MATLAB APPS & TOOLBOXES AT JAGUAR LAND ROVER
MATLAB EXPO – 5TH OCTOBER 2016
David Barry
Simulation Strategy & Tools | Simulation Group | Vehicle Engineering
Agenda

• Virtual Engineering Introduction
• MATLAB at Jaguar Land Rover
• How MATLAB tools are distributed throughout the organisation as apps and toolboxes using an in-house store
• Best practices for MATLAB tool development and how they are shared and encouraged
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11 vehicle lines.

3 UK vehicle assembly plants, with 2 UK design and engineering sites.

Nearly 40,000 people globally – headcount has almost doubled over the last five years.

Plants in China, India and Brazil.

Employs over 9,000 engineers and designers.

Sales network in 154 countries.

Jaguar Land Rover is the largest automotive employer in the UK.

150 awards won in 2015/16.
The Challenge for Engineering

10,000 Requirements
100,000 Test Cases
18 Customer attributes: e.g. Ride & Handling, Performance & Economy
Massively increased Systems Complexity
100 ECUs
>100 Millions of lines of code
1000s New Parts
55 Major Systems
1,200 features
4500 Data Signals
Refreshed 100*/Sec
154 Global Markets
10,000 Requirements
100,000 Test Cases
Massively increased Systems Complexity
100s New Leading Edge Technologies
100s New Leading Edge Technologies

“More Great Product Faster”
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MATLAB at Jaguar Land Rover

- Best in class tool – professionally developed & supported
- Highly productive and integrated environment for engineers to do their job
- Toolboxes provide out of the box capability for specialist engineering tasks
- Framework to build our own tools
The Code Sharing Challenge

- Strategic partnership with MathWorks helped to develop an internal MATLAB user community
- Recognised opportunities for code sharing and consolidation
  - No consistent way to share code across the business
  - Non-value add overhead for developers to maintain custom code sharing mechanisms
  - Difficult and time consuming for new users to get started
  - Difficult to know what is available - duplication of effort across teams

- MathWorks Consulting helped us to develop a solution – JLR MATLAB App Store
Many departments manage all of their automation routines through centralised toolboxes.
JLR Apps & Toolboxes
- Examples

- Vehicle diagnostics analysis – 2 similar apps on the store – common code now part of central toolbox
JLR Apps & Toolboxes
- Examples

- Toolbox for centralised development of data structures & file handlers
JLR Apps & Toolboxes
- Examples

• Apps for managing and sharing models & engineering data
• Apps for testing Simulink models
JLR App Store
- Examples

- Event extraction & metric calculation
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MATLAB Apps & Toolbox Packaging

- MATLAB Apps & Toolbox technology provide the mechanisms for packaging our code
JLR App Store Features
- Web based store
## JLR App Store Features

### - App Manager

![App Manager Screenshot](image.png)

<table>
<thead>
<tr>
<th>App Name</th>
<th>Installed Version</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>JLR Test Framework</td>
<td>1.7.2</td>
<td></td>
</tr>
<tr>
<td>Java Widgets Toolbox</td>
<td>1.6.1</td>
<td></td>
</tr>
<tr>
<td>MSBuild Test Runner</td>
<td>1.1.3</td>
<td></td>
</tr>
<tr>
<td>Metrics Toolbox</td>
<td>1.1.2</td>
<td>Upgrade to Latest</td>
</tr>
<tr>
<td>Model Repository Browser</td>
<td>2.3</td>
<td>Upgrade to Latest</td>
</tr>
<tr>
<td>Pardus</td>
<td>1.4.1</td>
<td></td>
</tr>
<tr>
<td>Roadrunner</td>
<td>1.2.0</td>
<td></td>
</tr>
<tr>
<td>VCF Compose</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Vehicle Feedback Analyzer</td>
<td>1.6.6</td>
<td>Downgrade to Compatible</td>
</tr>
<tr>
<td>Vehicle Feedback Toolbox</td>
<td>1.6.6</td>
<td></td>
</tr>
<tr>
<td>Driving Sim VBox Control</td>
<td>Net Installed</td>
<td>Install Recommended</td>
</tr>
<tr>
<td>Driving Sim VBox Control</td>
<td></td>
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</tr>
</tbody>
</table>

### Available Versions

**Version:** 1.2

**Name:** Driving Sim VBox Client

**Version:** 1.2

**Author:** Simulation Group

**Summary:** Video VBox client interface for use on Driving Simulator rig

**Compatibility:** R2015b and later

**Description:** Video VBox client interface for use on Driving Simulator rig. This relies on the Video VBox control interface application.

**Recommended by:** Chappell, Paul (P.A.)
JLR App Store
- Usage > Number of submissions
JLR App Store
- Usage > Number of users

![Graph showing the number of users over time from May 2015 to Oct 2016. The number of users increases gradually, reaching approximately 1200 by Oct 2016.](image)
JLR App Store
- Usage > Number of downloads
JLR App Store
- Usage > Number of downloads

App Store - Total Number of Downloads
1st May 2015 - 1st October 2016
JLR App Store
- Benefits

• Accelerate adoption of existing tools by new users
• Reduce duplication
• Improve quality & usability
• Reduce time spent on non-value-add tasks
• Encourage and recognise sharing of high-impact tools
• Educate developers
App Store Future Development Plans

- Approved Apps & Toolboxes – check for JLR coding standards and best practices

- Integrate the store with automated testing environment

Jenkins
App Store Future Development Plans

- Continue to engage with MathWorks developers for enhancements to MATLAB
- Add-On Explorer integration with JLR store
- Manage custom toolbox dependencies
- Improvements to App Designer
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Writing MATLAB Tools
- JLR best practices

• Apps are hand-written using GUI Layout Toolbox for positioning & resizing
• Apps should follow the Model View Controller (MVC) design pattern
• Use a consistent look and feel for user interfaces
• Make use of GUI mockup and architecture/class diagram tools for large projects
Writing MATLAB Tools - JLR best practices

• Use a source control and bug tracking tool

• Use a consistent naming convention

• Know your end-user – casual vs developer interfaces

• Use MATLAB Unit Testing Framework
Writing MATLAB Tools
- JLR best practices

- Develop a standard toolbox to group together data structures and file handlers
- Document all of your code as you write it
- Use MATLAB custom documentation to provide help and examples for your own toolboxes
Writing MATLAB Tools
- Sharing best practices

- User guides & how-to videos on the App Store
- On-site MathWorks training including JLR custom courses for OOP & app building
- MathWorks consulting projects
- Internal go-to experts
- Monthly lunch & learn events
- Internal WebEx sessions
- Website & blog for internal MATLAB user community
THANK YOU

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