# Optimizing System Testing

**Chandru Mirchandani**

## Abstract

Most control systems are complex. They consist of complex hardware controlled and monitored by equally complex software and people ware. This overall system undergoes rigorous testing before it is made operational. This study examines the extent of testing required for new or replacement systems. The test procedure is essentially concerned with verifying previous assumptions; diagnostic analysis; lessons learned; customer acceptance and confirming manufacturers data. Although the software component of the complex system requires more test time than the hardware component, and the peopleware component has more often than not been ignored; it will be shown that the analysis can be carried out at a system level. The paper will apply this paradigm to a system made up of one or more programmable devices and associated software. The process will examine the reliability of the system design; separate the performance of the system functionally; assess risk probabilities based on the functions and recommend a method by which the system is optimally tested.

## Summary

Essentially the sequence of steps is as follows:

1) Evaluate the reliability of the overall system in terms of hardware and software, and the combination of the two

2) Evaluate the sub-system reliability and weight the sub-systems function-wise as follows: highly critical, critical, marginally critical, negligible criticality and 'nice to have'

3) For each subsystem, evaluate the consequence of the failure in terms of highly critical severity, critical severity, marginal severity, negligible severity and negligible

4) Normalize the risk and represent the analysis as a decision matrix. on whether to test, and to what degree. Recommend a method to allocate test resources so as to optimally balance risk versus cost and time required for 100 % acceptance testing of every function and subsystem.

Analytical Hierarchical Process is a method by a decision analysis may be quantified. In this methodology, the factors that contribute towards the goal of the exercise are compared pair-wise to elicit a quantifiable result

The different levels in the hierarchy and what they consist of are listed and described in the next paragraph. The top level in the hierarchy is the goal of the whole exercise. The goal is further split up at level 2 into four main objectives to help define and explain the rationale for selecting the criteria for evaluation. The factors for comparison are the third level in the hierarchy and are used to set-up the comparison matrices. Two of the four factors are further split up into sub-factors. The last level in the hierarchy shows the options to be compared.

Level 1: GOAL: to choose the best option to testing the system.

Level 2

a) Meet the demands for the system
b) Minimize the Risk of Failure
c) Minimize Cost
d) Minimize Test time

Level 3

a) Performance

    i. Functionality: meets the requirements of the system
    ii. Hardware compatibility: the hardware component in the design is compatible with the existing hardware
    iii. Software compatibility: the software component in the design is compatible with the existing software
    iv. Expandability: the system should be capable of expanding to accommodate more users and system upgrades

b) Set-up/Transition

    The ease with which the system can be set-up

c) Cost

    i. System: the cost of acquiring the system, as well as cost effectiveness
    ii. Set-up: the cost involved in integrating the system
    iii. Maintenance: The cost involved in maintaining the new system (includes training the maintenance personnel)

d) Operability (ease of use)

The ease of operating and training on the new system

Level 4

a) TS - Traditional System testing to test the subsystems in accordance with historical and standard procedures laid down in MIL Standards.

b) LS - Localized System testing whereby the subsystems are tested according to the local interactions and not system level interactions.

c) NS - Normalized System testing whereby the testing process where the test results are normalized according to the weighting based on criticality.

d) HS - Hybrid System testing whereby subsystems are tested in relation to the functionality and O/I.

## Author Information


### Chandru Mirchandani

| | |
|---|---|
| Affiliation: | Chief Microelectronics Engineer, Lockheed-Martin Space Mission Systems, Seabrook, MD 20771 |
| Technical Area: | Systems & Design Engineer in VLSI systems and components |
| Address: | Code 566, N-38, Building 12,<br>Ground Systems Hardware Branch, GSFC NASA, Greenbelt, MD 20771 |
| E-mail: | chandru@kong.gsfc.nasa.gov. |
| Telephone: | (301) 286-7967 |