

A satellite is shown in space, with the Earth's surface visible in the background. The satellite is a complex structure with various instruments and antennas. The text "System Verification and Validation" is overlaid on the image.

# **System Verification and Validation**



**BURGE  
HUGHES  
WALSH**

## 1.0 Introduction and Background

Ensuring we have developed the right system and developed the system right is an important set of activities within system engineering. The complexity, timescales, and cost of modern systems make it impossible and highly undesirable to leave verification and validation until the system is built. Indeed, the need to manage risk and provide confidence during system development demands a systems approach to verification and validation.

A systems approach to verification and validation demands that we begin the work much earlier than is normally accepted. Moreover, it encourages the characterisation of the system as opposed to pass/fail digital assessment.

This module on System Verification and Validation aims to educate and train students in how to practically apply a systems approach to this critical activity. It is specifically for those people who are involved in new system introduction from marketing through to system support.

The focus on 'doing' combined with the system approach to verification and validation' makes it unique and a powerful module for anybody interested in systems and systems engineering.

It is also a natural follow-on from the 5-day System Design Course.

## 2.0 Course Aims, Outcomes and Content

### Aims:

This module aims to:

- introduce and explain the principles and concepts of a systems approach to verification and validation that demands the characterisation of the system design through the use of determination testing as opposed to reliance on demonstration testing
- provide a methodology and tool set that can be applied to characterising the concept design to:
  - identify the robust optimum
  - determine system design parameter targets
  - predict system reliability
  - undertake realisation and supportability assessments

### Learning Outcomes:

Knowledge and Understanding

On completion of the module students should be able to:

- Clearly define the differences between validation and verification and understand the various methods, and their relative merits for accomplishing verification and validation
- Understand and explain the verification and validation opportunities throughout the system development cycle
- Understand the principles and concepts of a systems approach to system verification and validation through system characterisation as opposed to system demonstration testing
- Understand and explain the concept of robust optimisation and system sensitivity
- Understand and explain the principles of parameter and tolerance design
- Clearly define the differences between determination and demonstration testing and how they relate to the system approach to verification and validation

- Understand the principles of designed experiments to explore the design solution space for robust optimums
- Clearly describe the fundamental process, activities and methodology for a systems approach to system verification and validation

### Skills and Attributes

On completion of the module students should be able to:

- Apply a systems approach to system verification and validation
- Determine a verification and validation strategy and plan
- Identify and prioritise system parameters that contribute to system sensitivity
- Perform sensitivity assessments
- Undertake parameter and tolerance design
- Design experiments to search a system design solution space
- Use simple reliability and supportability assessment tools
- Use systems approaches for application to problem scenarios.
- Work in a team recognizing and understanding group dynamics.
- Communicate findings through:
  - Oral presentations
  - written group reports
  - individual reports
- Find resources and information via information search strategies and evaluate usefulness

### Content

- Review of Systems, Systems Thinking and Systems Engineering leading to a systems approach to system design.
- A systems approach the verification and validation through system characterisation and determination testing. Developing a verification and validation plan
- Process and tool set for system verification and validation
- Systems Characterisation and Robust optimisation
  - A systems approach to system optimisation
  - Parameter vs. tolerance design
  - Understanding and modelling variation
  - Identifying, quantifying and prioritising sources of variation in a system
  - System robustness metrics
  - Searching the design space using design experiments
    - Full factorial experiments
    - Fractional factorial experiments
    - Response surface methods
    - Surrogate modelling
    - Validating and verifying system robust optimums
- Specifying system design parameters
- Supportability, realisability and reliability
  - Reliability engineering
  - Reliability prediction
  - Reliability testing and evaluation
  - Realisation assessment (manufacturability/implementability)
  - Capability assessments
  - Design for realisation
  - Supportability Assessment
- Systems qualification and acceptance
- Feedback/lessons learnt

### **3.0 Course Philosophy and Approach**

The course approach is based on the Kolb learning cycle with a significant proportion of the course set aside for exercises to reinforce the learning. Indeed, many of the small group exercises involve a case study which provides a practical focus for the course and enables the delegates to practise the tools and techniques presented. This case study culminates with a “design review” on the last day where the participants present their system concept solution.

### **4.0 Who is it for and Numbers?**

The short course in Systems Engineering is aimed at all personnel involved in the new system introduction and product support. Indeed, wherever possible having a mix of engineers, marketing, project managers, and customer support engineers is most beneficial in terms of deploying and adopting a systems approach.

The course has been designed for a maximum of 16 participants.