Instar Engineering and Consulting, Inc.

STDI—Structural Test Design and Interpretation
for Aerospace Programs

Course Overview

This new three-day course provides a rigorous look at structural testing and its roles in product development and verification for aerospace programs. The course starts with a broad view of structural verification throughout product development and the role of testing. The course then covers planning, designing, performing, interpreting, and documenting a test.

The course covers static loads testing at low- and high-levels of assembly, modal survey testing and math-model correlation, sine-sweep and sine-burst testing, and random vibration testing.

The objectives of this course are to improve your understanding of how to

- identify and clearly state test objectives
- design (or recognize) a test that satisfies the identified objectives while minimizing risk
- establish pass/fail criteria
- design the instrumentation
- interpret test data
- write a good test plan and a good test report

Target Audience

All engineers and managers involved in ensuring that flight vehicles and their payloads are structurally safe and ready to fly. This course is intended to be an effective follow-up to Instar's course "Space-Mission Structures (SMS): From Concept to Launch", although that course is not a prerequisite.

Instructor

Tom Sarafin is president and chief engineer for Instar Engineering. He has worked full time in the space industry since 1979. He worked over 13 years at Martin Marietta Astronautics, where he contributed to and led activities in structural analysis, design, and test, mostly for large spacecraft. Since founding Instar in 1993, he's consulted for NASA, DigitalGlobe, Lockheed Martin, AeroAstro, and other organizations. He's helped the U. S. Air Force Academy design, develop, and verify a series of small satellites and has been an advisor to DARPA. He is the editor and principal author of *Spacecraft Structures and Mechanisms: From Concept to Launch* and is a contributing author to *Space Mission Analysis and Design*. Since 1995, he's taught over 150 courses to more than 3000 engineers and managers in the space industry.

Course Length

Three full days or five 5-hour days

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Course Outline (subject to revision)

Introduction

1. **Overview of Structural Verification for Space Missions**
   Structural functions and requirements, understanding verification, the building-blocks approach to verification, verification methods and logic, development testing, acceptance testing, qualification and protoqualification testing, types of structural tests and when they apply, government standards
2. **Designing an Effective Test**
   Designing a test, contents of a test plan, defining objectives, boundary conditions, the key difference between a qualification test and an acceptance test, success criteria, instrumentation, preparing to interpret test data
3. **Testing of Coupons and Joints**
   Applications and objectives, loading systems, typical configurations, designing the test, ASTM standards, deriving statistically appropriate allowable, case history: designing a test to substantiate new NASA criteria for analysis of preloaded bolts
4. **Static Loads Testing of Structural Assemblies**
   Test fixtures and configuration, introducing and controlling loads with hydraulic jacks, developing the load cases, instrumentation, interpreting data, special considerations for centrifuge testing
5. **Testing on an Electrodynamic Shaker**
   Test configuration, fixture design, locating accelerometers, deriving overall loads on the test article from test data, sine-sweep testing, sine-burst testing, random vibration testing, notching and force limiting, example: designing a notching strategy
6. **Modal Survey Testing and Math-model Correlation**
   Test objectives, mass correlation, test configuration, approaches, limitations of testing on a shaker, selecting accelerometer locations, checking the test data with the orthogonality check, correlating the math model, the cross-orthogonality check
7. **Case History: Vibration Testing of a Spacecraft Telescope**
   Overview, initial structural test plan, problem statement, revised test plan, testing at the telescope assembly level, testing at the vehicle level, lessons learned, conclusions

Summary

Comments from past participants of other Instar courses

"It was a fantastic course—one of the most useful short courses I have ever taken."

"Interaction between instructor and experienced designers (in the class) was priceless."

"Great course! Lots of lessons learned. The examples made it that much better."

"Excellent presentation—a reminder of how much fun engineering can be."

"An excellent course. It gave me a lot to think about."

"Very valuable. Relates classroom knowledge to actual experiences in the space industry."

"I have a much better understanding of structure design issues, especially modeling and its limits. The instructor clearly understands and is effective at communicating this material."

"Great course!"—Retired Chief Engineer who helped develop the Saturn family of launch vehicles