Analysis of Vehicle Door Closing Effort Dimensional Issues

PolyWorks Conference USA 2015

Christopher Purdy  Scanning Technical Lead
General Motors
Manufacturing Engineering
Global Dimensional Center
April 15, 2015
Presentation Agenda

• Door closing effort
  • Metrics
  • Design variables
  • Engineering Methods

• Previous solution efforts
• Problem solving using PolyWorks IMInspect
• Example scanning setups
• Example data
• PolyWorks functions used
• Summary
• Q&A
Door Closing Effort

The physical effort required by a customer to close an automotive door.

- Must close smoothly and with minimal consistent effort.
- The force and sound are closely associated with the perception of quality, engineering and build excellence.

Metrics:

- Customer and industry survey data
- Specifications in terms of velocity or energy
- Internal quality audits during launch and production
- Velocity meter measurement
Predictive Engineering

The door system design must balance many variables:

- Safety
- Seals
- Hinges and check links
- Latches
- Air volume
- Door sheet metal assembly
- Body structure
- Door fitting to the body opening

Engineering methodologies:

- Design best practices
- CAE FEA simulations
- Dynamic motion analysis
Previous Solution Efforts

What do we do when we have a problem meeting the target metrics?

Previous problem solving methods

- Systematic removal of parts
- Part swaps
- Carbon paper and trace powder for seal margin checks
- Paper pull test

Results are often misleading as they remove the symptom but may not reveal the root cause.
Going Beyond Physical

VIRTUAL tools to SOLVE problems in HIDDEN areas

Technology in Manufacturing: Virtual Analytical Matching
Scanning Overview

Reference targets are applied to the vehicle with the doors closed and measured as targets in IMInspect. These targets keep the datasets aligned to each other.

Overall alignment can be made relative to a checking fixture or with reference point alignments in IMInspect.

- Reference points can be correlated to other datasets such as CMM body measurements.

The doors can then be physically opened for scanning, yet be aligned by the reference targets to be virtually closed.
Scanning Setup – Physical Reference Targets
Scanning Setup – Virtual Reference Point Alignment
Scanning Overview

The goal is to find the “hot spots” where the system doesn’t fit together properly.

Multiple layers of scanning are completed to provide a picture of the door, body, seal and trim system integration.

Typical scan layers
- 1 scan - exterior with doors closed, plus the reference targets
- 4 scans – front and rear door openings on body, with and without seals
- 4 scans – front and rear doors opened, with and without seals and interior trim
- 9 total scans
Scanning Layer Samples
Scanning Layer Samples – Door Header
Scanning Layer Samples – Door Header
Scanning Layer Samples – Center Pillar
Scanning Layer Samples – Center Pillar
Scanning Layer Samples – Door to Quarter Panel
Scanning Layer Samples – Door to Quarter Panel
Scanning Layer Samples – Interference & Gap Checks
PolyWorks IMInspect Functions Used

- Global targets
- Reference point alignments
- Properties applied to datasets, ensures the correct scans colormap to the correct reference data.
- Real Time Quality Mesh enables proper visualization of surface interfaces
- Cross section comparison points to measure the seal margins
- Clearance between Data Objects
- 3D Section View enables live data reviews with customers.
Summary

- Using these techniques creates an analytical problem solving approach to replace an often subjective physical evaluation process.

- Enables analysis of hidden and difficult to access systems.

- Process adds value by analyzing the data and providing relevant system integration information to the engineers.

- PolyWorks can be used for more than part inspection, it’s a powerful problem solving tool.
Questions and Answers