

Master Class

Getting to Done

Principles, Processes, Practices, and Tools to Increase the Probability of Successfully Complete Project's On-Time, On-Budget, with Needed Capabilities

Glen B. Alleman
Thursday 16th August 2018
9:00 AM – 5:00 AM

PROJECT AND PROGRAM MANAGEMENT SYMPOSIUM
• Better Management • Better Projects

1

Who Am I?

- I was educated as a Physicist, but practiced software development for radar, signal processing systems, and further educated as a Systems Engineer.
- Moved to managing Software Intensive System of Systems (SiSoS) for space, defense, enterprise IT, industrial systems, process control, and document management companies.
- Worked in heavy construction, electric utilities (conventional & nuclear), BioPharma, Federal and State IT systems, Policy and Root Cause Analysis for a DOD FFRDC firm.
- Developed and deployed program management systems based on the Principles, Processes, and Practices in the this workshop.
- Some charts here are from *Performance-Based Project Management*[®], Glen B. Alleman, American Management Association, 2014.

2

These Principles, Practices, Processes, and Tools Have Been Applied with Success At ...

3

TLO's for the Master Workshop

- Introduce the Five Immutable Principles and the Processes that implement them
- Show how the 10 Practices enable project success through the Five Principles and Five Processes
- Apply these Principles, Processes, and Practices to a *Real* project – TSAS
 - Or a project selected by the class
- Develop an artifacts package for the project

4

Why is it so hard to accept the truth that Principles must be in place, before any Practices and Process can be applied that might increase the Probability of Success?

5

All Successful Projects Require Credible Answers To These Five Questions ...

1. What Does *DONE* Look Like in Units of Measure meaningful to the Decision Makers?
2. How Can We Get to *DONE*?
3. Is There Enough Time, Money, and Resources, to Get to *DONE*?
4. What Impediments Will We Encountered Along The Way to *DONE* and How can They be Removed?
5. What Meaningful Units of Measure are used to confirm Progress To Plan Toward *Done*?

6

All Project Success Starts with the First Principle of the Five Immutable Principles

- The needed Capabilities, stated as Measures of Effectiveness and Measures of Performance define what *Done* looks like.
- These capabilities trace Value to the Strategy.
- Capabilities lay the ground for adapting to change found on all projects with emerging requirements.
- Features and Functions fulfill the stated Requirements needed to implement the Capabilities.
- Capabilities provide the means to address unstated future requirements.

7

There are 5 Process and 10 Practices that go along with the 5 Principles

5 Principles	5 Processes	10 Practices
<ol style="list-style-type: none"> 1. What Does Done Look Like? 2. What is the Plan to reach Done? 3. What Resource are needed to reach Done? 4. What Impediments will be encountered along the way to Done? 5. What are the measures of progress to Plan? 	<ol style="list-style-type: none"> 1. Identify Needed Capabilities 2. Identify Requirements Baseline 3. Establish Performance Measurement Baseline 4. Execute the PMB 5. Continuous Risk Management 	<ol style="list-style-type: none"> 1. Capabilities drive requirements 2. Requirements identify Technical and Process deliverables 3. Work Packages describes deliverables 4. IMS arranges deliverables 5. WFP progress measured as Physical Percent Complete 6. WA assures WP produce deliverables in planned order 7. EV/ES describes performance to plan 8. Conformance with TPM adjusts EV 9. Feedback adjusts WP sequence and resource allocation 10. Future performance based on TCPI, IEAC, and adjusted work sequence

8

In time allotted for this course, let's focus on ...

5 Principles	5 Processes	10 Practices
<ol style="list-style-type: none"> 1. What Does Done Look Like? 2. What is the Plan to reach Done? 3. What Resource are needed to reach Done? 4. What Impediments will be encountered along the way to Done? 5. What are the measures of progress to Plan? 	<ol style="list-style-type: none"> 1. Identify Needed Capabilities 2. Identify Requirements Baseline 3. Establish Performance Measurement Baseline 4. Execute the PMB 5. Continuous Risk Management 	<ol style="list-style-type: none"> 1. Capabilities drive requirements 2. Requirements identify Technical and Process deliverables 3. Work Packages describes deliverables 4. IMS arranges deliverables 5. WFP progress measured as Physical Percent Complete 6. WA assures WP produce deliverables in planned order 7. EV/ES describes performance to plan 8. Conformance with TPM adjusts EV 9. Feedback adjusts WP sequence and resource allocation 10. Future performance based on TCPI, IEAC, and adjusted work sequence

9

Every Project Manager in Every Domain is Faced with Balancing Cost, Schedule, and Technical Performance on the Path to Done

Let's Learn how Principles, Processes and Practices can Increase the Probability of Project Success (PoPS)

10

Failure to define *Done* in a meaningful way, means the project starts out without a Mission, Vision, or Goal and without any associated metrics. Progress can only then be measured by the passage of time and consumption of money. For success, progress must be measured by the Effectiveness and Performance of its outcomes. Technical Performance Measures and Key Performance Parameters inform the Measures of Effectiveness (MoE) and Measures of Performance MoP.

Project Success Starts with the 1st of 5 Immutable Principles

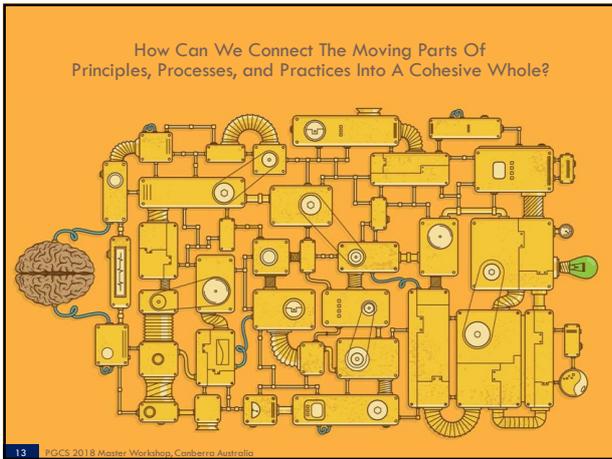
What Does Done Look Like in Units of Measure Meaningful to the Decision Makers

11

Let's Get Started ...

... But First Some Background Needed to Reach The End

12



13

These Connections Start with Three Core Frameworks...

- Data:** Data is the heart of Integrated Project Performance Management. Without data, we can't make decisions about program's performance meaningful to the decision makers – Dollars, Time, and Technical Performance. Without data, processes have nothing to work on.
- Processes:** Processes transform data into information. This information is used to make decisions about the program. The primary decision is how to correct or prevent undesirable variances to stay on plan to deliver needed capabilities.
- People:** People execute processes using data to increase Probability of Success for the program. People varying various roles and responsibilities in the process and the creation and use of the data.

14



15

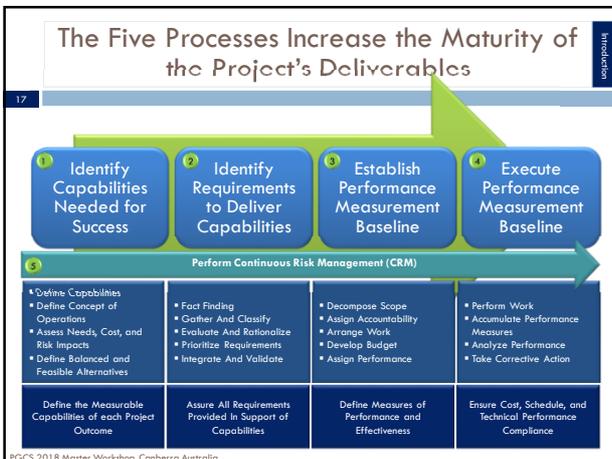
The 4+1 Questions Every Successful Project Must Answer

Capabilities Requirements Plans Execution + Continuous Risk Management

- What capabilities are needed to fulfill the Concept of Operations¹, the Mission and Vision, or the Business System Requirements?
- What technical and operational requirements are needed to deliver these capabilities?
- What schedule delivers the product or services on time to meet the requirements?
- What periodic measures of physical percent complete assure progress to plan?
- What impediments to success, their mitigations, retirement plans, or "buy downs are in place to increase the probability of success?"

1 A Concept of Operations (ConOps) describes the characteristics of a system from the point of view of an individual who will use that system. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders.

16



17

What is a Deliverable?

- The Deliverable is not the final assembled product.
- The Deliverable is the outcome of Work whose result increases the measurable maturity of the final assembled product.

Deliverables Incrementally Increase A Capability's Maturity

- Performance is specified and measurable.
- Design is complete and verifiable.
- Development is complete and testable.
- Testing complete, verified, and validated.
- Installation and deployment complete and operational.

Deliverables Result From "Units Of Work" – The Work Package

- Work Packages consume time and resources.
- Work Packages are owned by a single accountable person.
- Work Packages produce deliverables.

18

Five Process Areas Enabling the Five Principles of Project Success	
1 Identify Needed Capabilities	<p>What capabilities are needed to fulfill the project's mission or business goals?</p> <p>Define the set of capabilities needed to achieve the project objectives or the particular end state for a specific scenario. Using the Concept of Operations (ConOps), define the details of who, where, and how this capability is to be accomplished, employed, and executed.</p>
2 Establish Requirements Baseline	<p>What technical and operational requirements are needed to produce these capabilities?</p> <p>Define the technical and operational requirements for the system capabilities to be fulfilled. First, define these requirements in terms isolated from any implementation details. Only then bind the requirements with technology.</p>
3 Establish the Performance Measurement Baseline	<p>What is the schedule and cost to deliver products or services that meet the requirements?</p> <p>Build a time-phased network of work activities describing the work to be performed, the budgeted cost for this work, the organizational elements that produce the deliverables, and the performance measures showing this work is proceeding according to plan.</p>
4 Execute the Performance Measurement Baseline	<p>What are the periodic measures of physical percent complete?</p> <p>Execute work activities, while assuring all performance assessment represent 100% completion before proceeding. This means – No rework, no forward transfer of activities to the future. Assure all requirements are traceable to work & all work is traceable to requirements.</p>
5 Perform Continuous Risk Management	<p>What are the impediments to success and how are they being handled?</p> <p>Apply the processes of Continuous Risk Management for each Performance-Based Project Management® process area to Identify, Analyze, Plan, Track, Control, and Communicate programmatic and technical risk.</p>

19

1 Identify Needed Capabilities	<p>Define the capabilities needed to achieve a desired objective or a particular end state for a specific scenario. Define the details of who, where, and how these capabilities are to be delivered and employed to fulfill the Mission and Vision</p> <p>What capabilities are needed to fulfill the Business Case or a Program Mission?</p>
1.1 Define Capabilities as Operational Concepts	<ul style="list-style-type: none"> Partition system capabilities into classes of service within operational scenarios. Connect the capabilities to system requirements using some visual modeling notation. Define Measures of Effectiveness (MoE) and Measures of Performance (MoP). Define the delivery schedule for each measure of performance and effectiveness.
1.2 Define Capabilities with Scenarios or Use Cases	<ul style="list-style-type: none"> Define scenarios for each system capability. Connect these scenarios to a Value Stream Map of the increasing maturity of the program. Assess value flow through the map for each needed capability. Identify capability mismatches and make corrections to improve overall value flow.
1.3 Assess Needs, Costs, and Risks of the Capability Simultaneously	<ul style="list-style-type: none"> Assign costs to each system element using a value flow model. Assure risk, probabilistic cost and benefit performance attributes are defined. Use cost, schedule and technical performance probabilistic models to forecast potential risks to program performance.
1.4 Define Explicit, Balanced, & Feasible Alternatives	<ul style="list-style-type: none"> Make tradeoffs that connect cost, schedule, and technical performance in a single location that compares the tradeoffs and their impacts. Use Measures of Effectiveness (MoE) and Measures of Performance (MoP) for these alternative tradeoffs.

20

2 Establish Requirements Baseline	<p>Define the technical and operational requirements that must be met for the system capabilities to be delivered. Define these requirements in terms isolated from any technology or implementation. Assure each requirement is connected to a need system capability.</p> <p>What Technical and Operational Requirements are Needed to Deliver the Capabilities?</p>
2.1 Perform Fact Finding	<ul style="list-style-type: none"> Produce an overall statement of the problem in the operational context. Develop the overall operational and technical objectives of the target system. Defined the boundaries and interfaces of the target system.
2.2 Gather and Classify Requirements	<ul style="list-style-type: none"> Gather required system capabilities, functional, nonfunctional and environmental requirements, and design constraints. Build the Top Down capabilities and functional decomposition of the requirements in a Requirements Management System.
2.3 Evaluate and Rationalize Requirements	<ul style="list-style-type: none"> Answer the question "why do I need this?" in terms of operational capabilities. Build a cost / benefit model using probabilistic assessment of all variables, their dependencies, and impacts. For all requirements, perform a risk assessment to cost and schedule.
2.4 Prioritize Requirements	<ul style="list-style-type: none"> Determine criticality for the functions of the system. Determine trade off relationships for all requirements to be used when option decisions must be made. For all technical items, prioritize their cost and dependency.
2.5 Integrate and Validate Requirements	<ul style="list-style-type: none"> Address the completeness of requirements by removing all "TBD" items. Validate that the requirements are traceable to system capabilities, goals, and mission. Resolve any requirements inconsistencies and conflicts.

21

3 Establish Performance Measurement Baseline	<p>Build a time-phased network of activities describing the work to be performed, the budgeted cost for this work, the organizational elements that produce the deliverables from this work, and the performance measures showing this work is proceeding according to plan.</p> <p>A Baseline Schedule that Produces the Products or Services that Meet The Requirements</p>
3.1 Decompose Scope into Work Packages	<p>Decompose the program scope into a product based Work Breakdown Structure (WBS), then further into Work Packages describing the production of the deliverables traceable to the requirements, and to the needed capabilities.</p>
3.2 Assign Responsibility for Deliverables	<p>Assign responsibility to Work Packages (the groupings of deliverables) to a named owner accountable for the management of the resource allocations, cost and schedule baseline, and technical delivery.</p>
3.3 Arrange Work Packages in Logical Order	<p>Arrange the Work Packages in a logical network with defined deliverables, milestones, internal and external dependencies, with credible schedule, cost, and technical performance margins.</p>
3.4 Develop BCWS for Work Packages	<p>Develop the Time-Phased Budgeted Cost for Work Scheduled (BCWS) for the labor and material costs in each Work Package and the Project as a whole. Assure proper resource allocations can be met and budget profiles match expectations of the program sponsor</p>
3.5 Assign WP Measures of Performance	<p>Assign objective Measures of Performance (MoP) and Measures of Effectiveness (MoE) for each Work Package and summarize these for the Project as a whole.</p>
3.6 Set Performance Measurement Baseline	<p>Establish a Performance Measurement Baseline (PMB) used to forecast the Work Package and Project ongoing and completion cost and schedule performance metrics.</p>

22

4 Execute the Performance Measurement Baseline	<p>Execute the planned work, assuring all work is 100% complete before proceeding to the next planned work package. No rework, no forward transfer of activities or features. Assure every requirement is traceable to work and all work is traceable to requirements.</p> <p>How long are you willing to wait before you find out you're late?</p>
4.1 Perform the Authorized Work	<ul style="list-style-type: none"> Using the Work Package sequencing, release work to be performed as planned. With the responsibility assignments, identify the accountable delivery manager to guide the development of the products or services for each Work Package.
4.2 Accumulate and Report Work Package Performance	<ul style="list-style-type: none"> Using Physical Percent Complete or Apportioned Milestones, capture measures of progress to plan for each Work Package. Report this Physical Percent Complete in a centralized database for each Work Package and the program as a whole.
4.3 Analyze Work Package Performance	<ul style="list-style-type: none"> Compare the Physical Percent Complete against the Planned Percent Complete for each period of performance. Construct cost and schedule performance indices from this information and the Physical Percent complete measures.
4.4 Take Corrective Management Action	<ul style="list-style-type: none"> With Cost and Schedule performance indices, construct a forecast of future performance of cost, schedule, and technical performance compliance. Take management actions for any Work Packages not performing as planned.
4.5 Maintain the Performance Baseline	<ul style="list-style-type: none"> Record past performance based on Work Package completion criteria. Record past future forecast performance estimates in a historical database. Forecast next future performance estimate against the Performance Measurement Baseline. Report this next future performance estimate to the program stakeholders.

23

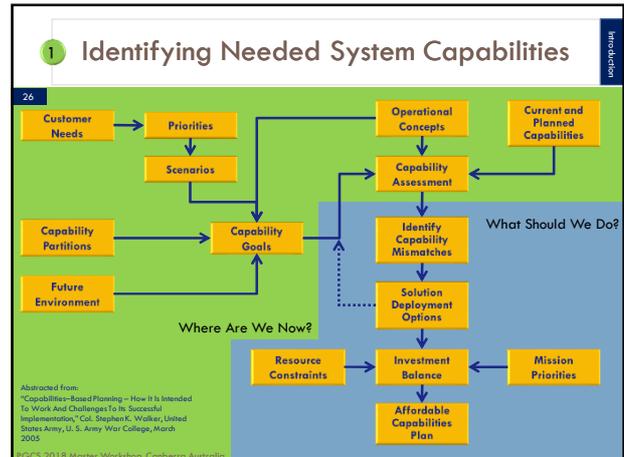
5 Perform Continuous Risk Management	<p>Continuous Risk Management starts with the underlying principles, concepts, and functions of risk management and provides guidance on how to implement risk management as a continuous practice in programs and the organizations that management programs.</p> <p>What are the impediments to success and what are their mitigations?</p>
5.1 Identify Risks	<ul style="list-style-type: none"> Identify and classify risks in a Risk Register. Separate reducible and Irreducible risks Manage this Risk Register through a Risk Management Board. Connect these risks and their handling and margins in the Master Schedule.
5.2 Analyze Risks	<ul style="list-style-type: none"> Convert risk data into risk decision-making information. Use this analysis information as the decision basis for the program manager to work on the "right" risks.
5.3 Plan Risk Response	<ul style="list-style-type: none"> Turn risk information into decision making information and actions (both present and future). Develop actions to address individual risks, prioritize risk actions, and create an integrated risk management plan to retire the risk or handle it when it turned into an issue.
5.4 Track the Risk Management Activities	<ul style="list-style-type: none"> Monitor the status of risks and actions taken to ameliorate risks. Identify and monitor risks to enable the evaluation of the status of risks themselves and of risk mitigation plans.
5.5 Control or Accept the Risks	<ul style="list-style-type: none"> Risk communication lies at the center of the model to emphasize both its pervasiveness and its criticality. Without effective communication, no risk management approach can be viable.

24

1 What Does A Capability "Sound" Like?

- We need the *capability* to pre-process insurance claims at \$0.07 per transaction rather than the current \$0.11 per transaction.
- We need the *capability* to remove 1½ hours from the retail ordering process once the merger is complete.
- We need the *capability* to change the Wide Field Camera and the internal nickel hydride batteries, while doing no harm to the telescope.
- We need the *capability* to fly 4 astronauts to the International Space Station, dock, stay 6 months, and return safely.
- We need the *capability* to control the Hell Fire Missile with a new touch panel while maintaining existing navigation and guidance capabilities in the helicopter.
- We need the *capability* to comply with FAR Part 15 using the current ERP system and its supporting work processes.

25



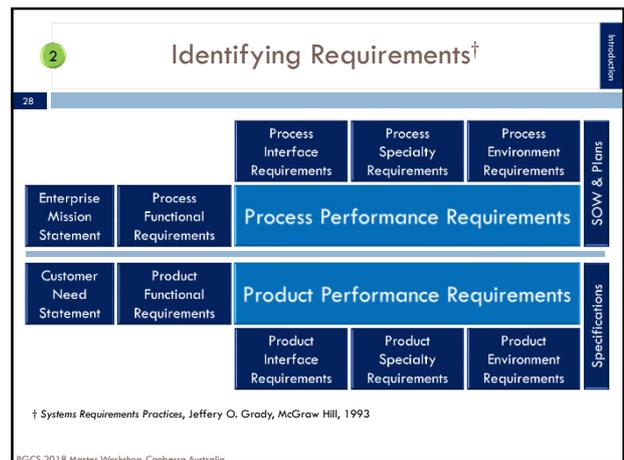
26

2 What Is a Requirement?

A Requirement is ... "A statement identifying a capability, a physical characteristic, or a quality factor that bounds a product or process need for which a solution will be pursued."
 – IEEE Standard 1220-2007-05-15

The hardest single part of building a system is **deciding** what to build ...
 ... No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later.
 – Fred Brooks "No Silver Bullet," 1987

27

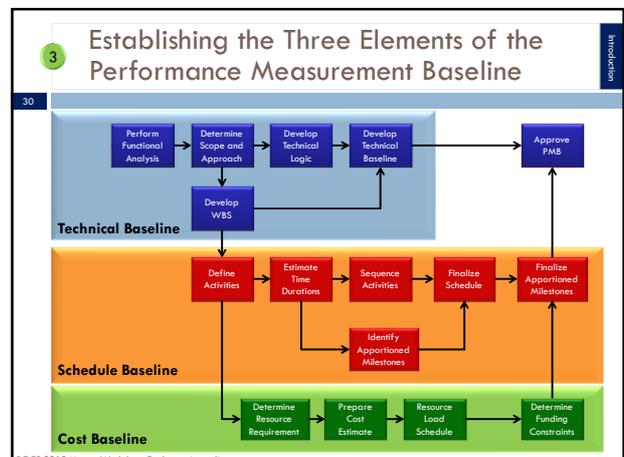


28

3 What Does a Credible Based Plan and Schedule Look Like?

- The **Plan** is the strategy to successfully deliver the needed Capabilities, described through Significant Accomplishments and their Accomplishment Criteria.
- The **Schedule** is the sequence of the work activities measured by the Accomplishment Criteria, that follow the **Plan** of the Significant Accomplishments.
- A credible **Plan** and **Schedule** means there is a statistical model of cost, schedule, and technical performance of deliverables as the foundation of the credibility of the program's probability of success.

29



30

4 How Do We Know We Are Making Progress to Plan?

- The **Best** measure of progress is the assessment of physical percent complete against the planned percent complete.
- This measurement **Must** be in units meaningful to the decision makers.
- These units can be:
 - Planned capabilities defined in Measures of Effectiveness,
 - Planned capacities defined in Measures of Performance,
 - Planned features and functions defined in Technical Performance Measures,
 - Planned quantities defined in Key Performance Indicators.
- Done** is evidenced by the production of deliverables, on the planned date, for the planned cost, with the planned measures of that performance.

31

4 Executing the Performance Measurement Baseline (PMB)

- Authorize and perform the Work according to the Plan (BCWS) described in the network of Work Packages and Planning Packages held in the scheduling tool.
- Accumulate and Report Performance Data using Earned Value (BCWP) and other measures of increasing maturing based on the assessment of the Physical Percent Complete.
- Analyze the Performance Data derived from the Earned Value metrics and make any adjustments to the network of Work Packages.
- Take management actions for any variances to assure on-time, on-budget and on-specification of all deliverables produced by the Work Packages.
- Maintain the Performance Management Baseline (PMB) throughout the programs duration for all Earned Value parameters.

32

5 Perform Continuous Risk Management

For Each Risk...

- Identify**: Subproject and partner data/constraints, hazard analysis, FMEA, FTA, etc. → Identify Risks, Issues, and Concerns → Statement of Risk
- Analyze**: Risk data: test data, expert opinion, hazard analysis, FMEA, FTA, lessons learned, technical analysis → Evaluate, classify, and prioritize risks → Risk classification, Likelihood Consequence, Timeframe Risk prioritization
- Plan**: Resources → Research, Watch (tracking requirements) → Acceptance Rationale, Mitigation Plans
- Track**: Replan Mitigation → Program/project data (metrics information) → Monitor risk metrics and verify/validate mitigations → Risk status reports on: Risks Risk Mitigation Plans
- Control**: → Close or Accept Risks Invoke contingency plans Continue to track

Make risk decisions

33

Integrating all the Parts into a Whole

34

From Mission Capabilities to Done

Acquirer Defines the Needs and Capabilities in terms of Operational Scenarios → Mission Need → MoE → MoP → TPM

Supplier Defines Physical Solutions that meet the needs of the Stakeholders → KPP → MoP → TPM

MoE: Operational measures of success related to the achievement of the mission or operational objective being evaluated.

MoP: Measures that characterize physical or functional attributes relating to the system operation.

TPM: Measures used to assess design progress, compliance to performance requirements, and technical risks.

35

4+1 Critical Processes for Success

Capabilities, Requirements & Deliverables	Program Architecture & Dependencies	Work Planning and Sequencing	Performance Measurement Baseline	Programmatic & Technical Risk Management
<ul style="list-style-type: none"> Balanced Scorecard Concept of Operations Statement of Objectives Requirements Traceability Measures Of Effectiveness (MoE) 	<ul style="list-style-type: none"> Integrated Master Plan (IMP) Gaps Overlaps Interfaces Value Stream Mapping (VSM) Design Structure Matrix (DSM) 	<ul style="list-style-type: none"> Integrated Master Schedule (IMS) Schedule margin to protect critical deliverables Work Packages Planning Packages Earned Value Management 	<ul style="list-style-type: none"> Cost And Schedule Baseline WBS RAM Resource Loaded IMS Technical Performance Measures (TPM) Measures Of Performance (MoP) 	<ul style="list-style-type: none"> Risk Registry Risk Handling Plans Contingency And Management Reserve Risk Integrated With IMS Risk Trending Monte Carlo Simulation

36

Getting On the Road to Success Means ...

... Providing Credible Answers To 5 Core Project Questions.

1	▶ Where are we going?	Capabilities and Requirements
2	▶ How do we get there?	Master Plan and Schedule
3	▶ Are there enough resources?	Contract Budget Baseline
4	▶ What are impediments to progress?	Risk Management Plan
5	▶ How do we measure progress?	Earned Value Management

37 PGCS 2018 Master Workshop, Canberra Australia Introduction

37

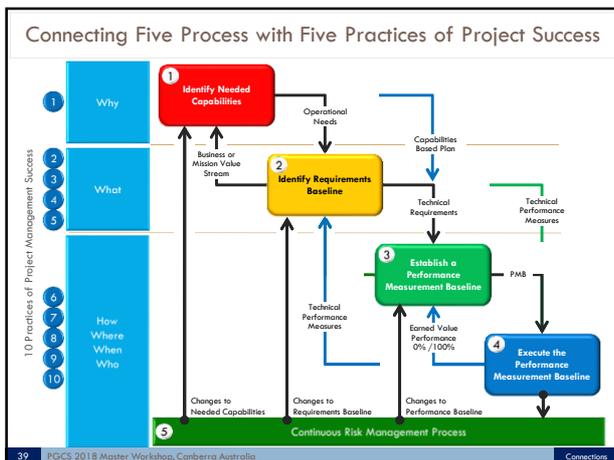
Practices of Performance-Based Project Management® guide the application of the 5 Principles and the 5 Process Areas in this handbook.

These practices define the reasons for each process, connect each practice to a beneficial outcome, and integrate the processes into a seamless delivery system.

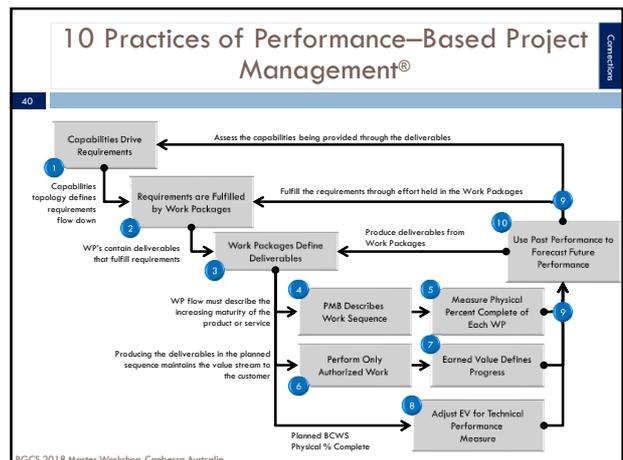
Connecting 5 Principles and 5 Processes With 10 Practices

38 PGCS 2018 Master Workshop, Canberra Australia Connections

38



39



40

Enough Show and Tell, Let's ...

41 PGCS 2018 Master Workshop, Canberra Australia

41

A Quick Reminder of the 5 Principles

Principle	Evidence the Principle of Being Implemented
What does Done Look Like?	Integrated Master Plan (IMP) with Measures of Effectiveness (MoE) and Measures of Performance (MoP)
What's the Plan and Schedule to get Done?	Integrated Master Schedule (IMS) with Technical Performance Measures (TPM) and Key Performance Parameters (KPP)
What resources do we need for Done?	Resource loaded IMS
What impediments will we encounter along the way?	Risk adjusted IMS
What are the units of progress toward Done?	Earned Value (EV) and Earned Schedule (ES) informed by compliance with compliance plans for MoE, MoP, TPM, KPP, Risk Buydown, and Margin Buydown

42 PGCS 2018 Master Workshop, Canberra Australia

42

One More Reminder, Project Success is About Doing a Lot Things Right ...

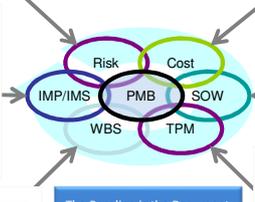
... But in the End, it's always About the Numbers



Cost Numbers, Schedule Numbers, Risk Numbers, Technical Performance Numbers

43

Integrating the Parts of a Credible Program Management System (PMS)



- Technical and Programmatic Risks Connected through the WBS, Risk Register, Plan and Schedule
- Budget at the Work Package level, rolled to the Control Accounts showing cost spreads for all work in the IMS
- Schedule contains all the Work Packages, Budget, Risk mitigation plans, with traces to the Plan measuring increasing maturity through Measures of Effectiveness (MoE) and KPPs (JROC and Program)
- Deliverables defined in the SOW, traced to the WBS, with narratives and Measures of Performance (MoP)
- The Products and Processes in a "well structured" decomposition, traceable to the deliverables
- Measures of Performance (MoP) for each critical deliverable in the WBS and identified in each Work Package in the IMS, used to assess maturity in the IMP

44

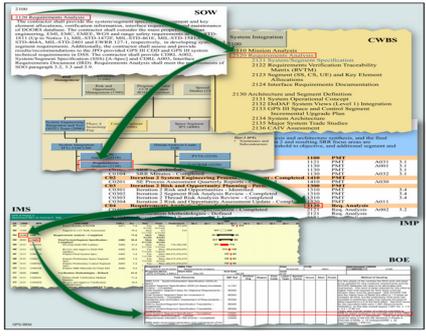
Before We Start the Hands On Part What does it mean to be Credible? The Simplest Answer is ...

Our Artifact's Are Believable

A credible
Integrated Master Plan, Integrated Master Schedule,
Cost Baseline, Risk Baseline, Estimate At Completion,
Physical Percent Complete

45

That are Connected in this Way



46

1 The WBS is Paramount

- The WBS defines the deliverables and the supporting processes that produce them
- The WBS Dictionary describes the technical and operation behaviors that will be assessed during the development of the deliverables
- The terminal nodes of the WBS define the deliverables produced by the Work Packages in the IMS and assessed through the IMP Accomplishment Criteria (AC)

47

2 The IMP Starts with the Buyer

- The IMP defines the measuring of increasing maturity for the deliverables as the program moves from left to right
- Significant Accomplishments (SA) are defined by the Measures of Effectiveness (MoE)
- Accomplishment Criteria (AC) are defined by the Measures of Performance (MoP)
- Risks are assigned at all levels of the IMP and IMS

48

3 Natural Uncertainties and Event Based Risks[†]

- Natural uncertainties in cost and schedule processes create risks to completing on time and on budget
- Event based risks create impacts to cost, schedule, and technical performance
- Event based risks are *handled* through risk mitigations
- Natural uncertainties are *handled* through in cost, schedule, and technical performance margins
- To be credible, the PMB must include both type of risks with their handling strategies

[†] These are referred to in the literature as Aleatory and Epistemic. We'll use the naturally occurring and Event Based in this introduction, but these terms are consider *operational* rather than mathematical.

49

4 Costs Assigned to *Packages of Work*

- Labor and material cost are represented in the Integrated Master Schedule (IMS) and provide visibility to the probability of program success
- Variances in labor and material costs are modeled in the same way as work durations
- Event based risks impact both cost and schedule and are modeled in the PMB
- Risk retirement cost is allocated for the work effort in response to Event Based risks

50

5 Statement of Work

- Work in the PMB starts with the Statement of Work and flows through the Work Breakdown Structure
- Measures of Effective (MoE) and Measures of Performance (MoP) can be defined in the SOW or WBS Dictionary
- Traceability from the IMP to the IMS to all performance measures in the SOW is the basis of program performance measurement

51

6 Technical Performance Measures

- Key Performance Parameters (KPP, both Acquisition owner and Program specific) and Technical Performance Measures (TPM) define how the deliverables complying with the Statement of Work, Concept of Operations, and CDRLs
- TPMs inform the measures cost and schedule for delivered program outcomes
- TPM, MoE, MoP, and KPPs provide assessment of the cost and schedule effectiveness

52

TSAS



Ground Based Sensors

Command and Data Center

UAV with Airborne Sensors

Mobile Sensors

53

TSAS



Ground Based Sensors

Command and Data Center

UAV with Airborne Sensors

Mobile Sensors

54

Top Level Capabilities for Airborne Sensors

Capability	Program Goal
Maximum Range	2,000 NM
Maximum Altitude	35,000 feet
Maximum endurance	12 hours
SATCOM Link	1.5 – 50 Mbps
LOS Datalink	> 50.0 Mbps
Synthetic Aperture Radar (SAR)	1.0/0.3m resolution (WAS/Spot)
Moving Target Indicator (MTI)	20 -200km/10m Range resolution
Electro Optical	NIIRS 6.5/6.0 (Spot/WAS)
Infrared	NIIRS 5.5/5.0 (Spot/WAS)
Wide Area Search	250 Sq. NMI/Day (50 x 50)
Target Coverage	1,000 spot targets / day
Location Accuracy	< 20 meter CEP

55

TSAS Performance Measures Derived from those Top Level Capabilities

TSAS Element	Measures	Answers the Question	Example
SOW, SOO, ConOps	Measures of Effectiveness (MoE)	How Do We Know we are Accomplishing the Mission?	We need the capability to Increase IED Placement search capabilities by 50%
WBS	Technical Performance Measure (TPM)	What are we building and how do we know it meets the specifications that will accomplish the Mission?	Systems, subsystems, and supporting processes for each deliverable
IMP – PE and SA	MoE for the Program Events and Significant Accomplishments	How can we measure the increasing maturity of the deliverables in the narratives in the Capabilities Based documents	Sensor payloads capable of IR and UV detectors within the avionics bay
IMP – AC	Measures of Performance (MoP)	Technical Performance of the deliverables derived from the MoEs	100 square miles per hour search capabilities
IMS	Technical Performance Measures (TPM)	How does the work increase the maturity of the deliverables?	Sensor platform TPMs inside the bounds, on-time, on-schedule?
Tasks	CPI, SPI, TCPI	What work is needed to increase the maturity of the deliverables?	Cost and schedule matching TPM progress?
Risk Register	Identified risks, with handling strategies	What are the Epistemic risks and how are they represented in the IMS?	All aleatory risks included in duration and cost. Epistemic risk retirement handled in IMS, others contained in MR

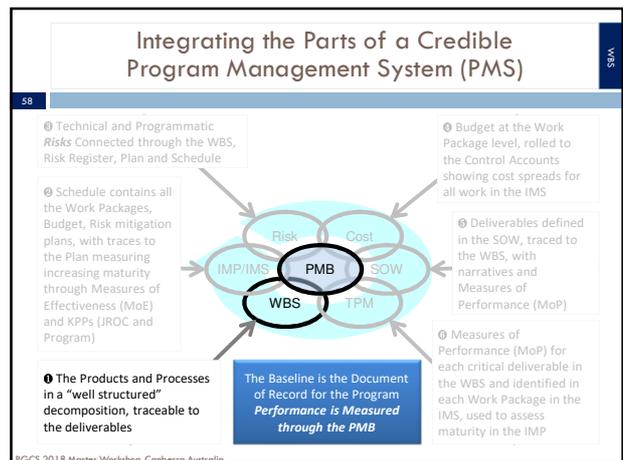
56

The Work Breakdown Structure is our starting point for developing all other elements needed for the Performance Measurement Baseline.

The TSAS WBS is defined using the a standard. In the US that is MIL-STD-881C, with an appendix for UAVs. From this, the details of the avionics subsystems will be used for the development of the Integrated Master Plan and Integrated Master Schedule.

The WBS is Paramount

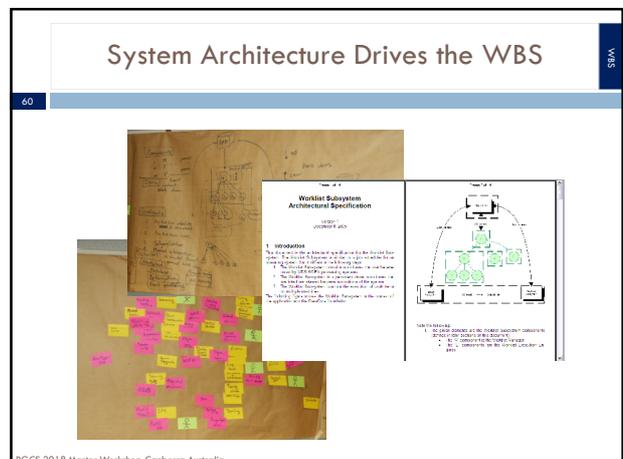
57



58

- ### What is the Work Breakdown Structure?
- Defines the total System or the System of Systems (SoS)
 - Provides the framework for planning, prioritizing, managing, and tracking all work done on the program
 - Products
 - Supporting services
 - Facilities
 - Provides the framework for
 - Cost Structure for estimating and cost reporting
 - Resource allocation
 - Status Reporting
 - Performance Measurement
 - Identify and managing program risk

59



60

Structure of the TSAS WBS

- End Products used to implement the mission
 - ▣ Based on the System (Physical) Architecture
- Enabling Products and Services
 - ▣ Products and services required to develop, produce, and support the end items
 - ▣ Based on Life Cycle
- The first three (end product) WBS levels:
 - ▣ Level 1: Overall System
 - ▣ Level 2: Major Element (or Segment)
 - ▣ Level 3: Subordinate Components (or Prime Items)
- Levels 4+ continue the decomposition to the Configuration Item (CI) level

61

Three WBS's for TSAS

Program WBS	Contract WBS	Subcontract WBS
<ul style="list-style-type: none"> □ High-Level (First 3 levels) □ Provides Program Structure □ Generally developed/controlled by Customer (Government) 	<ul style="list-style-type: none"> □ Detailed (Levels 4+) □ Provides framework for Contract Work Packages and Costing □ Generally developed by Contractor □ Generally follows Program WBS 	<ul style="list-style-type: none"> ▣ Detailed (Level 4+) ▣ Provides framework for Subcontract Work Packages and Costing ▣ Generally developed by Subcontractor ▣ Generally follows Contract WBS

62

Level 1 (System of Systems) WBS

1.0 Tactical Situational Awareness System (TSAS)	
1.1	Unmanned Air Vehicle (UAV)
1.2	Mobile Sensor System
1.3	Ground Based Sensors
1.4	Ground / Host Segment (Command and Control)
1.5	System of Systems Engineering
1.6	Program Management
1.7	System of Systems Test and Integration
1.8	System of Systems Training
1.9	Systems of Systems Data Packages
1.10	Peculiar Support Equipment
1.11	Common Support Equipment
1.12	Operational and Site Support
1.13	Industrial Facilities
1.14	System of Systems Initial Spares and Repair Parts



63

Level 2 Unmanned Air Vehicle (UAV)

1 TSAS Unmanned Air Vehicle	
1.1	Air Vehicle
1.2	Payload
1.3	Ground / Host Segment
1.4	UAV Software Integration Releases
1.5	UAV System Integration, Assembly, Test and Checkout
1.6	Systems Engineering
1.7	Program Management
1.8	System Test And Evaluation
1.9	Training
1.10	Data Package(s)
1.11	Peculiar Support Equipment
1.12	Common Support Equipment
1.13	Operational/Site Activation
1.14	Industrial Facilities
1.15	Initial Spares and Repair Parts



64

Level 3 UAV Avionics

1 TSAS Unmanned Air Vehicle	
1.1	Air Vehicle
1.1.1	Airframe
1.1.2	Propulsion
1.1.3	Vehicle Subsystems
1.1.4	Air Vehicle Avionics
1.1.5	Air Vehicle Auxiliary Equipment
1.1.6	Air Vehicle Crosscutting Software Releases
1.1.7	Air Vehicle Integration, Assembly, Test and Checkout
1.2	Payload
1.3	Ground / Host Segment
1.4	UAV Software Integration Releases
1.5	UAV System Integration, Assembly, Test and Checkout
1.6	Systems Engineering
1.7	Program Management
1.8	System Test And Evaluation
1.9	Training
1.10	Data Package(s)
1.11	Peculiar Support Equipment
1.12	Common Support Equipment
1.13	Operational/Site Activation
1.14	Industrial Facilities
1.15	Initial Spares and Repair Parts



65

Level 4 UAV Avionics – GN&C

1 TSAS Unmanned Air Vehicle	
1.1	Air Vehicle
1.1.1	Airframe
1.1.2	Propulsion
1.1.3	Vehicle Subsystems
1.1.4	Air Vehicle Avionics
1.1.4.1	Avionics Integration, Test, and Checkout
1.1.4.2	UHF/VHF Communications and Data Link
1.1.4.3	Navigation & Guidance
1.1.4.4	Automated Flight Control
1.1.4.5	Health Monitoring System
1.1.4.6	N/A (Stores Management)
1.1.4.7	Mission Management Computer/Processing
1.1.4.8	N/A (No Fire Control System)
1.1.4.9	Avionics System Crosscutting Software Releases
1.1.4.10	Avionics System Crosscutting Software Subsystems
1.1.4.11	Avionics Crosscutting Systems Engineering
1.1.4.12	Avionics System Program Management



66

Level 4 UAV Avionics - MMS




TSAS Unmanned Air Vehicle	
1.1	Air Vehicle
1.1.1	Airframe
1.1.2	Propulsion
1.1.3	Vehicle Subsystems
1.1.4	Air Vehicle Avionics
1.1.4.1	Avionics Integration, Test, and Checkout
1.1.4.2	UHF/VHF Communications and Data Link
1.1.4.3	Navigation & Guidance
1.1.4.4	Automated Flight Control
1.1.4.5	Health Monitoring System
1.1.4.6	N/A (Stores Management)
1.1.4.7	Mission Management Computer/Processing
1.1.4.8	N/A (No Fire Control System)
1.1.4.9	Avionics System Crosscutting Software Releases
1.1.4.10	Avionics System Crosscutting Software Subsystems
1.1.4.11	Avionics Crosscutting Systems Engineering
1.1.4.12	Avionics System Program Management

67

Building the IMP is a Systems Engineering activity.

The Integrated Master Plan (IMP) is a Programmatic Architecture in the same way the hardware and software are a Product Architecture.

Poor, weak, or unstructured Programmatic Architecture reduces visibility to the Product Architecture's performance measures of cost and schedule connected with Technical Performance Measures.

The Measures of Effectiveness (MoE) and Measures of Performance (MoP) are held in the Integrated Master Plan (IMP)

68

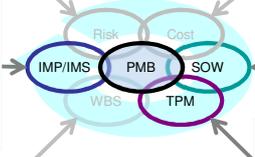
Quick View of Building the IMP

- Start with each Program Event and define the Significant Accomplishments their entry and exit criteria to assess the needed maturity of the key deliverables
- Arrange the Significant Accomplishments in the proper dependency order
- Segregate these Significant Accomplishments into swim lanes for IPTs
- Define the dependencies between each SA

69

Integrating the Parts of a Credible Program Management System (PMS)

- ① Technical and Programmatic Risks Connected through the WBS, Risk Register, Plan and Schedule
- ② Schedule contains all the Work Packages, Budget, Risk mitigation plans, with traces to the Plan measuring increasing maturity through Measures of Effectiveness (MoE) and KPPs (JROC and Program)
- ③ The Products and Processes in a "well structured" decomposition, traceable to the deliverables



- ④ Budget at the Work Package level, rolled to the Control Accounts showing cost spreads for all work in the IMS
- ⑤ Deliverables defined in the SOW, traced to the WBS, with narratives and Measures of Performance (MoP)
- ⑥ Measures of Performance (MoP) for each critical deliverable in the WBS and identified in each Work Package in the IMS, used to assess maturity in the IMP

The Baseline is the Document of Record for the Program Performance is Measured through the PMB

70

The Critical Purpose of the IMP

Product-Oriented

	Space Segment	Ground Segment	I&T Segment
	SE Satellite Payload	Satellite Cntl Data Fusion	PM SE I&T
Engineering	↓	↓	↓
Test	↓	↓	↓
Mfg	↓	↓	↓
Suppliers	↓	↓	↓
Contracting	↓	↓	↓
Legal	↓	↓	↓
Financial Mgt	↓	↓	↓
Logistics	↓	↓	↓
Design	↓	↓	↓

Functional-Oriented

	Space Segment	Ground Segment	I&T Segment
	SE Satellite Payload	Satellite Cntl Data Fusion	PM SE I&T
Engineering	→	→	→
Test	→	→	→
Mfg	→	→	→
Suppliers	→	→	→
Contracting	→	→	→
Legal	→	→	→
Financial Mgt	→	→	→
Logistics	→	→	→
Design	→	→	→

The IMP defines the connections between the Product maturity – Vertical – and the implementation of this Product maturity through the Functional activities – the Horizontal

71

Next Step is the Build an Integrated Master Plan

- From the WBS define the Significant Accomplishments (SA) and Accomplishment Criteria (AC) for each Program Event (PE) for each of the terminal nodes in the WBS

What must be accomplished to complete the Program Event?

This is where the WBS and the IMP are joined and are at the same time separate Both are needed for a credible PMB

72



The IMP tells us where is the program going?

The Integrated Master Plan (IMP) Is A Strategy For The Successful Completion Of The Project

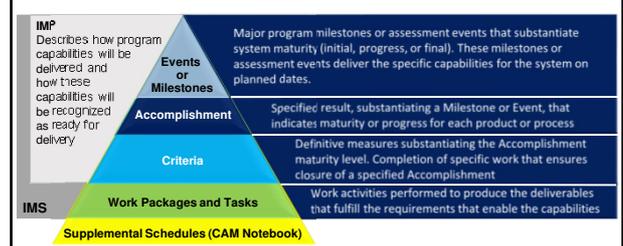
The Plan describes where we are going, the various paths we can take to reach our destination, and the progress or performance assessment points along the way to assure we are on the right path.

These assessment points measures the "maturity" of the product or service against the planned maturity. This is the only real measure of progress – not the passage of time or consumption of money.

73 PGCS 2018 Master Workshop, Canberra Australia

73

The IMP / IMS Structure



IMP
Describes how program capabilities will be delivered and how these capabilities will be recognized as ready for delivery

Events or Milestones
Major program milestones or assessment events that substantiate system maturity (initial, progress, or final). These milestones or assessment events deliver the specific capabilities for the system on planned dates.

Accomplishment
Specified result, substantiating a Milestone or Event, that indicates maturity or progress for each product or process

Criteria
Definitive measures substantiating the Accomplishment maturity level. Completion of specific work that ensures closure of a specified Accomplishment

IMS
Work Packages and Tasks
Work activities performed to produce the deliverables that fulfill the requirements that enable the capabilities

Supplemental Schedules (CAM Notebook)

This decomposition is not unique to the IMP/IMS paradigm. Without some form of decomposition of what **DONE** looks like, it is difficult to connect the work of the project to the outcomes of the project. This decomposition – which is hierarchical - provides the mechanism to increase cohesion and decrease coupling of the work effort. This coupling and cohesion comes from the systems architecture world is has been shown to increase the robustness of systems. The project cost, schedule, and resulting deliverables are a system, subject to these coupling and cohesion.

74 PGCS 2018 Master Workshop, Canberra Australia

74

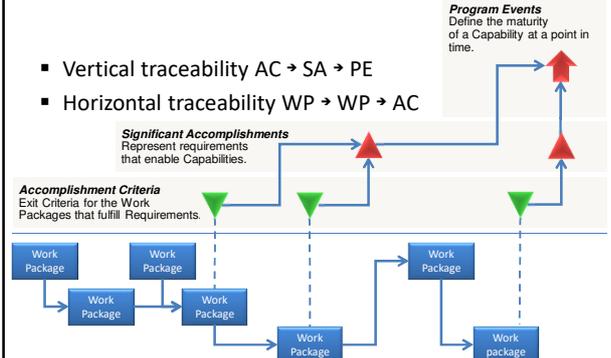
Vertical and Horizontal Traceability

- Vertical traceability AC → SA → PE
- Horizontal traceability WP → WP → AC

Program Events
Define the maturity of a Capability at a point in time.

Significant Accomplishments
Represent requirements that enable Capabilities.

Accomplishment Criteria
Exit Criteria for the Work Packages that fulfill Requirements.

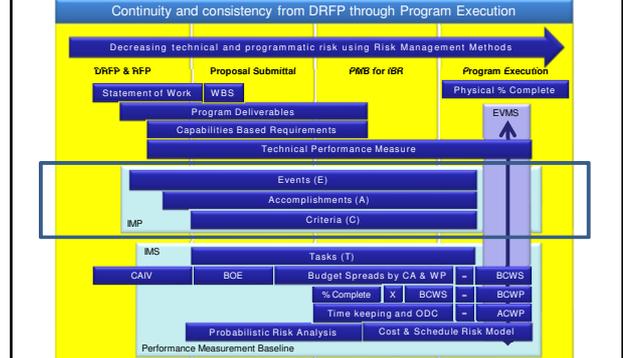


75 PGCS 2018 Master Workshop, Canberra Australia

75

The IMP's role during Execution

Continuity and consistency from DRFP through Program Execution



76 PGCS 2018 Master Workshop, Canberra Australia

76

The IMP speaks to Measures of Effectiveness (MoE) and Measures of Performance (MoP)

Mission Capabilities and Operational Need

Measures of Effectiveness (MoE)	Measures of Performance (MoP)	Technical Performance Measures (TPM)
<ol style="list-style-type: none"> Provide Precision Approach for a 200 FT/0.5 NM OH Provide bearing and range to AC platform Provide AC surveillance to GRND platform 	<ol style="list-style-type: none"> Net Ready <ul style="list-style-type: none"> IPv4/6 compliance 1Gb Ethernet Guidance quality <ul style="list-style-type: none"> Accuracy threshold p70 @ 6M Integrity threshold 4M @ 10° Approach Land interoperability <ul style="list-style-type: none"> Processing capability meets LB growth matrix Manpower <ul style="list-style-type: none"> MTBC >1000 hrs MCM < 2 hrs Availability <ul style="list-style-type: none"> Clear threshold >99% Jam threshold >90% 	<ol style="list-style-type: none"> Net Ready <ul style="list-style-type: none"> Standard message packets Guidance Quality <ul style="list-style-type: none"> Multipath allocation budget Multipath bias protection Land Interoperability <ul style="list-style-type: none"> MOSA compliant Civil compliant Manpower <ul style="list-style-type: none"> Operating elapsed time meters Standby elapsed time indicators Availability <ul style="list-style-type: none"> Phase center variations

JROC Key Performance Parameters (KPP)

- Net Ready
- Guidance Quality
- Land Interoperability
- Manpower
- Availability

Technical Insight – Risk adjusted performance to plan

- This is where TPMs are connected with the MoE's and MoP's
- For each deliverable from the program, all the "measures" must be defined in units meaningful to the decision makers.
- Here's some "real" examples.

77 PGCS 2018 Master Workshop, Canberra Australia

77

F-22 Example



- Program Event (PE)**
 - A PE assess the readiness or completion as a measure of progress
 - First Flight Complete*
- Significant Accomplishment (SA)**
 - The desired result(s) prior to or at completion of an event demonstrate the level of the program's progress
 - Flight Test Readiness Review Complete*
- Accomplishment Criteria (AC)**
 - Definitive evidence (measures or indicators) that verify a specific accomplishment has been completed
 - SEEK EAGLE Flight Clearance Obtained*

78 PGCS 2018 Master Workshop, Canberra Australia

78

The IMP's connection to the WBS

- Start with the Significant Accomplishments and sequence them to the maturity flow for each Program Event
- The WBS connections then become orthogonal to this flow

Program Event	SRR	SDR	PDR	CDR	TRR	ATLO
4.920-SDAI	A01, A02	B01	C01, C02	D01	E01	F01
4.200-Sys Test	A05	B03, B04	D02, D03	E02	F02	
4.300-Radar	A03	B02	C03	E03	F03, F04	
4.330-O&C Sys	A06, A07	B05	C04	D04	E04	F03, F04
4.400-I&T	A08	C05	E05, E06	F05		
4.500-Support	A09		D05	E07	F06, F07	

79

The Primary Role of the IMP is to Describe what Done Looks Like in MoE's and MoP's

19 October 1899 Robert Goddard decided that he wanted to "fly without wings" to Moon.

80

Developing the Integrated Master Schedule from the Integrated Master Plan

The Integrated Master Schedule (IMS) is derived directly from the Integrated Master Plan's Accomplishment Criteria (AC). The IMS shows the order in which the Work Packages must be performed to assure the Accomplishment Criteria are completed within the define Measures of Performance, the Key Performance Parameters, and the Technical Performance Measures.

81

Quick View of Building the IMS

- The WBS is Paramount
- The IMP defines the increasing maturity of the program's deliverables (end item)
- The IMS sequences the Work Packages containing the work activities to produce the End Item Deliverables
- The IMS is built from the IMP, with WBS coding to assure coverage of all deliverables

82

The Integrated Master Schedule

- The horizontal sequence of work activities that produce increasing maturity of the product or services delivered by the program

83

A Credible Integrated Master Plan Must ...

- Show what **Done** looks like through tangible evidence of success
- Show the order of the work needed to get to **Done** at each stage
- Define the needed resources to reach **Done**
- Identify risks to **Done** and their handling
- Measure physical progress toward **Done** in units meaningful to the decision makers

84

Building the Integrated Master Schedule requires 10 Steps

- 1 Capture All Activities
- 2 Sequence These Activities
- 3 Assign Resources To These Activities
- 4 Establish Duration For These Activities
- 5 Verify Schedule Is Traceable Horizontally And Vertically
- 6 Confirm Valid Critical Path – schedule matches program
- 7 Ensure Reasonable Total Float
- 8 Conduct Schedule Risk Analysis
- 9 Update Schedule With Actual Progress
- 10 Maintain Baseline with Repeatable Process

PGCS 2018 Master Workshop, Canberra Australia

85

Back to the WBS It connects Work Packages in IMS to IMP

The WBS is derived from the breakdown of the business capabilities and their stated requirements. From this WBS Work Packages are defined with their deliverables. The tasks that produce these deliverables are not explicitly stated in the Performance Measurement Baseline, but rather are held by the Work Package Manager. Physical percent complete performance is measured through apportioned milestones or a 0%/100% outcome for the Work Package.

Callouts in diagram:
 - A decomposition of the work needed to fulfill the business requirements.
 - Terminal Node in the WBS defines the products or services of the project.
 - Terminal node of the WBS defined by a Work Package.
 - Tasks within the Work Package produce the Deliverables.
 - Management of the Work Package Tasks is the responsibility of the WP Manager. These are not held in the master plan.
 - Deliverables defined in WP.
 - 100% Completion of deliverables is the measure of performance for the Work Package.

PGCS 2018 Master Workshop, Canberra Australia

86

The IMS Provides Visibility to ...

Mission Requirements	Deliverables represent the required mission capabilities and their value as defined by the mission and shared by the development team.
Technical Capabilities	When all deliverables and their Work Packages are completed, they are not revisited or reopened.
Work Packages	The progression of Work Packages defines the increasing maturity of the project.
Deliverables	Completion of Work Packages is represented by the <i>Physical Percent Completion</i> of the program.

PGCS 2018 Master Workshop, Canberra Australia

87

Quantifiable Backup Data (QBD)

- QBD is a detailed listing of tasks necessary to complete all scope in a work package during the defined period of performance.
- It is an approach to objectively measure performance
 - Each task on the list is weighted – total weighting equals 100% of the work package's Budget at Completion. This weighting should not be equal weighting on every task.
 - The CAM assesses physical percent complete of each QBD task.
 - The percent complete is calculated from the cumulative assessments.
- The purpose of the QBD is to help:
 - Ensure and demonstrates that all contract work is accounted for
 - Ensure the schedule and budget are realistic and achievable
 - Mitigate schedule and budget risks
 - Provide a basis for objectively assessing progress for discretely measured work packages.

PGCS 2018 Master Workshop, Canberra Australia

88

Naturally occurring uncertainties (Aleatory) in cost, schedule, and technical performance can be modeled in a Monte Carlo Simulation tool.

Event Based uncertainties (Epistemic) require capturing and defining the probability of their occurrence, modeling their impacts, defining handling strategies, modeling the effectiveness of these handling strategies, and modeling the residual risks, and the impacts of both the original risk and the residual risk on the program.

The management of Uncertainties in cost, schedule, and technical performance; and the Event Based uncertainty and the resulting risk are both critical success factors for the programs.

Risk Management is Project Management for Adults – Tim Lister

PGCS 2018 Master Workshop, Canberra Australia

89

Core Elements of Program Risk Management

- The effectiveness of risk management depends on the people who set it up and coordinate the risk management process
- On many program risk management consists only of having a policy and oversight
- If we treat *red flags* as false alarms rather than early warnings of danger this incubates the threats to program success
- Group think of dominate leaders often inhibits good thinking about risks

*Towards a Contingency Theory of Enterprise Risk Management," Anette Miles and Robert Kaplan, Working Paper 13-063 January 13, 2014
 PGCS 2018 Master Workshop, Canberra Australia

90



Uncertainties are things we can not be certain about.

Uncertainty is created by our incomplete knowledge; not by our ignorance

91 PGCS 2018 Master Workshop, Canberra Australia

91

Some Words About Uncertainty

- When we say *uncertainty*, we speak about a future state of a system that is not fixed or determined
- Uncertainty* is related to three aspects of our program management domain:
 - The **external** world – the activities of the program
 - Our **knowledge** of this world – the planned and actual behaviors of the program
 - Our **perception** of this world – the data and information we receive about these behaviors

92 PGCS 2018 Master Workshop, Canberra Australia

92

Some Words About the Risk that Results from Uncertainty

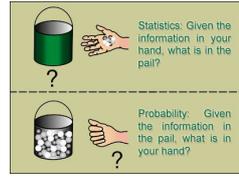
- Risk has Two Dimensions
 - The degree of possibility that a *state or condition* will take place or occur sometime in the future
 - The consequences of that *state or condition*, once it has occurred
- The degree of possibility is qualified as the
 - Probability of Occurrence* (event based)
 - Probability Distribution Function* (a distribution of the variability of a random number)
- The consequences are usually taken to be undesirable and qualified as the magnitude of harm and the remaining probability of a recurrence of the same risk.

93 PGCS 2018 Master Workshop, Canberra Australia

93

All Program Activities have Naturally Occurring (Aleatory) Uncertainties

- Naturally occurring* uncertainty and its resulting risk, impacts the probability of a successful outcome.
- The irreducible statistical behavior of these activities, their arrangement in a network of activities, and correlation between their behaviors creates risk.
- Adding margin protects the outcome from the impact of this naturally occurring uncertainty
- The question is – given the *statistical nature of the Irreducible Uncertainty*, what's the *Probability* we will be late, over budget, or the *technical outcome* won't work as needed?



94 PGCS 2018 Master Workshop, Canberra Australia

94

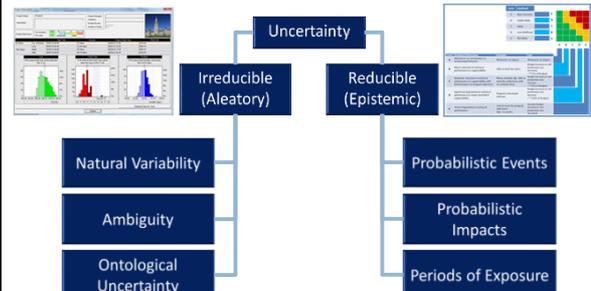
The Relationship Between Uncertainty and Risk

- Uncertainty** is present when probabilities cannot be quantified in a rigorous or valid manner, but can be described as intervals within a probability distribution function (PDF)
- Risk** is present when the Uncertainty of an outcome can be quantified in terms of
 - Probability of Occurrence (Epistemic uncertainty)
 - A range of possible values in a Probability Distribution Function (Aleatory Uncertainty)
- This distinction is important for modeling the future performance of cost, schedule, and technical outcomes of a program.
 - Risk from Epistemic uncertainty is **reducible**
 - Risk from Aleatory uncertainty is **irreducible**

95 PGCS 2018 Master Workshop, Canberra Australia

95

Taxonomy of Uncertainty and the Risk it Creates



96 PGCS 2018 Master Workshop, Canberra Australia

96

Remember – WBS is Paramount ? Risk Propagates Through the WBS

PGCS 2018 Master Workshop, Canberra, Australia

97

Connecting Epistemic Risk Retirement in the IMS

- The work to “Buy down” risk is planned in the IMS.
- MoE, MoP, and KPP defined in the Work Packages for the critical measure, e.g. weight.
- If we can't verify we've succeeded, then the risk did not get reduced.
- The risk may have gotten worse.

PGCS 2018 Master Workshop, Canberra, Australia

98

The Final Notion of Risk

The causes for risks clearly lie in our incomplete knowledge of the subject matter, thus if a project establishes all possible causes of risks they can be managed away.
And of Course that is Simply not Possible

This puts the focus on discovering and delaying with Epistemic Risks.
And modeling Aleatory Risks with Reference Class Forecasting driving Monte Carlo Simulation.

PGCS 2018 Master Workshop, Canberra, Australia

99

Root Causes of Risk Some are Reducible some are Irreducible

The Lens of the Performance Indicators

- Unrealistic Performance Expectations missing Measures of Effectiveness (MOE), Performance (MOP), and Technical Performance Measures (TPM)
- Unrealistic Cost and Schedule Estimates based on inadequate risk adjusted growth models
- Inadequate assessment of risk and unmitigated exposure to these risks without proper handling plans
- Unanticipated Technical Issues without alternative plans and solutions to maintain effectiveness

Cost, Schedule, and Technical Impacts

"Borrowed" with permission from Mr. Gary Bliss, Director, Performance Assessments and Root Cause Analysis (PRACA), Office of Assistant Secretary of Defense for Acquisition.

PGCS 2018 Master Workshop, Canberra, Australia

100

Without Removing these items, Train Wreck of the Program Starts When there is ...

- Inattention to budgetary responsibilities
- Work authorizations that are not always followed
- Issues with Budget and data reconciliation
- Lack of an integrated management system
- Baseline fluctuations and frequent replanning
- Current period and retroactive changes
- Improper use of management reserve
- EV techniques that do not reflect actual performance
- Lack of predictive variance analysis
- Untimely and unrealistic Latest Revised Estimates (LRE)
- Progress not monitored in a regular and consistent manner
- Lack of vertical and horizontal traceability cost and schedule data for corrective action
- Lack of internal surveillance and controls
- Managerial actions not demonstrated using Earned Value

Mary K. Evans Picture Library

PGCS 2018 Master Workshop, Canberra, Australia

101

Beware the Black Swan

PGCS 2018 Master Workshop, Canberra, Australia

102

Using Integrated Master Plan and Risk Adjusted Integrated Master Schedule, showing the needed progress to that plan is the basis of measuring physical percent complete. These measures start with Technical Performance Measures (TPM)

Measuring Progress to Plan means Measuring Physical Percent Complete in meaningful units of Measure. These are Technical Performance Measures (TPM) This Does NOT Start with EV or ES

103 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

103

TPM's Inform EV and ES to show progress to our destination

- How do we increase visibility into the program's performance?
- How do we reduce cycle time to deliver the product?
- How do we foster accountability?
- How do we reduce risk?
- How do we start this journey to success?



Increasing the Probability of Success means we have to Connect The Dots to Reach Our Destination

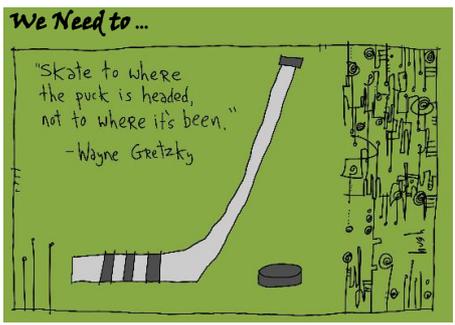
104 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

104

To Achieve Success ...

We Need to ...

"Skate to where the puck is headed, not to where it's been."
- Wayne Gretzky



©gapingvoid ltd www.gapingvoidgallery.com

105 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

105

Here's where TPMs Start

Systems engineering uses **technical performance measurements** to balance **cost, schedule** and **performance** throughout the life cycle. Technical performance measurements compare **actual versus planned technical development and design**. They also report the degree to which system requirements are met in terms of **performance, cost, schedule** and **progress** in implementing **risk** handling. Performance metrics are traceable to **user-defined capabilities**.

— Defense Acquisition Guide
(<https://dag.dau.mil/Pages/Default.aspx>)

In The End — It's All About Systems Engineering

106 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

106

Guidance for MoE's, MoP, and TPMs Belongs to Systems Engineering

The starting point is not **EVM**, it's **Systems Engineering**

- MOE's are an essential part of Systems Engineering, guided by IEEE 1220 and EIA 632.
- System's Engineers drive the content of all measurement items, customer or supplier



107 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

107

Previous Approaches Using EV are Mostly Unsuccessful Connecting these Measures

- Traditional approaches to program management are retrospective
 - Cost and schedule of Earned Value
 - Risk Management
 - Systems Engineering
- Reporting past performance
 - Sometimes 30 to 60 days old
 - Variations are reporting beyond the widow of opportunity for correction

108 PGCS 2018 Master Workshop, Canberra Australia Progress to Plan

108

TPMs have been around for 34 years

109

... the basic tenets of the process are the need for seamless management tools, that support an integrated approach ... and "proactive identification and management of risk" for critical cost, schedule, and technical performance parameters.
— Secretary of Defense, Perry memo, May 1995

TPM Handbook 1984

Why Is This Hard To Understand?

- We seem to be focused on EV reporting, not the use of EV to manage the program.
- Getting the CPR out the door is the end of Program Planning and Control's efforts, not the beginning.

PGCS 2018 Master Workshop, Canberra, Australia

109

110

Back to Technical Performance Measures

Technical Performance Measures do what they say,
say,
Measure the Technical Performance
of the product or service produced by the program

PGCS 2018 Master Workshop, Canberra, Australia

110

What's Our Motivation for "Connecting the Dots?"

111

TPMs are a set of measures that provide the supplier and acquirer with insight into progress to plan of the technical solution, the associated risks, and emerging issues.

Technical Performance Measures ...

- Provide program management with information to make better decisions
- Increase the probability of delivering a solution that meets both the **requirements** and **mission need**

We've been talking about this since as early as 1984, in *Technical Performance Measurement Handbook*, Defense Systems Management College, Fort Belvoir, VA 22060

PGCS 2018 Master Workshop, Canberra, Australia

111

Measure of Effectiveness (MoE)

112

The operational measures of success that are closely related to the achievements of the mission or operational objectives evaluated in the operational environment, under a specific set of condition

Measures of Effectiveness ...

- Are stated by the buyer in units meaningful to the buyer
- Focus on capabilities independent of any technical implementation

MoE's Belong to the End User

"Technical Measurement," INCOSE-TP-2003-020-01

PGCS 2018 Master Workshop, Canberra, Australia

112

Measure of Performance (MoP)

113

Measures that characterize physical or functional attributes relating to the system operation, measured or estimated under specific conditions

Measures of Performance are ...

- Attributes that assure the system has the capability to perform
- Assessment of system to assure it meets design requirements necessary to satisfy the MOE

MoP's belong to the Program – Developed by the Systems Engineer, Measured By CAMs, and Analyzed by PP&C

PGCS 2018 Master Workshop, Canberra, Australia

113

Key Performance Parameters (KPP)

114

Represent the capabilities and characteristics so significant that failure to meet them can be cause for reevaluation, reassessing, or termination of the program

Key Performance Parameters ...

- have a threshold or objective value
- Characterize the major drivers of performance
- Are considered Critical to Customer (CTC)

The acquired defines the KPPs during the operational concept development – KPPs say what DONE looks like

PGCS 2018 Master Workshop, Canberra, Australia

114

Technical Performance Measures (TPM)

Attributes that determine how well a system or system element is satisfying or expected to satisfy a technical requirement or goal

Technical Performance Measures ...

- Assess design progress
- Define compliance to performance requirements
- Identify technical risk
- Are limited to critical thresholds
- Include projected performance

PGCS 2018 Master Workshop, Canberra, Australia "Technical Measurement," INCOSE-TP-2003-020-01

115

Dependencies Between Measures

PGCS 2018 Master Workshop, Canberra, Australia "Coming to Grips with Measures of Effectiveness," N. Sproles, Systems Engineering, Volume 3, Number 1, pp.50-58

116

"Candidates" for Technical Measures

Concept	Description
Physical Size and Stability	Useful Life Weight Volumetric capacity
Functional Correctness	Accuracy Power performance
All the "ilities"	Supportability Maintainability Dependability Reliability = Mean Time Failure
Efficiency	Utilization Response time Throughput
Suitability for Purpose	Readiness

PGCS 2018 Master Workshop, Canberra, Australia INCOSE Systems Engineering Handbook

117

"Measures" of Technical Measures

Attribute	Description
Achieved to Date	Measured technical progress or estimate of progress
Current Estimate	Value of a technical parameter that is predicted to be achieved
Milestone	Point in time when an evaluation of a measure is accomplished
Planned Value	Predicted value of the technical parameter
Planned Performance Profile	Profile representing the project time phased demonstration of a technical parameter
Tolerance Band	Management alert limits
Threshold	Limiting acceptable value of a technical parameter
Variations	<ul style="list-style-type: none"> Demonstrated technical variance Predicted technical variance

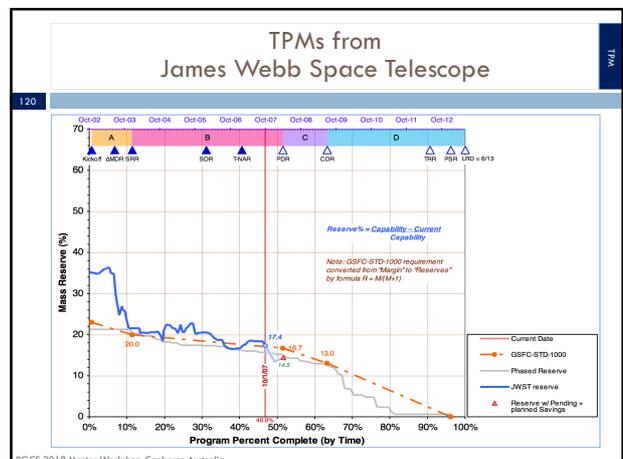
PGCS 2018 Master Workshop, Canberra, Australia INCOSE Systems Engineering Handbook

118

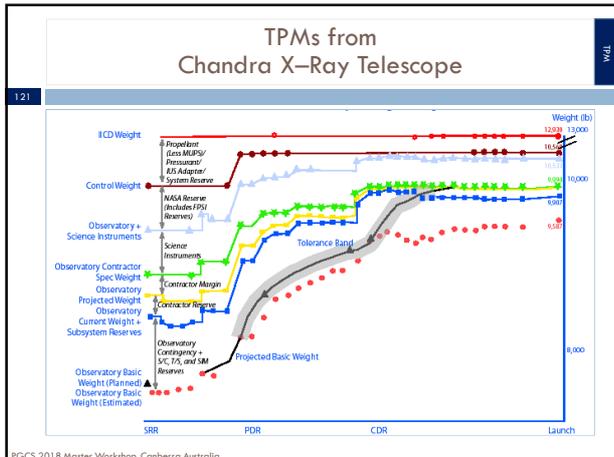
A Simple Method of Assembling the TPMs

PGCS 2018 Master Workshop, Canberra, Australia

119



120



121

TPMs Start With The WBS

The WBS for a UAV

- 1.1 Air Vehicle
 - 1.1.1 Sensor Platform
 - 1.1.2 Airframe
 - 1.1.3 Propulsion
 - 1.1.4 On Board Comm
 - 1.1.5 Auxiliary Equipment
 - 1.1.6 Survivability Modules
 - 1.1.7 Electronic Warfare Module
 - 1.1.8 On Board Application & System SW
- 1.3 Mission Control / Ground Station SW
 - 1.3.1 Signal Processing SW
 - 1.3.2 Station Display
 - 1.3.3 Operating System
 - 1.3.4 ROE Simulations
 - 1.3.5 Mission Commands

122

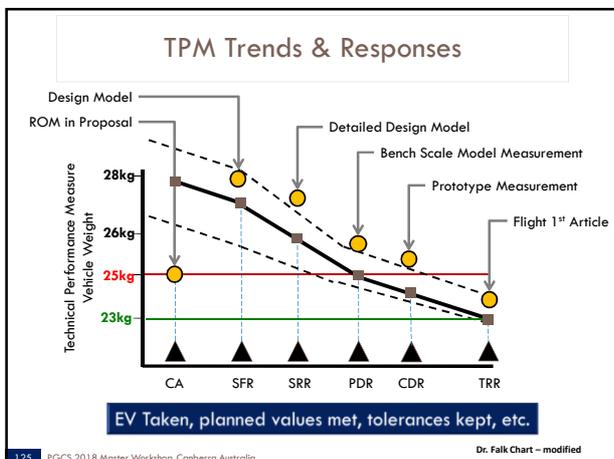
- ### What Do We Need To Know About This Program Through TPMs
- What WBS elements represent the TPMs?
 - What Work Packages produce these WBS elements?
 - Where do these Work Packages live in the IMS?
 - What are the Earned Value baseline values for these Work Packages?
 - How are going to measure all these variables?
 - What does the curve look like for these measurements?

123

Verifying Each TPM at Each Stage in the Program

	Question Answered by the TPM	Evidence that we're meeting the TPM
Contract Award	Do we know what we promised to deliver, now that we've won?	With our submitted ROM what are the values we need to get through Integrated Baseline Review (how do we measure weight for each program event?)
System Functional Requirements	Can we proceed into preliminary design?	The contributors to the vehicle weight are confirmed and the upper limits defined in the product architecture and requirements flow down database (DOORS) into a model
System Requirements Review	Can we proceed into the System Development and Demonstration (SDD) phase	Do we know all drivers of vehicle weight? Can we bound their upper limits? Can the subsystem owners be successful within these constraints uses a high fidelity model?
Preliminary Design Review	Can we start detailed design, and meet the stated performance requirements within cost, schedule, risk, and other constraints?	Does each subsystem designer have the target component weight target and have some confidence they can stay below the upper bound? Can this be verified in some tangible way? Either through prior examples or a lab model?
Critical Design Review	Can the system proceed to fabrication, demonstration, and test, with the within cost, schedule, risk, and other system constraints.	Do we know all we need to know to start the fabrication of the first articles of the flight vehicle. Some type of example, maybe a prototype is used to verify we're inside the lines
Test Readiness Review	Can the system ready to proceed into formal test?	Does the assembled vehicle fall within the weight range limits for 1 st flight – will this thing get off the ground?

124



125

- ### The Assessment Of Weight As A Function Of Time
- At Contract Award there is a *Proposal* grade estimate of vehicle weight
 - At System Functional Review, the *Concept of Operations* is validated for the weight
 - At System Requirements Review the weight targets are flowed down to the subsystems components
 - At PDR the CAD model starts the verification process
 - At CDR actual measurements are needed to verify all models
 - At Test Readiness Review we need to know how much fuel to put on board for the 1st flight test

126

Raison d'etre for Technical Performance Measures

- The real purpose of Technical Performance Measures is to reveal Programmatic and Technical RISK and engage in the Risk Management Process

PGCS 2018 Master Workshop, Canberra, Australia

127

Buying Down Risk with TPMs

- "Buying down" risk is planned in the IMS.
- MoE, MoP, and KPP defined in the work package for the critical measure – weight.
- If we can't verify we've succeeded, then the risk did not get reduced.
- The risk may have gotten worse.

PGCS 2018 Master Workshop, Canberra, Australia

128

Increasing Probability of Success Requires Risk Management

- Going outside the TPM limits always means cost and schedule impacts
- "Coloring Inside the Lines" means knowing the how to keep the program GREEN, or at least stay close to GREEN

PGCS 2018 Master Workshop, Canberra, Australia

129

Technical Performance Measures Checklist

MoE	MoP	TPM
Traceable to needs, goals, objectives, and risks	Traceable to applicable MOEs, KPPs, system level performance requirements, and risks	Traceable to applicable MoPs, system element performance, requirements, objectives, risks, and WBS elements
Defined with associated KPPs	Focused on technical risks and supports trades between alternative solutions	Further decomposed, budgeted, and allocated to lower level system elements in the WBS and IMS
Each MoE independent from others	Provided insight into system performance	Assigned an owner, the CAM and Work Package Manager
Each MoE independent of technical any solution	Decomposed, budgeted and allocated to system elements	Sources of measure identified and processes for generating the measures defined.
Address the required KPPs	Assigned an "owner," the CAM and Technical Manager	Integrated into the program's IMS as part of the exit criteria for the Work Package

PGCS 2018 Master Workshop, Canberra, Australia

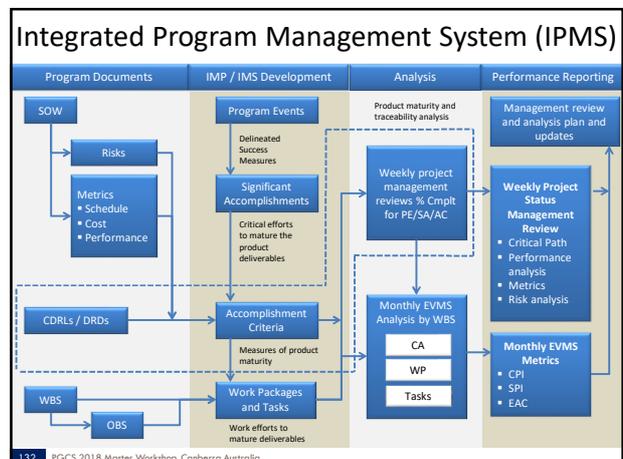
130

All the program performance data in the is historical. This past performance data – by itself – is like driving in the rear view mirror. What is needed is Leading Indicators that can be derived from this past performance data.

Creating an Integrated Program Performance Management System (IPPMS) starts with the Five Principles, their Processes, and the Practices

PGCS 2018 Master Workshop, Canberra, Australia

131



132

Earned Value Management is the 'best tool' for managing large, complex acquisition programs.

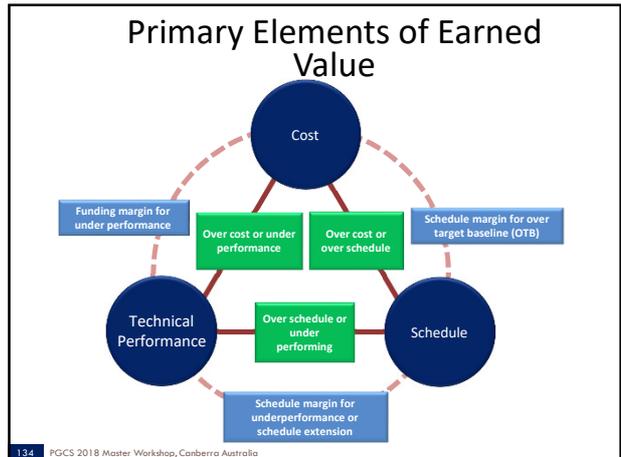
– Dr. Ashton Carter (USD, AT&L)
26 November 2009



Ashton Carter, Secretary of Defense

133 PGCS 2018 Master Workshop, Canberra Australia

133



134

Connecting the EVM Variables with Technical Performance Measures

Integrating Cost, Schedule, and Technical Performance
Assures Program Management has the needed performance information to deliver on-time, on-budget, and on-specification

Cost Baseline	Technical Performance	Schedule Baseline
<ul style="list-style-type: none"> Master Schedule is used to derive Basis of Estimate (BOE) not the other way around. Probabilistic cost estimating uses past performance and cost risk modeling. Labor, Materiel, and other direct costs accounted for in Work Packages. Risk adjustments for all elements of cost. 	<ul style="list-style-type: none"> Earned Value is diluted by missing technical performance. Earned Value is diluted by postponed features. Earned Value is diluted by non compliant quality. All these dilutions require adjustments to the Estimate at Complete (EAC) and the To Complete Performance Index (TCPI). 	<ul style="list-style-type: none"> Requirements are decomposed into physical deliverables. Deliverables are produced through Work Packages. Work Packages are assigned to accountable manager. Work Packages are sequenced to form the highest value stream with the lowest technical and programmatic risk.

135 PGCS 2018 Master Workshop, Canberra Australia

135

Connecting EVM and Technical Performance Measures, we get the one and only way to measure progress with EV

136

BCWP (EV) = BCWS (PV) × Physical Percent Complete

- This is all that is needed to be successful with EVM
- Measure what has been completed compared what was planned to be completed in units meaningful the decision makers
 - That's Physical Percent Complete
- Defining Physical Percent Complete starts and ends with
 - MoE's
 - MoP's
 - TPM's
 - Key Performance Parameters

Never the passage of time or consumption of money

Never someone telling you how much effort they've done

Only *Tangible Evidence* that progress to plan has been made

136 PGCS 2018 Master Workshop, Canberra Australia

136

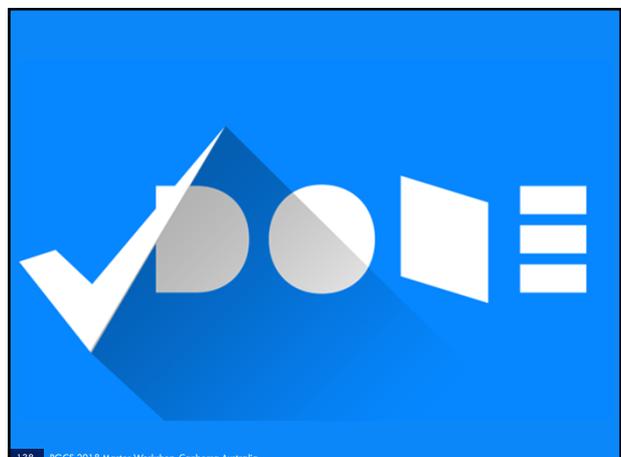
Earned Value and Earned Schedule can provide Answer these four Critical Questions

137

- Where have we been?
- Where are we now?
- Where are we going?
- Are we making planned progress to completing the project's outcomes as needed?

137 PGCS 2018 Master Workshop, Canberra Australia

137



138

Bibliography

139

*"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.
When we enquire into any subject, the first thing we have to do is to know what books have treated of it.
This leads us to look at catalogues, and at the backs of books in libraries."
— Samuel Johnson (Boswell's Life of Johnson)*



PGCS 2018 Master Workshop, Canberra, Australia

139

Bibliography Principles and Processes

140

- *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, INCOSE-TP-2003-002-03.1, August 2007, www.incose.org
- *Systems Engineering: Coping with Complexity*, Richard Stevens, Peter Brook, Ken Jackson, and Stuart Arnold, Prentice Hall, 1998.
- *Henri Fayol: Critical Evaluations in Business and Management*, John C. Wood and Michael C. Wood, Routledge, 2002.
- "Technical Performance Measurement, Earned Value, and Risk Management: An Integrated Diagnostic Tool for Program Management," Commander N. D. Pisano, SC, USN, Program Executive Office for Air ASW, Assault, and Special Mission Programs (PEO(A))

PGCS 2018 Master Workshop, Canberra, Australia

140

Bibliography Practices

141

- *Modeling Homeland Security: A Value Focused Thinking Approach*, Kristopher Pruitt, Air Force Institute of Technology, March 2003
- *Performance Based Earned Value*, Paul Solomon.
- *Guide to the Project Management Body of Knowledge*, Project Management Institute.
- "No Silver Bullet: Essence and Accidents of Software Engineering," Fred Brooks, IEEE Computer, 10-19, April 1987.
- *Systems Requirements Analysis*, Jeffrey O. Grady, Academic Press, 2006.
- "Further Development in Earned Schedule," Kym Henderson, The Measurable News, Spring 2004.
- "Schedule is Different," Walter Lipke, The Measurable News, Summer 2003.
- "A Simulation and Evaluation of Earned Value Metrics to Forecast Project Duration," M. S. Vanhoucke, Journal of Operations Research Society, October 2007.
- *Standard for Application and Management of the Systems Engineering Process*, Institute of Electrical and Electronics Engineers, 09-Sep-2005
- *Systems Engineering: Coping with Complexity*, Richard Stevens, Peter Brook, Ken Jackson, and Stuart Arnold, Prentice Hall, 1998.
- *The Requirements Engineering Handbook*, Ralph R. Young, Artech House, 2004

PGCS 2018 Master Workshop, Canberra, Australia

141

Bibliography Practices

142

- "Technical Performance Measurement, Earned Value, and Risk Management: An Integrated Diagnostic Tool for Program Management," Commander N. D. Pisano, SC, USN, Program Executive Office for Air ASW, Assault, and Special Mission Programs (PEO(A))
- "Issues with Requirements Elicitation," Michael G. Christel and Kyo C. Kang, Technical Report, CMU/SEI-92-TR-12, Software Engineering Institute, Carnegie Mellon University Pittsburgh, Pennsylvania 15213.
- "Managing complex product development projects with design structure matrices and domain mapping matrices," Mike Danilovic and Tyson Browning, International Journal of Project Management, 25 (2007), pp. 300-314.
- "Architectural optimization using real options theory and Dependency structure matrices," David M. Shorman, Ali A. Yassine+, Paul Carille, Proceedings of DETC '02 ASME 2002 International Design Engineering Technical Conferences 28th Design Automation Conference Montreal, Canada, September 29-October 2, 2002.
- "Modeling and Analyzing Cost, Schedule, and Performance in Complex System Product Development," Tyson Browning, Massachusetts Institute of Technology, February 1999.
- *The Integrated Project Management Handbook*, Dayton Aerospace, 8 Feb 2002, Dayton Ohio.
- "Analytic Architecture for Capabilities-Based Planning, Mission-System Analysis, and Transformation," Paul K. Davis, RAND Corporation.
- *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, INCOSE-TP-2003-002-03.1, August 2007, www.incose.org

PGCS 2018 Master Workshop, Canberra, Australia

142

Bibliography Capabilities

143

- "Analytic Architecture for Capabilities-Based Planning, Mission-System Analysis, and Transformation," Paul K. Davis, RAND Corporation.
- *Portfolio-Analysis Methods for Assessing Capability Options*, Paul K. Davis, Russell D. Shaver, and Justin Beck, Rand Corporation, 2012
- "Architectural optimization using real options theory and Dependency structure matrices," David M. Shorman, Ali A. Yassine+, Paul Carille, Proceedings of DETC '02 ASME 2002 International Design Engineering Technical Conferences 28th Design Automation Conference Montreal, Canada, September 29-October 2, 2002.
- "Modeling and Analyzing Cost, Schedule, and Performance in Complex System Product Development," Tyson Browning, Massachusetts Institute of Technology, February 1999.
- *The Art of Systems: Architecting*, Mark W. Maier and Eberhardt Rechtin, CRC Press, 2000.
- *Systems Engineering: Coping With Complexity*, Richard Stevens, Peter Brook, Ken Jackson, and Stuart Arnold, Prentice Hall, 1998.
- *Assumption Based Planning: A Tool for Reducing Avoidable Surprises*, James A. Dewar, Cambridge University Press, 2002.
- *Capabilities-Based Planning: A Methodology for Deciphering Commander's Intent*, Peter Kossakowski, Evidence Based Research, Inc. 1205 Spring Hill Road, Suite 220 Vienna, VA 22182.
- *Competing on Capabilities: The New Rules for Corporate Strategy*, George Stalk, Phillip Evans, and Lawrence Shulman, Harvard Business Review, No. 92209, March-April 1992.
- *Effects-Driven, Capabilities-Based, Planning for Operations*, Maj Kira Jeffery, USAF and Mr Robert Herslow.
- *Effects-based Operations: Building Analytical Tools*, Desmon Saunder-Newton and Aaron B. Frank, Defense Horizons, October 2002, pp 1-8.
- *Guide to Capability-Based Planning*, Joint Systems and Analysis Group, MORS Workshop, October 2004, Alexandria, VA. <http://www.mors.org/>

PGCS 2018 Master Workshop, Canberra, Australia

143

Bibliography Requirements

144

- "Issues with Requirements Elicitation," Michael G. Christel and Kyo C. Kang, Technical Report, CMU/SEI-92-TR-12, Software Engineering Institute, Carnegie Mellon University Pittsburgh, Pennsylvania 15213.
- *The Requirements Engineering Handbook*, Ralph R. Young, Artech House, 2004
- *Software Risk Management*, Barry W. Boehm, IEEE Computer Society Press, 1989.
- *Software Requirements Analysis & Specifications*, Alan M. Davis, Prentice Hall, 1990.
- *Requirements Engineering: A Good Practice Guide*, Ian Sommerville and Pete Sawyer, John Wiley & Sons, 1997.
- *Systems Requirements Practices*, Jeffrey O. Grady, McGraw Hill, 1993
- *Four Key Requirements Engineering Techniques*, Christof Ebert, IEEE Software, May / June 2006.
- *Intent Specifications: An Approach to Building Human-Centered Specifications*, Aeronautics and Astronautics, MIT.
- *Sample TCAS Intent Specification*, Nancy Leveson and Jon Damon Reese, Software Engineering Corporation .

PGCS 2018 Master Workshop, Canberra, Australia

144

Bibliography Performance Measurement Baseline

145

- "Managing complex product development projects with design structure matrices and domain mapping matrices," Mike Danilovic and Tyson Browning, *International Journal of Project Management*, 25 (2007), pp. 300–314.
- MIL-STD-881A, Work Breakdown Structures.
- *The Management of Projects*, Peter W. G. Morris, Thomas Telford, 1994
- *Modelling Complex Projects*, Terry Williams, John Wiley & Sons, 2002.
- *The Handbook of Program Management*, James T. Brown, McGraw Hill, 2007.
- *AntiPatterns in Project Management*, William J. Brown, Hays W. McCormick III, and Scott W. Thomas, John Wiley & Sons, 2000
- *Earned Value Management*, 3rd Edition, Quentin W. Fleming and Joel M. Koppelman, Project Management Institute, 2005.

PGCS 2018 Master Workshop, Canberra Australia

145

Bibliography Continuous Risk Management

146

- "Understanding Risk Management in the DoD," Mike Bolles, *Acquisition Research Journal*, Volume 10, pp. 141–145, 2003.
- *Effective Risk Management: Some Keys to Success*, 2nd Edition, Edmund H. Conrow, AIAA Press, 2003.
- *Managing Risk: methods for Software Systems Development*, Elaine M. Hall, Addison Wesley, 1998
- Integrating Risk Management with Earned Value Management, National Defense Industry Association.
- Three point estimates and quantitative risk analysis a process guide for risk practitioners, Acquisition Operating Framework, UK Ministry of Defense, <http://www.aof.mod.uk/index.htm>
- [Effective Opportunity Management for Project: Exploring Positive Risk, David Hillson, Taylor & Francis, 2004.
- [Catastrophe Disentanglement: Getting Software Projects Back on Track, E. M. Bennaton, Addison Wesley, 2006.
- *Software Engineering Risk Management*, Dale Walter Karolak, IEEE Computer Society Press, 1998.
- *Assessment and Control of Software Risks*, Capers Jones, Prentice Hall, 1994
- Three Point Estimates and Quantitative Risk Analysis – A Process Guide For Risk Practitioners – version 1.2 May 2007 – Risk Management – AQF, <http://www.aof.mod.uk/aofcontent/tactical/risk/downloads/3neprocguide.pdf>
- *How much risk is too much risk?*, Tim Lister, Boston SPIN, January 20th, 2004.
- *Risk Management Maturity Level Development*, INCOSE Risk Management Working Group, April 2002.
- "A Methodology for Project Risk Analysis using Bayesian Belief Networks within a Monte Carlo Simulation Environment," Javier F. Ordóñez Arizaga, University of Maryland, College Park, 2007.
- An Approach to Technology Risk Management, Ricardo Valerdi and Ron J. Kohl, Engineering Systems Division Symposium, MIT, Cambridge, MA 29–31 March 2004.

PGCS 2018 Master Workshop, Canberra Australia

146

Bibliography Continuous Risk Management

147

- "An Industry Standard Risk Analysis Technique," A Terry Bahill and Eric D. Smith, *Engineering Management Journal*, Vol. 21 No. 4, December 2009.
- *Risk Management Process and Implementation*, American Systems Corporation, 2003.
- The Basics of Monte Carlo Simulation: A Tutorial, S. Kandaswamy, *Proceedings of the Project Management Institute Seminars & Symposium*, 1–10 November 2001.
- *Bayesian Inference for NASA Probabilistic Risk and Reliability Analysis*, NASA/SP–2009–569, June 2009.
- *Common Elements of Risk*, Christopher J. Alberts, CMU/SEI–2006–TN–014, April 2006.
- "Development of Risk Management Defense Extensions to the PMI Project Management Body of Knowledge," Edmund H. Conrow, *Acquisition Review Quarterly*, Spring 2003.
- *Continuous Risk Management Guidebook*, Audrey J. Dorofee, Julie A. Walker, Christopher J. Alberts, Ronald P. Higuera, Richard L. Murphy, and Roy C. Williams, Software Engineering Institute, 1996.
- *Risk Management Guide for DoD Acquisition*, Fifth Edition, June 2002.
- *Emerging Practice: Joint Cost & Schedule Risk Analysis*, Eric Drucker, 2009 St. Louis SCEA Chapter Fall Symposium, St Louis, MO.
- *Making Risk Management Tools More Credible: Calibrating the Risk Cube*, Richard L. Coleman, Jessica R. Summerville, and Megan E. Dameron, SCEA 2006, Washington, D.C., 12 June 2006.
- A Theory of Modeling Correlations for Use in Cost–Risk Analysis, Stephen A. Book, Third Annual Project Management Conference, NASA, Galveston, TX, 21–22 March 2006.
- The Joint Confidence Level Paradox: A History of Denial, 2009 NASA Cost Symposium, 28 April 2009.

PGCS 2018 Master Workshop, Canberra Australia

147



Niwo Ridge Consulting, L.L.C.
 4347 Pebble Beach Drive
 Longmont, Colorado 80503
 +1 303 241 9633
glen.alleman@niwo Ridge.com

Performance–Based Project Management[®]
 Integrated Master Plan
 Integrated Master Schedule
 Earned Value Management
 DCMA / DCAA Validation
 Programmatic and Technical Risk Management
 Proposal Support Service

148 PGCS 2018 Master Workshop, Canberra Australia

148