You Can Have It All: The Customizable Standard Data Analysis Process

Using Metadata to Drive Your Process

Toyota FT-1
**Agenda**

- Intro to Toyota, Fun Facts
- The Toyota Way, Toyota Production System and Standardization
- Body and Chassis Reliability - Vehicle Measurement Example
- Challenge/project scope
- Process Efficiency Improvement
- Customizable Standard Process Overview
- Metadata Example
- Conclusions
Intro to Toyota Motor Engineering and Manufacturing North America

Toyota in the US

70% of the vehicles sold in the U.S. are built in the U.S.

1,334,691 vehicles produced

1 Toyota vehicles and components are assembled using U.S. and globally sourced parts.

365,000 jobs created in the U.S.

2 2011 Center for Automotive Research Study. Includes direct dealer and supplier employees and jobs created through their spending.

$21.2 billion direct investment in the U.S.

Toyota Principles are shared and used to help non-profits and small businesses achieve success.

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What is standardization?

Companies have methods they call “standards,” but it’s not what Toyota means by using the term “standardized work” to define the method used to perform work tasks with the least amount of waste.
Body and Chassis Reliability - Vehicle Measurement Example

Instrument Vehicle and Measure on Different Surfaces

- Vehicle Accelerations
- Strain (Local Strain, Calibrated Input Force)

Measurement data consists of many different files and data from each surface may require different processing (filter parameters, plots, tables, etc). Standardization in data analysis is the key to efficient vehicle development.
Challenge/project scope

- Develop a **standard** process that can adapt depending on the type of output required
  - Reduce the amount of N-code flows (each of which require some maintenance due to version upgrade, correction of bugs, evolution of data processing method, etc)
  - Reduce waste by only requesting output that is needed
  - Take advantage of common elements of data analysis process

- Retain **customization**
  - Create output that matches reporting need

- **Reduce total manual activity**
  - Run multiple files in batch mode to save time running N-code
  - Provide N-code flow information about how plots should be titled and what channels should appear on each plot so they are created as part of the process
To improve efficiency, we greatly reduced manual involvement in data processing by including process control instructions and using batch processing.
Customizable Standard Process Overview

Process Inputs
① Input all time series files
② Input single metadata file

Process Customization Features
② Test Splitter + Time Extraction used to trim time history using File Metadata.
③ Test Splitter Glyphs used to activate selectable modules using File Metadata
  - When modules are not used, the data flow is disabled.
④ Channels reordered for plot customization using Channel Metadata
⑤ An additional Test Splitter is used to generate plots only for specified channels using Channel Metadata

Test splitters are used to activate modules based on metadata specs

File and Channel Metadata are used to control process and get customized output with reduced manual activity.
**Metadata Example**

**File Metadata**

- For each data file, metadata is used to determine which modules are executed

### NEW Plot Customization

### Analysis Customization

### NEW Output Customization

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Plot Title</th>
<th>Proving Ground</th>
<th>Mass Condition</th>
<th>Surface Name</th>
<th>Driving Event</th>
<th>Filter Type</th>
<th>Cut-off Freq 1</th>
<th>Cut-off Freq 2</th>
<th>Data table format</th>
<th>Calculate Damage</th>
<th>Output Cumulative Curves</th>
<th>Output PSDs</th>
<th>Output time histories</th>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>160_channels_out</td>
<td>SLM No. 1</td>
<td>TTC Check Road</td>
<td>Cond 1</td>
<td>Smooth Road</td>
<td>Rapid Start</td>
<td>LowPass</td>
<td>600</td>
<td>max-min</td>
<td>N</td>
<td>n</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>50</td>
<td>250</td>
</tr>
<tr>
<td>160_channels_out2</td>
<td>SLM No. 2</td>
<td>TTC Check Road</td>
<td>Cond 2</td>
<td>Smooth Road</td>
<td>Figure 8</td>
<td>LowPass</td>
<td>600</td>
<td>max-min</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>160_channels_out3</td>
<td>SLM No. 3</td>
<td>TTC Check Road</td>
<td>Cond 1</td>
<td>Smooth Road</td>
<td>Rapid Stop</td>
<td>LowPass</td>
<td>600</td>
<td>max-min</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>45</td>
<td>500</td>
</tr>
<tr>
<td>160_channels_out4</td>
<td>SLM No. 4</td>
<td>TTC Check Road</td>
<td>Cond 2</td>
<td>Smooth Road</td>
<td>Circle Turn</td>
<td>LowPass</td>
<td>600</td>
<td>max-min</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>79</td>
<td>670</td>
</tr>
<tr>
<td>160_channels_out5</td>
<td>SLM No. 5</td>
<td>TTC Check Road</td>
<td>Cond 1</td>
<td>Smooth Road</td>
<td>Speed Bump</td>
<td>LowPass</td>
<td>600</td>
<td>max-min</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160_channels_out6</td>
<td>SLM No. 6</td>
<td>TTC Check Road</td>
<td>Cond 2</td>
<td>Rough Road</td>
<td>Std Rough Road</td>
<td>BandPass</td>
<td>2</td>
<td>400</td>
<td>long</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160_channels_out7</td>
<td>SLM No. 7</td>
<td>TTC Check Road</td>
<td>Cond 2</td>
<td>Rough Road</td>
<td>Wave Road</td>
<td>BandPass</td>
<td>2</td>
<td>400</td>
<td>long</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Channel Metadata**

- Some output is needed only for specific channels, not the entire file

### NEW Plot Customization

<table>
<thead>
<tr>
<th>Channel No.</th>
<th>Channel Name</th>
<th>Plot Number</th>
<th>Ch Order</th>
<th>Cumulative Curve Title</th>
<th>PSD Title</th>
<th>Output time history</th>
<th>Time Slice (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chan 1</td>
<td>1</td>
<td>1</td>
<td>Cumul Title 1-1</td>
<td>PSD Title 1-1</td>
<td>N</td>
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</tr>
<tr>
<td>2</td>
<td>Chan 2</td>
<td>1</td>
<td>2</td>
<td>Cumul Title 1-2</td>
<td>PSD Title 1-2</td>
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<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Chan 3</td>
<td>1</td>
<td>3</td>
<td>Cumul Title 1-3</td>
<td>PSD Title 1-3</td>
<td>N</td>
<td></td>
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<tr>
<td>4</td>
<td>Chan 4</td>
<td>1</td>
<td>4</td>
<td>Cumul Title 1-4</td>
<td>PSD Title 1-4</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>Chan 5</td>
<td>2</td>
<td>1</td>
<td>Cumul Title 2-1</td>
<td>PSD Title 2-1</td>
<td>Y</td>
<td>8</td>
</tr>
</tbody>
</table>

By deciding what output is needed in advance and front-loading metadata setup, the process execution time is ultimately reduced.
Conclusions

✓ Finally, we developed a process using N-code that can take common elements of our data analysis and create a STANDARDIZED data process that can accommodate most of our needs.

✓ The process is completely CUSTOMIZABLE, so the output matches our desired reporting format.

✓ Batch processing and front-loading INCREASES EFFICIENCY.

Multiple Flows  →  Customizable Standard Flow


Man hours  →  Front-load  →  Previous  →  New  →  Time
Questions?
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