Michigan Alliance for Greater Mobility Advancement

Course Title: Validating Requirements and Improving Specifications with Telematics Data

Course Length: 2 days

Time Online: N/A

Time in Class: 16 hours

Time in Lab: N/A

Class Size: Minimum 5 / Maximum 24

Price Per Student: $1,940.00*

Location: Company Site

Course Description:

By attending this course, participants will be able to:

- Define different types of data in Telematics.
- Determine the need and ways to standardize data metrics
- Determine the best probability distributions to describe counting or continuous data for a group of vehicles

Course Syllabus

Day One

- Greeting and Introduction
  - Tools: Laptop (or desktop); MS Office, Minitab
  - Need for company software to store, retrieve, and provide analytic tools.
- Privacy Security Issues
  - People are concerned about their privacy; afraid of Big Brother, Corporations
  - A new threat: Hacking
  - Who has access to the data? What type of data is available?
- Could data be subpoenaed for crash information? Could GPS and time information be used in trials?
  - Engineers use data to understand events around fault codes, part interactions
  - Use to define mission profiles and lifetime usage
- The Cost of Quality
  - Prevention Costs to prevent problems from occurring – Specifications, Requirements Validation, Product Verification, SPC
  - Appraisal Costs – Testing,
  - External Failure Costs – warranty, litigation, customer satisfaction, breach of contracts
  - Internal Failure Costs – scrap, rework, material costs

* Price based on minimum enrollment, subject to change

- Review common requirement sources: Prior similar product, expert opinion, customer surveys, management direction, program timing limitations, data driven requirements
- Systems Approach
    - An interdisciplinary approach to System Requirements Definition; Product Development; Verification; Life Cycle; Project Management; and the technical disciplines (electrical, mechanical…)
    - Methods:
- Define the Mission, operating concept, or functional improvement/changes
- Define Requirements from multiple sources (customers, House of Quality
- P-diagram focuses on inputs/outputs to system element
- Define interfaces and interactions between system elements (functions, faults)
    - Telematics Analysis will assist to
- Define the product life
- Develop Valid Requirements and a Verification Plan to meet product requirements

Day Two

- Review/ Recap / Questions
- Data Review
    - Millions of data records and missing channels
    - Intermittent data prevents time series analysis (graphic example)
    - Suggest a statistical approach
- Count Events
- Continuous Variables
- State Variables
- Multi-Variables
- Transmission Example
- The analysis of event counts, across a vehicle population, develops validated targets for different vehicle usage parameters
    - Count Examples: engine starts, vehicle start/stop cycles, trip count, operating days, door open/close cycles
- Equally weight vehicle with standard metrics: trips/day, miles/day, events/day, events/mile
- Projection to different design targets expressed as years, miles, cycles
    - Examples: Trip and Operating days data, Histogram of Trips or Days, Scatter Plot of Trips vs. Days, Standardize Trips/day, Median Rank Plot
- From the probability distribution plot project the 5th, 50th and 95th percentiles for engineering validated requirements
- Comparison of continuous variables by determining high stress usage patterns and low stress usage patterns
    - Vehicle speed, engine torque, engine speed, voltage, accelerometer readings, engine temperature, brake pressures, accelerator pedal position
- Data issues
    - CAN data was highly intermittent, preventing time series analysis of the data. The solution was to consider each reading as a statistical sample
- Compare how different vehicles may have very different total usage by using a percentile histogram. Examples include histogram plot issues, median rank plots, cumulative distributions, Minitab distribution ID Plot, distribution analysis, overlay of CDFs and percentile analysis

- Review state variables such as door open/closed/locked, transmission gear state, PRNDL position, switch state
- Transmission Example:
    - Markov analysis and model discussion
- Review frequently encountered multi-variable problem
    - Define torque and rpm intervals to bin the data into cells
    - Raw data is the number of 1-second counts in an array of torque-rpm cells
    - Standardize the data by dividing the count in each cell by the total counts
    - A contour plot is useful for displaying the usage pattern for a vehicle or the average across a fleet.
    - Compare contour plots for different fleets, dynamometer tests
        - Extend the data to components
- Engineering design information required to perform a cumulative damage analysis for an individual vehicle
- Comparison of cumulative damage across a fleet of vehicles to determine percentiles of the distribution
- Extend the comparison to vehicle dynamometer testing
- For practical work use a 3-parameter model gear x engine torque x engine speed
- Use public data to calculate torque x speed for each gear state
- Gear design information is needed to calculate fatigue damage – stress levels, cycles, gear profile
- Develop equation to calculate time at torque x rpm for each gear
- Design engineer can combine the usage and design information to estimate cumulative damage over 150,000 miles or another target
- Combine vehicle damage results for a fleet
- Compare the 95th percentile to dynamometer tests