term competitive Pricing
Share associated business Risks

Basic set of expectations
Not a differentiator

Technical Capability is not a Differentiator

Risk sharing
Is the Key Differentiator

PARTNER SUPPLIER REWARDS

Large Content on long-term programs
First offer for new opportunities
Grow as Moog grows

Partner suppliers take the same steps Moog has taken to secure long-term stable business.
Strategic Suppliers

- Business Risk Sharing

- Partners need to have long range interests in being a supplier with significant value additions.

- Partners should have an investment plan for:
  - Manufacturing facilities and technologies
  - People
    - Skill levels that are required for absorbing the technology quickly and developing in the future
  - Tools
    - ERP and beyond
    - Project Management: Manage the capacity ramp up for first articles and production to meet high aerospace volume.
  - Process
    - Quality management and Beyond: Similar to Level 5 maturity for Services
    - Continuous flow lines dedicated to Moog
    - Online gauging, SPC, Stable mature production process with Cpk of 2.0

- Moog will commit to a long term future with the supply base
Supplier Expectations

• High degree of complexity/ tolerance expectations (inspection min 10x to 20x is normal)

• Suppliers able to grow to take 5 - 10% of commodity spend ($5m USD) in the future

• Suppliers where Moog will not be more than 20-30% of the suppliers total business.

• Suppliers who will hold 6 to 8 weeks of buffer stock finished ready to ship

• 98%+ OTD minimum and deliver 99.5% Quality (5000 PPM)

• Weekly delivery performance management reporting (safety stock and delivery commit)

• Actively support Moog to reduce cost of critical components – DFMA, continuous improvement, six sigma approach
External Machined Profile

- Increased spend due to:
  - Shift to 80% buy
  - New business
  - Acquisitions
Moog Support Means...

- **Manufacturing Engineering**
  - Operation Sheets (when available)
  - Tool, Fixture & Gage drawings and/or duplicates when available
  - Proactive / On-Site Support as required

- **Lean and Six-Sigma**
  - Assessing process work flow and implementing Lean/Six Sigma. Moog’s Process Improvement Consultancy Team will recommend actions, projects and programs that enhance improvement activities within your facility.
  - Demonstrating an active, collaborative working relationship between the supplier and Moog partners associated with this manufacturing approach

- **Materials Management**
  - Capacity Planning
  - Forecast
  - Raw Materials Agreement
  - OSP Agreement
Summary

• Moog is a growing company through acquisition and organic growth.

• The aircraft market has shifted from “cost based” pricing to “market based’ pricing. This requires “low cost economy” production and risk sharing through the entire supply chain.

• Moog is outsourcing more $ then ever.

• Moog has transitioned from 80% make to 80% buy.

• Many opportunities for partner suppliers who are aligned with demanding aircraft business conditions.

Suppliers who can demonstrate risk sharing ability will share in Moog’s business growth
Moog Aircraft Group

Questions?