15 Nov 62

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Not Published
Delivered at ORLANDO

"THE RELIABILITY PICTURE AT MARSHALL SPACE FLIGHT CENTER - PHILOSOPHY, STAFFING AND MANAGEMENT"

Proposed talk to Orlando Section of American Society for Quality Control
November 15, 1962

by

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Introduction

Just as the period of 1930-1950 saw the development of Quality Control and the acceptance of QC in manufacturing, the decade from 1950-1960 introduced the field of "Reliability Engineering" into development programs. Numerous efforts by the ASQC, the Department of Defense AGREE Committee, the AIA Electronic Reliability Panel, and a host of others began to keynote the importance of reliability considerations in the conduct of government sponsored programs.

The effect of unreliability was obvious. Rand Corporation studies showed that the cost of maintenance of military equipment annually exceeded the initial procurement cost.

Initially, reliability engineering devoted itself to field failure analysis, maintenance costs, and feedback of data for decisions regarding engineering changes. Gradually techniques were proposed for "preventive" rather than "corrective" engineering during product development to reduce the volume of field modifications.

Reliability Activities

The motive of reliability engineering is to reduce consumer's risk prior to manufacture. To do so involves assurance of design maturity. This assurance is possible only by a testing program carried out during development. The test program, then, becomes the heart of the reliability program and

consumes the bulk of the cost of the reliability program. The purpose of the test is initially to denote design weakness and finally to demonstrate achieved reliability.

To enable a central reliability group to make maximum contributions, control for many suplimental activities are now commonly assigned to reliability. According to one study, the following are reliability tasks:

Initial Design:

@1. Prediction model
@2. Apportionment
3. Trade offs
4. Classification of characteristics
5. Review of drawings
6. Standards, specs, and drawings
@7. Human factors, maintainability
@8. Value engineering
@9. Design review
10. Failure mode analysis
@11. Failure analysis

Testing:

@1. Statistical test design
2. Development testing
@3. Reliability verification
@4. Test data acquisition and dissemination

@Denotes activities predominately assigned to the Central Reliability staff of most Aerospace Industries.

To relate reliability to its relationship to the program, the simplest analogy is to consider it a form of design control. In this context, reliability is to development as quality control is to manufacture. The use of the concept of design control then makes possible an understanding of the motives and location of reliability personnel within a development organization.

Control in this sense is the same as that taught in Industrial Engineering and refers to the total management concept of planning, operating, and reviewing.

MSFC Philosophy

The present MSFC reliability concepts are based on an accumulation of several philosophies. When NASA was first created, the headquarters reliability policies were established by Dr. Seaman and Dr. Golovin and leaned heavily on the proposal that reliability goals be established and demonstration tests be conducted to verify achievement. The present headquarters philosophy is less adamant regarding the role of statistics to reliability but does support the majority of the requirements of the Air Force specification, Mil R 27542. The third important influence was that of Robert Lusser

and George Henderson and stemmed from the previous relationship of MSFC with the old Redstone Arsenal a few years past.

Several reliability policy directives have been issued by Dr. Rees. In summary these state:

1. Hardware scheduled for flight vehicles shall not undergo vibration testing prior to the time that hardware must fly.

2. Known or estimated environments of each system under development will be determined. These environments will be used as a basis for test planning.

3. A coordinated parts qualification program will be maintained.

4. Overall test plans will be prepared for all systems and evaluations by test will include the milestones at pre-flight certification and qualification.

5. Operate time (MTBF) for time critical flight and ground equipments will be continuously monitored.

6. A coordinated MSFC Approved Vendor's List will be established.

7. Design reviews shall be conducted.

8. Reliability program budgets shall be established for development programs.

9. MSFC contracts for major development programs shall include reliability program requirements.

MSFC Organization

Just prior to the time MSFC was transferred from the Army to NASA, reliability staffing existed as a combined line-staff function under Mr. Schulze in the System Analysis Division. The new MSFC organization required many changes. The initial change was to elevate Mr. Schulze to a staff group and to establish line functions in reliability within each design division. The staff office, as present, helps formulate policy, coordinates reliability actions, and monitors the line groups to assure that reliability requirements are met.

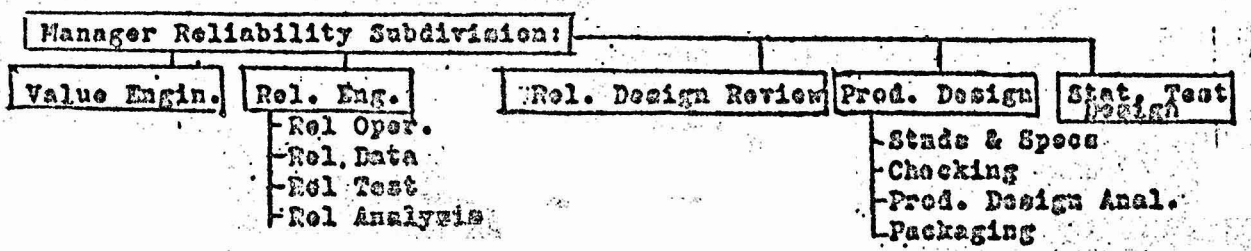
Although there are full time reliability line people in each MSFC element, the largest staffing exists in the P&VE Division, Astrionics Division, the Saturn Systems Office and the Light & Medium Vehicles Office (Agena). P&VE and Astrionics Reliability Groups do support work for in-house development programs. The Saturn and Agena Projects are contract operations and their reliability coordinators are in project management.

The reliability picture at MSFC is a healthy one. In addition to Civil Service staffing, there has been a contract for reliability posters issued weekly, a contract with ARINC for an independent evaluation of Saturn, and a contract with the University of Alabama for development of statistical techniques.

Contract Management

MSFC development contracts contain reliability contract clauses similar to those of Mil R 27542. There are also numeric goals stated such as .95 reliability at .90 confidence and an elaborate procedure set up for grading systems test to determine these achievements.

In practice, the degree of contractor implementation of the reliability requirements is related to the attitudes organization, and funding assigned by the contractor to his reliability effort. Although not typical, the staffing at Rocketdyne is of interest in this field. Out of a total plant employment in the range of 9,000 of which 1/3 are assigned to engineering, the reliability staff numbers approximately 180. Another 900 are separately assigned to QC and Inspection. The Department subdivision is:



At Rocketdyne, in a manner similar to that at MSFC, a reliability policy board exists and consists of top level management from all major departments or divisions. This tie in of top management improves the effectiveness of reliability groups working in the line.

Summary of Techniques

In summary, I would like to review some of the important techniques developed and in use in reliability engineering.

1. MTBF
2. Minuteman Program
3. Safety margin testing ***
4. Mortality curves and the fallacy of infant mortality
5. MSFC policy directive #1; production environmental testing

* Proceedings of the IRE, May 1962, pgs. 1321-1338, Ryerson.

** "Authority and Responsibility of the Central Reliability Group," Ronald S. Nelson, July 1962, Rocketdyne.

*** "A Reliability Test Method for One Shot Items," Aeronutronic Report #U-1792, H. J. Langlie.