MxD 16-01-02	Category: Quoting Process, Recurring Manufacturing
Title:	Analytical Solutions for Production Variability in Complex Assemblies
Completion Date:	2018-02-28
Project Team:	Ohio State University, Arizona State University (ASU), Rolls-Royce, Siemens
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Problem:

The business case for this project is based on better competitive positioning for complex engineered systems by introducing analytical methods and digital tools with tandem objectives of improved robustness in product performance and reduced product cost. Many engineering organizations typically rely on traditional dimensional analysis techniques whose calculations are mostly 1-D in nature. Small or medium manufacturers may not even have such expertise and may rely on trial and error or past experience. Traditional method may be sufficient to handle relatively simple assembled geometries, it may be very difficult to understand dimensional variations of complex assemblies with several degrees of freedom. As a result, expensive and time consuming manual adjustments are needed on the final assembly to meet specifications.

Objective:

- Creation of mathematical and statistical methods, and computer tools for supporting variability mitigation via inter-operable digital tools which enable designers and manufacturing engineers to account for full 3D geometric variations in complex assemblies ensuring accuracy, efficiency, ease of use, digital interoperability and scalability.
- Moving T-maps technology from TRL 4 to 6

Summary:

We executed a two-pronged technical approach: 1. Pre-manufacturing (feed forward) strategy to use new predictive 3D capabilities to gain better understanding of the variability in assemblies. 2. Post-manufacturing (feedback) strategy to determine optimal use of the tolerance budget to minimize accumulated effect on assemblies. The revolutionary T-map model and VSA was benchmarked against as-is 1D methods; data was collected with respect to accuracy, ease of use by non-specialists and labor savings in pre and post-manufacturing

- Reduce time, cost & training to perform assembly stack analysis
  • Time stats for all steps given on slide 108 show order of magnitude improvement over manual 1D analysis
  • Training: all T-map based steps are fully automated; the user need not know any mathematical or computational methods used
- Minimize human intervention
  • Auto-loop detection: removes human judgement in defining assembly conditions and feature abstraction
  • Automation avoids human errors
- Establish Digital Thread
  - aCTF data structure used to drive all analysis software (1D, Monte Carlo, T-map)
  - aCTF obtained from either pdo summary or AP242
  - Unresolved issue: since no ISO standard data format includes assembly mating condition or analyzed gap, this has to be manually added (neither JT nor AP242 can solve this issue now); this is out of our control.