Applying Systems Engineering Practices To Project A

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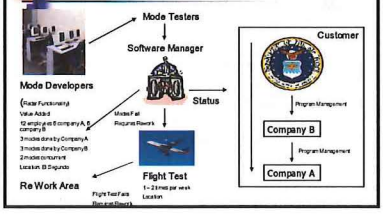
Overview Presentation

1) Introduction and Overview
2) Organization of Program
3) Systems Engineering Principles
4) Applying Principles
5) Examples
6) Lessons Learned

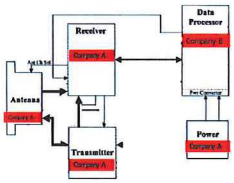
Case Study: Next Gen Airborne Air-ground, Air-air radar program

- Two companies working together to integrate hardware and develop software for the next generation radar system.
  - Higher resolution.
  - Improvements made to collect ground and moving targets by using better algorithms and faster processing.
  - Greater Reliability

Organizational Layout



Radar System Functional Flow Diagram



Functional Flow

Antenna:
- Receives a high power microwave pulse from the transmitter and radiates a beam in the azimuth and elevation beam pattern.

Receiver/Exciter:
- Down converts detected target returns, then converts signal for processing by the Radar Data Processor.

Radar Data Processor:
- Processes digitized radar data from the receiver using various algorithms.

Power Supply:
- Supplies power to the Antenna, Transmitter and RDP.

Transmitter:
- Amplifies the output of the receiver to provide a high power microwave pulse to the antenna.

Types of Software Modes

- GMTI- Ground Moving Target Indicator – Such as cars, trucks, (Company A)
- Air to Air Mode – Other planes, missiles (Concurrent)
- SAR – Synthetic Aperture Radar – imaging stationary targets (Company B)

Summary of Interfaces

- Hardware Interface
- Software Interface
- Organizational Interface
- Communication Interface
- Integration Interface

Hardware Interface

- Structure Integrity
  - Retrofits in the Antenna structure resulted in flight delays (schedule delay)
- Main subsystems
  - No budget was allocated after the delivery of Receiver/Exciter (over budget).

Software Interface

- When one mode changed effected all the modes, result in drastic schedule and cost overruns.
- Two different companies working on own proprietary software
- Coding Techniques from the 80s, instead of using modular design.
- Common problem of high turnover, so if someone retires, and had bad code, can't just delete his stuff because it effects many other functions.

Organizational Interface

- Poorly staffed early on, lack of people with necessary skills.
- Two different companies working together to integrate different hardware and software with proprietary techniques.

Communication Interface

- Employees not happy, high turnover
- Lack of feedback during year
- Mistrust between two companies
- Proprietary information makes it harder to troubleshoot problems.

Integration Interface

- Prime and Sub using different database in requirements
- Software developers company A are on the East coast trying to communicate with testing with the West coast when they should be here.
- Necessary specs were not provided by vendors to complete test plans on time, this includes qual test, and environmental. (Schedule Delay)

Matrix Organization

Advantages of a Matrix Organization

- Project Manager maintains maximum project control (through the line managers) over all resources, including cost and personnel.
- Policies and Procedures can be set up independently for each project, provided that they do not contradict company policies and procedures.
- The project manager has the authority to commit company resources, provided that scheduling does not cause conflicts with other projects.
- Rapid response are possible to changes, conflict resolution, and project needs (as technology or schedule).
- Key people can be shared, the program cost is minimized. People can work on variety of programs.
- Stress is distributed with the team, and functional managers.

Disadvantages of Matrix Organization

- Dual reporting
- Difficulty in monitoring and control
- People do not feel that they have control over their future when they are continuously reporting to multiple managers.
- Company wide not as cost effective, requires more people then necessary.
- Continuously changing priorities.

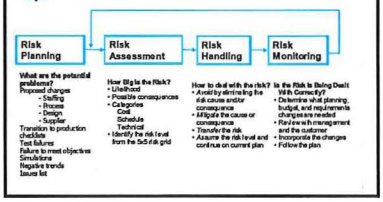
Key Risk Terms

- **Risk:** Something that may cause disruption to the program's schedule, increase the baseline cost, or impact the product's performance and/or quality requirements, or imparts uncertainty about the outcome
- **Opportunity:** Something that may improve the program's schedule, reduce the baseline cost, or improve the product's performance. The determination of whether something is a risk or an opportunity depends on its relationship to the program's baseline
- **Mitigation:** Used for both risks and opportunities. It is the set of tasks needed to reduce a risk or to capture an opportunity.
- **Probability:** A numeric value (Normally a percentage) that represents the likelihood the Risk or Opportunity will occur.
- **Consequence:** A quantified number that represents the effect that the program will incur if the Risk or Opportunity transpires
- **Cost:** A dollar amount representing the consequence to the program if the risk occurs

Risk

- Risk is defined as potential loss beyond expected program execution.
- Risk Management is a continuous process, which captures new risks as they emerge while tracking the status of already identified risks.
- Virtually are projects that do not do well, fail because of unmitigated or unexpected risks.
- Categories of risk includes: Cost, Schedule, Resource, Process, Technical (functional, performance) and Operational

Risk Management Process



Risk Management Process

Risk Planning

1. Identify individuals who will implement the risk management process on the program.
2. Create a consistent approach to identifying and ranking programs risk and opportunities

Risk Assessment

1. The process of identifying unexpected cost AND unexpected gain
2. To Estimate the risk (opportunity) probability of occurring, and it's consequence to the program.

Risk Management Process

Risk Handling

Develop and Implement a method to de al with each risk

- *Risk Control*. Create a mitigation plan to reduce the probability of occurrence
- *Risk Avoidance*. To avoid the action
- *Risk Assumption*. To accept the consequence of the risk

Risk Monitoring

1. To monitor the status of each risk and to identify the successfulness of each mitigation plan
2. Based on current risk, to report the estimated expected risk cost and schedule slippage to the appropriate people

Risk Problems

Talking To Risk Manager:

- We don't quantify risks correctly; we don't look at the big picture (time and money). We don't mitigate correctly. As Engineers we are too optimistic.
- When there is a problem, our company will place too many unqualified people to get job done, instead of a few skilled employees vice versa is also true, assign problems to not enough resources.

Risk Problems Cont

- A huge problem we have in our company is that we don't mitigate the problem of someone who is in charge of many crucial tasks to a person leaving the company, or getting sick.
- What we should do are train employees to be able to fill in roles before the problem occurs.

LEAN

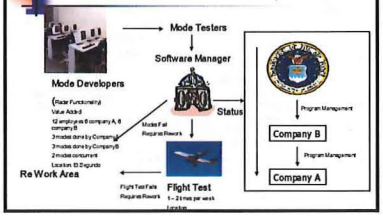
There are five key principles of Lean

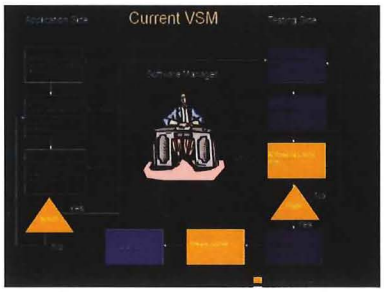
- Value – What customer is willing to pay for
- Value Stream – The steps that deliver value
- Flow - Organizing the Value Stream to be continuous
- Pull - Responding to downstream customer demand
- Perfection - Relentless continuous improvement

Value:

- Customer: Air Force
- Stakeholders:
  Prime: Company A
  Subs: Company B
- Value: Done right the first time, no rework, on schedule, and at cost.

Currently: Blame Game, Huge Wastes





Current State

- Blame game between False Accusations
- No Collaborations
- Huge Waste, when one mode gets changed, effects all other modes.
- Bad design
- Lack of flexibility, when one employee sick, everything stops

Type of Waste:

Transportation Waste:
6 employees with hotel average cost per month $40,000

Waiting Waste:
40 Hrs/Month at $8000

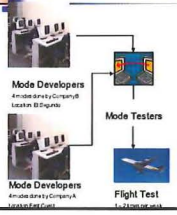
Rework Waste:
80 hrs/month $16,000/month

Over Processing Waste:
30 Hrs/Month at $6000

2 Month Behind Schedule: Over Budget

Total Waste: $68,000/Month

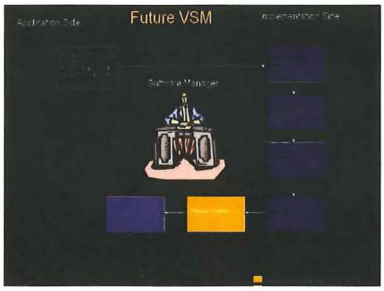
Ideal VSM: Better communications, better layout



Ideal State

No Waste:

- Better Communications
- Roles Stated
- Assumptions Stated
- Team Work
- Honesty
- No Rework
- Better insight by top leadership
- No Waste



Future State

- Non value added activities greatly reduced
- Rework greatly reduced
- When one mode gets changed, does not effect other modes.
- Stronger leadership, who are willing to admit problems, without blame mentality.
- Team members will not accept lies, and excuses from their management, problems will be eliminated immediately.
- Instill management with insight, and understanding of what needs to be done, who don't resist change.
- Employees well trained, to handle various tasks, flexible. No more work stoppages due to key employee absents.

Type of Waste:

- Transportation Waste Greatly Reduced by 75% cost savings of $30,000
- Waiting reduced by 24 hrs/month at a cost savings of $4800
- Over Processing Eliminated
- Rework nearly eliminated cost savings of $14,000

Just In Time:

Cost Savings: $48,800

Pull

In Order to Create Pull:

- Understand who and what customer wants, and make sure the work is delivered.

Pull Systems to be Implemented:

- Standard Procedures
- Standard Work
- Visual Controls
- Kanban – When build ready, have system that immediately notify mode testers.
- Just In Time

Perfection

- Strive for continuous improvement
- Provide training
- No more money spent on flying from and to Company B as a result money saved in hotel and airfare bills.
- Less waiting
- Rework Reduced
- No more over processing
- Employees trained, flexible

Project Management

Earned Value Management System

- With EVMS can see problems early
- Later a problem is detected more expensive it is to repair

Technical Planning

- Good technical planning and management allows Lead Systems Engineers to structure and monitor project plans so that they not only meet their schedule, but reduce risk and their time, money, and resource efficiently.
- Benefits includes reducing risk, don't run out of money, people, alignment, profit

Project Management

- During first flight budget for work performed for Calibration of the antenna was nearly 80% while the actual work completed on the Cal part was only 10%.
- Management does what's best for the individual companies not the program, when deciding what needs to be scheduled.

Hardware Interface

- Structure Integrity
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Lessons Learned:

- When bidding program use trade studies how long it took a similar program to complete software modes, our program had an impossible schedule to meet

Software Interface

- When one mode changed effected all the modes, result in drastic schedule and cost overruns.
- Two different companies working on own proprietary software
- Coding Techniques from the 80s, instead of using modular design.
- Common problem of high turnover, so if someone retires, and had bad code, can't just delete his stuff because it effects many other functions.

Lessons Learned:

- Use modular design when integrating software.
- Provide training on latest software methods

Organizational Interface

- Poorly staffed early on, lack of people with necessary skills.
- Two different companies working together to integrate different hardware and software with proprietary techniques.

Lessons Learned:

- Starting a program use best people, and delegate work to maximize productivity
- Managers should have strong technical skills to understand how to staff project

Communication Interface

- Employees not happy, high turnover
- Lack of feedback during year
- Mistrust between two companies
- Proprietary information makes it harder to troubleshoot problems.

Lessons Learned

- Use Co-Locations – This would improve efficiency by having all work done in one site.
- Provide feedback and expectations to employees on a quarterly basis.

Integration Interface

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Lessons Learned

- Force suppliers to commit to specific time frames for delivery of specs, or financial penalty.

Lessons Learned Cont:

- Use EVMS to ensure program meets schedule and cost requirements. Train all managers in EVMS as well as have a monitoring process to ensure done correctly.
- Inaccurate Basis of Estimate – due to not taking into account; risk, issues regarding the five interfaces – such as software, and hardware

Questions?