BAE Systems

U.S. Combat Systems

Tailoring Systems Engineering for Technical Support of Legacy Products

M88 HERCULES Recovery System

Presented by: Joe Skandera, Derrick Min and Virginia Doyle

BAE SYSTEMS

Agenda

- **Introduction**
- Schedule Development
- Requirements Management
- Risk Management
- Summary

BAE SYSTEMS

50+ Years Designing/Manufacturing Over 6400 Recovery Systems

- **1951: Designed the M74, First Recovery Vehicle with Hydraulic Powered Recovery Systems**
- **1953: Contract Award to convert 1,100 M4A3's to M74 RV's**
- **1954: Designed and Prototyped 3 T-88 Recovery vehicles**
- **1960: Contract Award for 1,075 M88A0 Recovery vehicles**
- **1963: 1,000 M88 Produced**
- **1965: Production of 1,844 M578 Light Recovery vehicles begins**
- **1972: 875 Vehicle M88 Conversion to Diesel Contract Awarded**
- **1975: M88A1**
- **1982: M88AX Automotive Demonstrator Design**
- **1987: M88A1E1 Prototype Contract**
- **1993 5 M88A1E1's Complete Testing**
- **1994: LRIP Award for M88IRV (M88A2 production begins)**
- **1997: M88A2**
- **2009: 491 M88A2 vehicles delivered to customers globally**
- **Today: Over 2000 M88 vehicles are in service**

M88 Family of Vehicles History

M88 FOV

M88A0-1960

55 TONS

Recovery of M48-M60 Tanks

- M88 Steel Fabricated Hull
- AVIS-1790-6A, 12 Cylinder Petrol Engine
- It was the First Armored Recovery Vehicle to be Designed, Produced, and Fielded as a New System
- Mechanical Transmission

M88A1-1975

56 TONS

Recovery of M48-M60 Tanks

- M88 Steel Fabricated Hull
- AVDS-1790-2DR, 12 Cylinder Diesel Engine (750 HP)
- Increased Operating Range from 360 to 450 km
- Modified Transmission
- Diesel Fired Personnel Heater
- Auxiliary Power Unit

M88A2 HERCULES-1997

70 TONS

Recovery of M1A1/M1A2 Tanks

- M88 Steel Fabricated Hull
- AVDS-1790-8CR 12 Cylinder Diesel Engine (1050 HP)
- Recovery for 70 Ton MBT
  - 20-25% Improved Towing
  - 55% Improved Main Winch
  - 40% Improved Hoist winch
- Added Auxiliary Winch
- Improved Ballistic Protection
- Laser Protected Vision Blocks/Scope
- Enhanced Hydraulic Diagnostics

Baseline Configuration
Enhancements

Agenda

- Introduction
- **Schedule Development**
- Requirements Management
- Risk Management
- Summary

BAE SYSTEMS

Schedule Development

- What is the most popular way to plan schedules?
  - SOW to Solution Confusion
  - Reverse thinking and define measurement needs first
    - Is EVMS, CPI and SPI required and supported by funding or will something simpler work?
    - Defining these measures can help indicate depth of WBS detail
  - Then dissect the SOW to develop a WBS based on deliverables
    - Socialize with your IPT- your life depends on it - train as needed - gain agreement & approval
    - WBS sets the stage for responsibilities
  - Define time phased sequence of events including internal & external reviews, decision gates and milestones that end in deliverables

    (referred to as a Summary Schedule or Horse Blanket Schedule)

BAE SYSTEMS

Schedule Development – continued

- $1B Question
  - How deep do we dive to reach deliverables?
    - What does the customer require and is there funding to support it?
    - What is the size and complexity of the project?
    - Is there any new technology development?
    - Who and what resources are needed for the project?
    - How accurate are the material estimates?
    - Do we need activities narrowed down to the point of selecting a bolt?
    - How urgent is the need? Do they need it tomorrow?

BAE SYSTEMS

Continue Schedule Development

- The answers are based on legal requirements, your organizational requirements, customer requirements and the risk against deliverables
- Create a draft detailed schedule
- Socialize with the Project Team, Management and Customer for agreement
- Measure, monitor and continuously update the schedule methodology from lessons learned throughout execution

Remember - all the answers depend on the requirements and risks.

BAE SYSTEMS

Agenda

- Introduction
- Schedule Development
- **Requirements Management**
- Risk Management
- Summary

BAE SYSTEMS

Requirements Management

- Requirements for legacy systems may not be documented in typical Systems Engineering documentation and tools
- *What should be the approach to defining/refining requirements for technical support projects on legacy systems?*
- Requirements efforts must be tailored to fit the size and cost of the project
  - Establishing a requirements baseline
  - Clarifying ambiguously derived requirements

Successfully tailored requirements process helps to maintain budget, scope, and performance

BAE SYSTEMS

Requirements Management – continued

- Example: Developing an automated hydraulic diagnostics on the M88A1
  - Research documentation for existing requirements
    - Statement of Work (SOW)
    - Purchase Description
    - Tech Manuals
    - Previous milestone review materials
    - Subject Matter Experts
    - Any potential source of data
  - Identify legacy system (vehicle) requirements that are relevant to hydraulic diagnostics
    - Operational requirements
    - Interface requirements
  - Baseline requirements determined at System Requirements Review (SRR)
    - Opportunity for customer to review requirements and traceability
  - Review updates to requirements at following milestone reviews

BAE SYSTEMS

Requirements Management – continued

- Tailoring Challenges
  - Appropriate level of requirements for the scope of the project
    - Over-committing can lead to cost/schedule overruns
    - Useful to consider verification/validation matrix, especially when addressing system-level requirements
  - Modeling and simulation may be limited in determining capability to meet requirements
    - System-level models may not exist, and may be too costly to develop within scope of the project
  - Cost-benefit and trade studies are beneficial in resolving conflicting requirements, especially when legacy technology is involved
  - Robust **Risk and Opportunity Management** is critical in maintaining cost and schedule
    - Provides a structured method to identify, assess, and communicate potential issues due to limited scope
    - Provides a structured method to identify performance and cost benefits which may be realized on current projects or follow-on projects
- Overall, requirements process is similar to “standard” requirements development
  - Process must be *appropriately* tailored to fit the project

BAE SYSTEMS

Agenda

- Introduction
- Schedule Development
- Requirements Management
- **Risk Management**
- Summary

Risk Management

We all do risk management and mitigation, even if not formally documented.

- What are some examples?

How to manage risks at a level appropriate to the project?

Tailoring

Risk management is applicable on EVERY project.

BAE SYSTEMS

Risk Management - continued

Project (Work Directives) Examples

- Find a replacement for a major sub-assembly in the vehicle.
  - Customer active member of weekly team meetings
  - Approx $25M in funding
  - Risk approach -> Formal risk register at project level, team involved customer, costing of risks tracked separately, met at a minimum monthly to update status of actions, prioritized based on probability and impact.

- Work on improvements needed to bring older model up to date.
  - 13 tasks (develop, integrate, drawings, maintenance manuals, etc) under main title assigned to different project leads.
  - Approx $5M in funding
  - Risk approach -> Informal risk management at project/task level, risks captured formally in Engineering Program risk register, customer not involved in risk review board, monthly program risk meetings to update status of actions.

BAE SYSTEMS

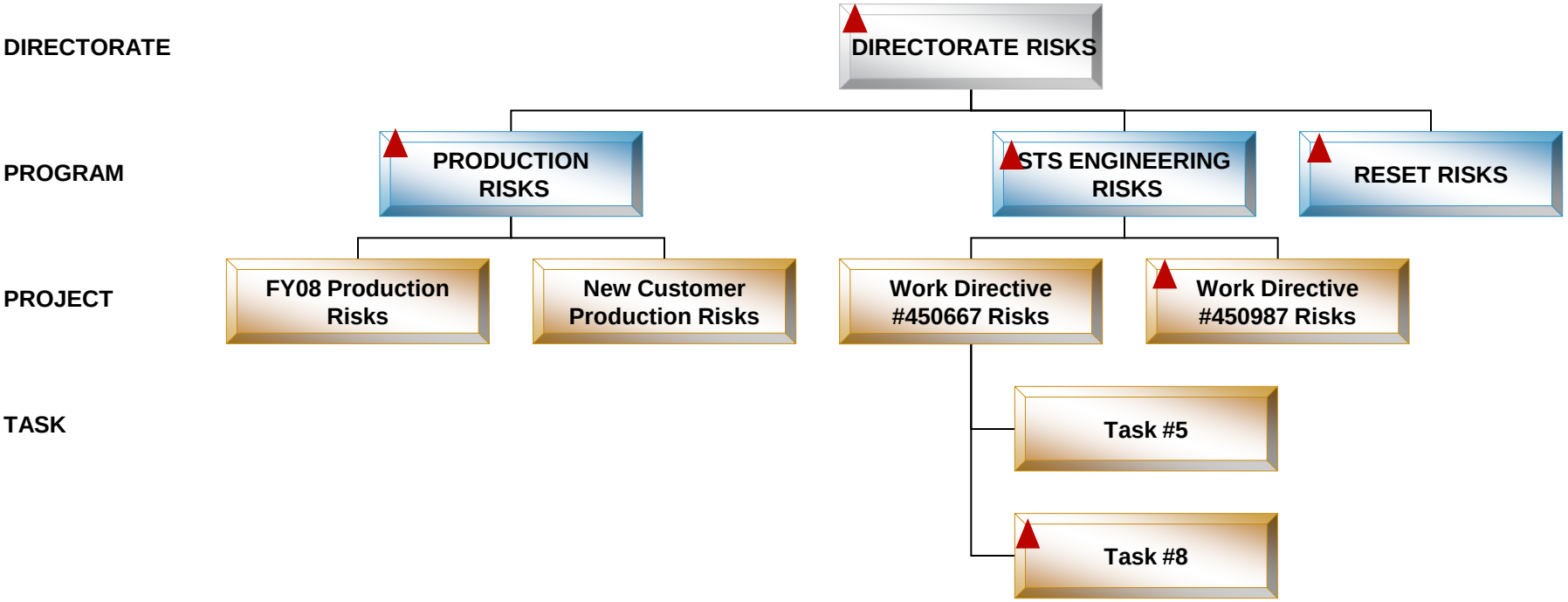
Risk Management - continued

- Establish basic requirements for all projects:
  - Statement (If…due to..., then…)
  - Handling Approach – If mitigation, include due dates and assignee.
  - Prioritization method
  - Periodic reviews
  - Contingency plans

- Tailor other areas of risk management:
  - Reporting frequency and structure
  - Level of detail
  - Costing approach
  - Project risks versus Program risks

Risk Management - continued

- Best approach when dealing with multiple levels of tailoring
  - Multiple levels of management



▲ - Risk registers

BAE SYSTEMS

Agenda

- Introduction
- Schedule Development
- Requirements Management
- Risk Management
- **Summary**

BAE SYSTEMS

Summary

Of the three areas covered, you can see importance of understanding the customer needs, cost, and type of each project.

- Where else could we apply this approach?
  - Verification and Validation
  - Quantitative Project Management

Just as you need a good CAST when you go fishing in order to place your bait in the stream to catch the elusive trout….

You need good tailoring of the Systems Engineering processes to effectively apply the techniques to result in a successful project!

So when you start a project, remember it's all about the CAST.

Summary - continued

C - Identify what the **customer** wants!
(timeframe of need, level of participation, etc)

A - **Assess** each project individually
(same approach does not apply to all)

S - Consider the **size** or funding level
(dollar amount, number of people, number of tasks, etc)

T - Consider the **type** of project
(development, integration, field support, reset, etc)

A good CAST produces accurate tailoring for project success.

BAE SYSTEMS

Questions?