Accommodating the 21st century pilot: The Human Factor in Ejection Seat restraint

Pete Marston
Human Factors Engineer

Paul Adams
Human Engineering Manager

Martin-Baker Aircraft Company Ltd.
Contents

▼ Case study – restraint system upgrade
▼ Headline figures of increased population accommodated
▼ Cockpit accommodation assessment
▼ Ergonomic aids
▼ Generation 5 Integrated harness
▼ QRBs – safety and training considerations
Restraint system upgrade
Increased flying population

- Initial aim = increased mass range
- Increased mass range = increased size range?
- Increased size range = restraint system modifications
## Increased population accommodation

<table>
<thead>
<tr>
<th></th>
<th>PC7 MkII</th>
<th>Hawk Mk120</th>
<th>Gripen JAS39</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td><strong>Front Cockpit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>75%</td>
<td>62%</td>
<td>62%</td>
</tr>
<tr>
<td>Post Mod</td>
<td>93%</td>
<td>92%</td>
<td>87%</td>
</tr>
<tr>
<td><strong>Rear Cockpit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>68%</td>
<td>40%</td>
<td>56%</td>
</tr>
<tr>
<td>Post Mod</td>
<td>93%</td>
<td>77%</td>
<td>87%</td>
</tr>
</tbody>
</table>

- Percentage of overall population accommodated before and after modification programme

© Martin-Baker Aircraft Co. Ltd. 2014.
Cockpit accommodation assessment
Small subject accommodation

▼ Small subjects:
  ▼ Over-nose vision
  ▼ Arm reach
  ▼ Leg reach
Large subject accommodation

- Large subjects:
  - Head clearance
  - Shin clearance both operationally and during ejection
Regression to find limits

- Over-nose vision
- Minimum Sitting Eye Height

- Shin clearance
- Maximum Comboleg

© Martin-Baker Aircraft Co. Ltd. 2014.
Multivariate anthropometry

- Case sizes rather than percentiles
- Understanding that body proportions vary
- Effect of one measure on another
- Hard versus soft limits
Variation in arm reach

© Martin-Baker Aircraft Co. Ltd. 2014.
Variation in arm reach

Additional section not accommodated by traditional methods

Not accommodated
Variation in leg reach

Not accommodated
Variation in leg reach

Additional section not accommodated by traditional methods

Not accommodated
Anthropometric modifications
Anthropometric modifications

- Modified Sitting Height range
- Improved comfort

© Martin-Baker Aircraft Co. Ltd. 2014.
Anthropometric modifications - 2

▼ Improved reach using:
  ▼ Tilting seat
  ▼ Translating back rest
  ▼ Role fit back rest
  ▼ Role fit spacer

▼ Safety considerations:
  ▼ Change of CoG

© Martin-Baker Aircraft Co. Ltd. 2014.
Restraint Systems
Restraint systems

Gen 1 & 2

- Improved suspension geometry
- Increase anthropometric range
- Reduced helmet / riser interaction

Gen 5

© Martin-Baker Aircraft Co. Ltd. 2014.
Restraint systems

Generation 5 Integrated Harness:
- Improved comfort and fit
- Designed to fit Case sizes 1 to 8
- Latest Quick Release Box (QRB)
- Improved strapping in procedures
- Maintains (vertical) suspension angle

© Martin-Baker Aircraft Co. Ltd. 2014.
QRB – Safety and Training

- Consistent procedures
- Either hand operation
- No potential errors in operation

PC-7 MkII
Hawk

Gripen

All aircraft post mod

© Martin-Baker Aircraft Co. Ltd. 2014.
MWARS

- Martin-Baker Water Activated Release System
- Automatic harness release on sea water entry
- Qualified and in-service on F-35

© Martin-Baker Aircraft Co. Ltd. 2014.
Summary

- Improved cockpit accommodation assessment using multivariate anthropometry
- Hard versus soft accommodation limits
- Ergonomic aids used to improve accommodation
- Generation 5 Integrated harness
- QR Bs – safety and training considerations
Questions?
Next Event:

▼ Mk17 Ejection Seat demo at the Martin-Baker stand at 3pm