Using GlyphWorks to Create a Composite Random Vibration Profile from Field Acceleration Data

Lisa Meegan
Hardware Test Engineer
John Deere Intelligent Solutions Group
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Displays

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Operator Station
ISG Global Locations
The Challenge

Develop a random vibration test that covers
• Multiple vehicle platforms
• Multiple mounting locations
• Crop condition, soil condition and other external factors

Without being overly conservative
Process

- Define use cases that represent significant vibration to the product
- Gather acceleration data for each use case
- Perform a damage analysis to find the worst use case
- Use the datasets from the worst use case to develop the test
- Apply the duty cycle
- Output a field level random vibration profile

Glyphworks can do this efficiently using standard processes
Define Use Cases

- **Vehicle**
  - Where is the device mounted?
  - How is the device oriented?
- **Operation**
  - What is the vehicle doing?
- **Environment**
  - What are the ground conditions?
  - What crop is in contact with the machine?
Gather Acceleration Data

- Take acceleration data for each use case
- If possible, plan all of your data gathering to use common instrumentation, units of measure, sampling rates, axes orientation and channel numbering schemes
Check and Pre-Process Your Data

**Units of Measure**
- Make sure all of the acceleration data is expressed in common units

**Channel Numbering**
- Make sure that the channel numbering is consistent across datasets

**Check for Anomalies**
- Check each dataset for anomalies and edit or discard if found
Identify Worst Case

- Calculate relative damage per unit time for each run of data.
- Select most damaging run for each use case.
- Calculate lifetime damage for each vehicle.
- Base test on vehicle with highest lifetime damage.
Calculate Relative Damage

Used Standard Process “Relative Damage” as a starting point
Summarize Damage Profile by Use Case

- Copy and paste from Glyphworks metadata display into spreadsheet
- Identify run with highest damage per second for each use case/axis
- Use these runs for the next calculations

<table>
<thead>
<tr>
<th>Worst Case for Driving with Rows</th>
<th>Chan</th>
<th>Chan Title</th>
<th>Damage per Run</th>
<th>Damage per Second</th>
<th>Test Duration (sec)</th>
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</table>
Roll Into Damage Profile by Vehicle

- Calculate lifetime damage by applying duty cycle as a percent of life or # of occurrences and the design life
- Identify vehicle with highest lifetime damage
- Use data from this vehicle to generate the test
Create the Random Vibration Profile

- Now that we know which vehicle has the most vibration damage over its design life, we make a shaker test to impart the same damage.
- Use a custom process derived from the Glyphworks worked example 11 “Creating Accelerated Vibration Fatigue Tests”
  - Generate FDS for each run, using fatigue parameters from weakest material.
  - Create a schedule combining all of the FDS files.
  - Generate a PSD for each axis using the Test Synthesis glyph.
Calculating Fatigue Damage Spectra

ShockResponseSpectrum Properties

- **General**
  - Minimum Frequency: 5
  - Maximum Frequency: 2500
  - Linear/Lin Bin: Log/Log Bin

- **Input Data**
  - Input Units: Auto
  - Repeat Count Source: Meta Data
  - Custom Repeat Count: 1

- **Dynamic Settings**
  - Response Type: Acceleration
  - Response Values: A
  - Dynamic Amplification Q: 200
  - Spring Stiffness: 4

- **Fatigue Settings**
  - SN Coefficient Format: SN Coefficient Format
  - SN Coefficient A: 1
  - SN Coefficient C: 1

Fatigue Damage Spectra

Legend

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<th>Marker</th>
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</table>
Creating a Mission Profile using Schedule Create

Apply duty cycle weighting either for lifetime total repeats or a unit time total with # repeats being a fractional percent.
Creating a Field Level PSD

Set time to reflect either life or unit time, depending on how you did the schedule – BE CONSISTENT
Next Steps

- Copy and paste PSD display into spreadsheet
- If using this for a virtual test (fatigue analysis), provide as is.
- If using this for a lab shaker test,
  - Reduce number of data points to 30 or less, keeping the Grms the same.
  - Accelerate the test to fit available time
    - This can be done in Glyphworks, but we stop there at JD.
Thank you!

Lisa Meegan
Hardware Product Validation & Verification
John Deere Intelligent Solutions Group
Tel. +1 (515) 253-6611
meeganlisaa@johndeere.com