

Historian's Corner

Ray Ziehm (POC)

(rzandmm@comcast.net)

Titan Systems Effectiveness: An Organization Ahead of its Time

By: Bill Cossaboom

Advisor: Debi Floyd (*Debi was the Sr. Manager of Titan Systems Effectiveness for approximately nine years*).

Last fall, we discussed the advent of process level focused work tools at Martin Marietta. This month, we will focus on systems, their measurements, and the organization charged with doing so for the Titan program: Titan Systems Effectiveness (TSE)

TSE was a pioneering force in the concept, development and implementation of system measurement metrics and tools that our organizations and programs still use, as part of conducting normal business.

Metrics Development

The TSE was authorized by contract to generally provide the Air Force customer and the customer delegate, Aerospace Corporation, evidence that all systems were working effectively. There are a staggering number of systems, which are fed by processes at Lockheed Martin (LM). The Aerospace Corporation's role is defined as helping to assure space mission success for DOD, the intelligence community, and civil and commercial customers.

Each department, each area, and each function has its processes, subsystems, and systems. Processes were viewed as integral to the requirements and task flows. Processes are foundational with elements flowing upward into sub-systems and, in turn, systems. Now multiply that by our suppliers (known today as the supply chain) and you have one piece of the scope of TSE!

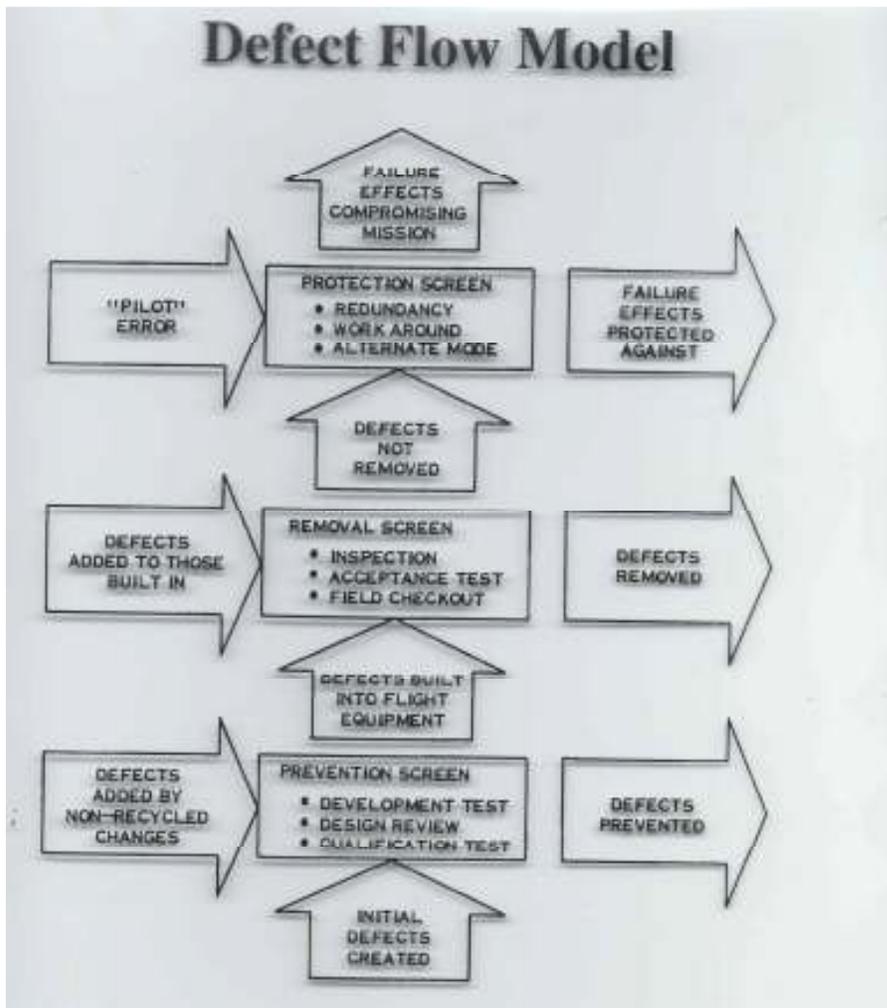
TSE also conducted extensive partnering with our suppliers; in particular the Major Element Contractors (MECs), in helping them develop metrics to measure the effectiveness of their systems. MECs included: CSD, Honeywell, Aerojet, and Alliant among others. Overall, TSE consulted 100 key suppliers to improve process and establish measures and metrics for continuous improvement.

Results were presented semi-annually to the Air Force customer and Aerospace at Systems Effectiveness Review Conferences. TSE eventually teamed with Aerospace in establishing Process Reliability controls and decomposing human reliability requirements into Titan processes and controls.

TSE theorized that association and integration relationships between processes, subsystems and systems could be proved, illustrated, and correlated through data. TSE was correct.

One focus of TSE was improving our nonconformance system to exhibit more meaningful system data. Taking the systems approach, TSE looked at when the nonconformance was discovered as opposed to when the first screening for that nonconformance took place. Critical Gates was a concept whereby if a defect was not caught by the last and final gate, an impact to mission could occur. Screens were defined as review, inspection, or performance testing.

TSE also instituted modeling (read Flow Charting) in their effectiveness measurements. Below is a system Defect Flow Model (certain information excluded) as developed by TSE with the help of consultants contracted to Martin Marietta.



A score could be calculated for the prevention, removal, and protection screens, e.g. Prevention Screens are 75% effective. The system of screens effectiveness could also be quantified and calculated.

TSE researched, tested, and implemented Quality tools at the MECs including but not limited to:

- Design of Experiments (Statistics thorough controlled experiments)
- Quality Function Deployment (House of Quality / Value Engineering)- QFD (migrated to business and training processes)
- Kepner-Tregoe (problem solving / decision making tool)

At the behest of the Titan program, TSE developed a functional product life cycle flow of measures which are crucial to an integrated product culture. Key functions identified their 4-6 critical performance measures that would have usefulness not only within their functions, but also across the gap to the next function (or customer) downstream. The final result was a performance panel that flowed from one function to the next function reflecting each function's impact.

Many of the metrics, concepts, and integrated cultural impacts between both internal and external members of our industry have been adopted and enhanced by current value added initiatives such as Green Belt and Black Belt --- All owe a debt to TSE.

Process Assessment (P.A.)

The Space Launch Systems P.A. manual was also developed and implemented under the auspices of TSE. The goal of the group was to find the next failure before it could happen. Our MECs also adopted the program, some per their contracts and others simply by understanding the value of understanding their processes.

Below is an excerpt from the manual the practitioners used. The "Truth Table" illustrates at a high level P.A. approach

PHILOSOPHY (continued)

B. Truth Table

The Process Assessment approach is described as a way to "Find Our Next Failure - Before It Happens." The Truth Table was developed to assist in visualizing "The Process", to convey an awareness of the different phases where a process requirement exists, and where subsequent testing must be controlled. By taking the issues and actions from a process assessment and applying the truth table categories, the organization will achieve process-to-process linking for diagnosing the process health. The Truth Table is the cornerstone of the Process Assessment philosophy and should instill the concept of identifying process requirement omissions and requiring detailed process verifications.

TRUTH TABLE
(WHAT GETS US IN TROUBLE)

	VERIFIED	NOT VERIFIED
REQUIREMENT	1. COMPLIANT	2. OMISSION INADEQUATE TEST
UNRECOGNIZED REQUIREMENT	3. TRIBAL KNOWLEDGE	4. PROCESS CONTROL/ OMISSION UNKNOWN IMPACT



The development of the Truth Table depicts the evolution of this process approach. The left margin currently reflects the distinction between a requirement and an unrecognized (derived) requirement. This concept is important to the philosophy behind the approach because it reveals that not all activities necessary in performing a process are a result of direct requirements. They may in fact be derived requirements.

The following narrative presentation of the Truth Table provides further definition of each category.

Take a look at Block 3, "Tribal Knowledge," which may be described in Six Sigma language as any unwritten information that is commonly unknown to others within the company. Therefore, the information is not contained within engineering documents, process plans, manuals, etc. The term, Tribal Knowledge, is used most when referencing information that is needed to be known by others in order to produce a quality product or service. TSE measures scored these types of errors as medium-high and systematic, because the lack of a requirement would continue to cause the problem down stream and in the processes.

After a problem at one of Titan's MECs, the TSE team discovered that a person who retired had not passed on his personal "Tribal Knowledge"- therefore, the person now performing the task, in accordance with his written step-by- step direction, had failed in the task.

In another situation, TSE was working with a MEC to determine why a product produced on first-shift conformed to requirements, but the same product produced on second-shift was nonconforming. The result was simple yet effective. The culprit: touch and feel. The first shift operator worked with an uncovered hand and the second shift operator wore a glove. The glove made it impossible to gauge when the product was complete.

“Tribal Knowledge” was a ‘tough nut to crack’ due to mindsets that if everyone knew an operator’s technique, the operator would cease to be a valuable employee. Such was the case when a longeron assessment by TSE failed to catch the next nonconformance before it could happen.

TSE also chaired the Titan Skills Certification and Training Board and aptly so, considering the impact skills and training, such as high temperature soldering, had on our process, as well as conforming or nonconforming hardware, even possibly impacting a fleet of Titan Launch Vehicles in storage awaiting call-up and delivery to the Air Force for launch processing.

In conclusion, TSE was a pioneering organization within Martin Marietta that provided a concrete foundation upon which to build and improve, thereby contributing to the success of today’s Lockheed Martin Space Systems Company -- and the industry as a whole.