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

PGCS PROJECT AND PROGRAM MANAGEMENT SYMPOSIUM • Better Management • Better Projects
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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.

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

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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

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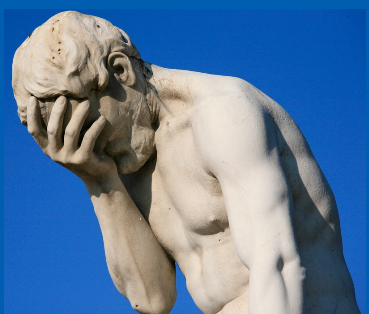
Why is it so hard to accept the truth that Principles must be in place, before any Practices and Process can be applied that might increase the Probability of Success?



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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*?

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

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- 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.

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

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5 Principles	5 Processes	10 Practices	
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 wat y to Done? 5. What are the measures of progress to Plan?	1. Identify Needed Capabilities 2. Identify Requirements Baseline 3. Establish Performance Measurement Baseline 4. Execute the PMB 5. Continuous Risk Management	1. Capabilities drive requirements 2. Requirements identify Technical and Process deliverables 3. Work Packages describes deliverables 4. IMS arranges deliverables 5. WP 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

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

Introduction

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5 Principles	5 Processes	10 Practices	
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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)

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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

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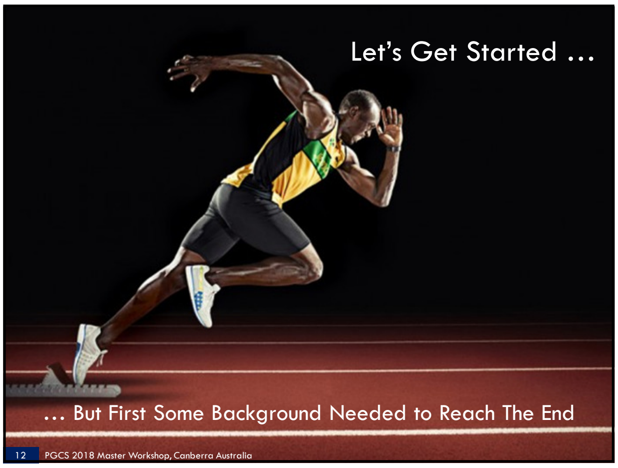

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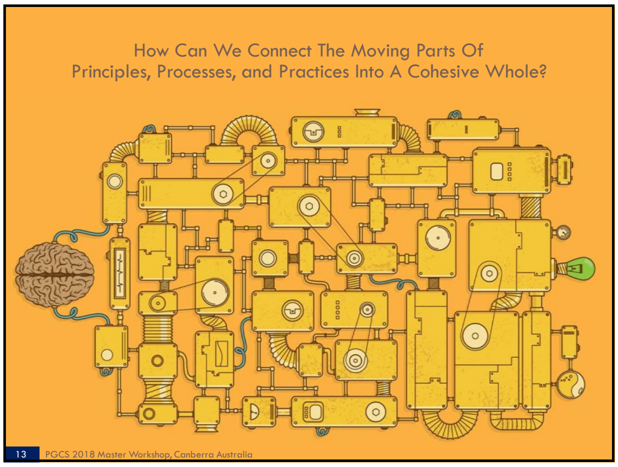

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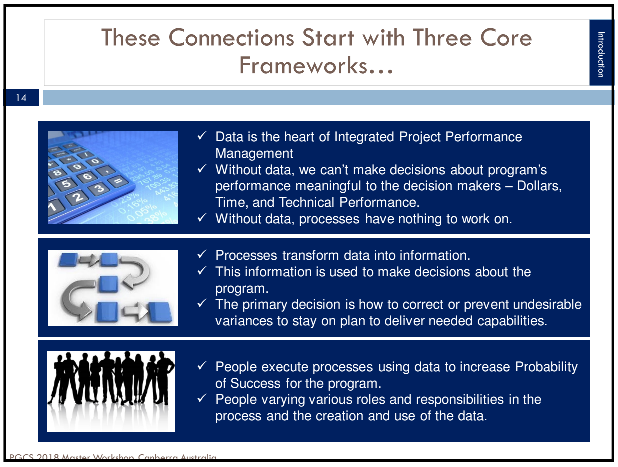

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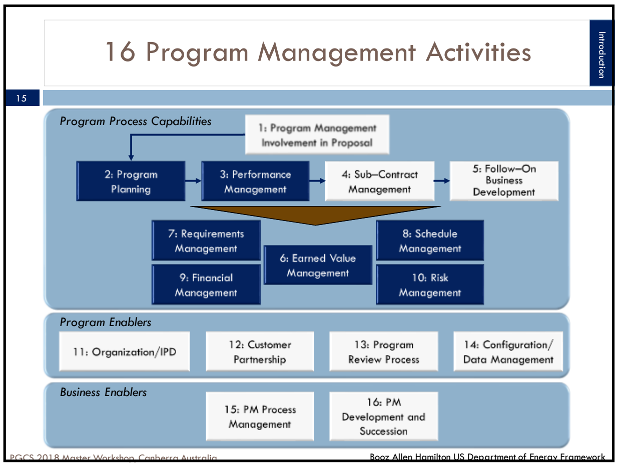

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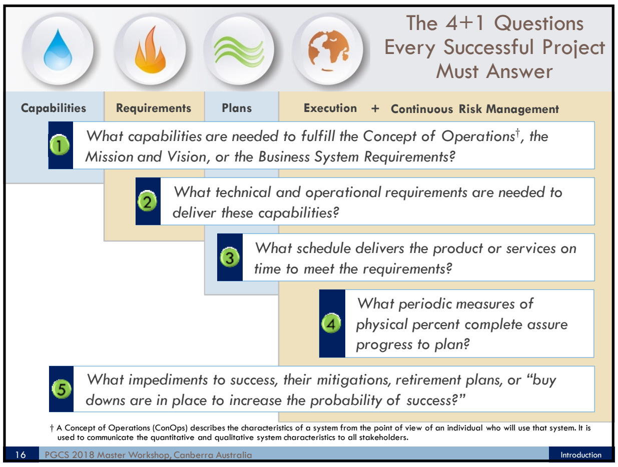

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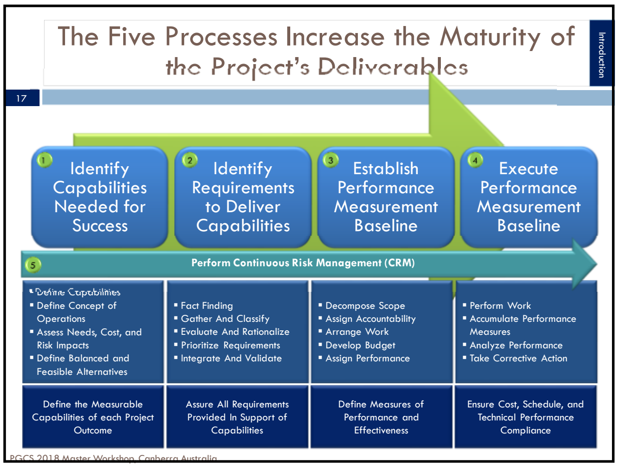

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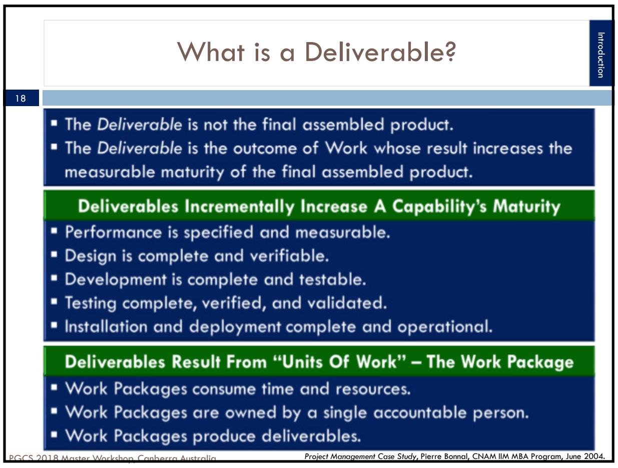

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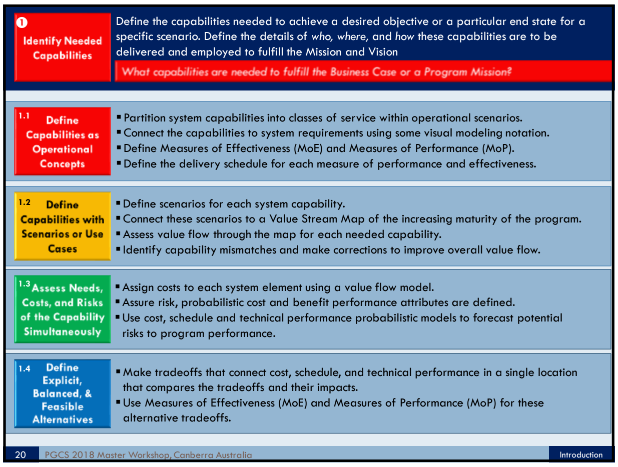

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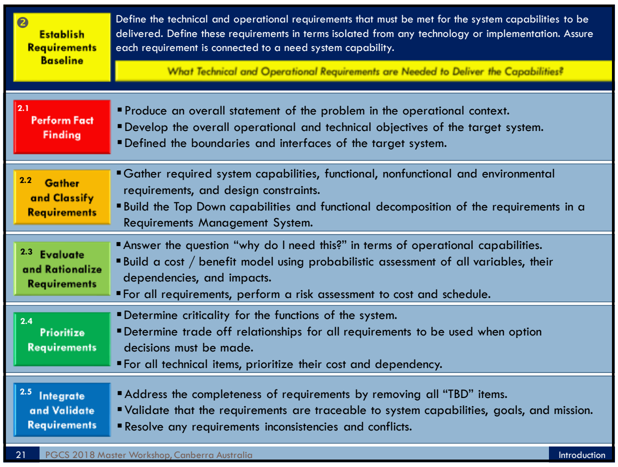

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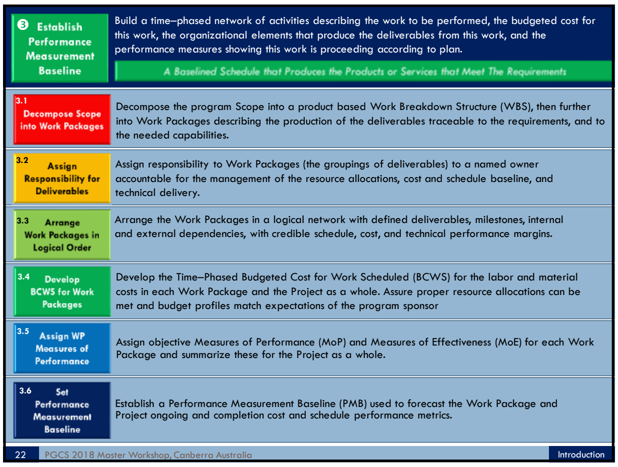

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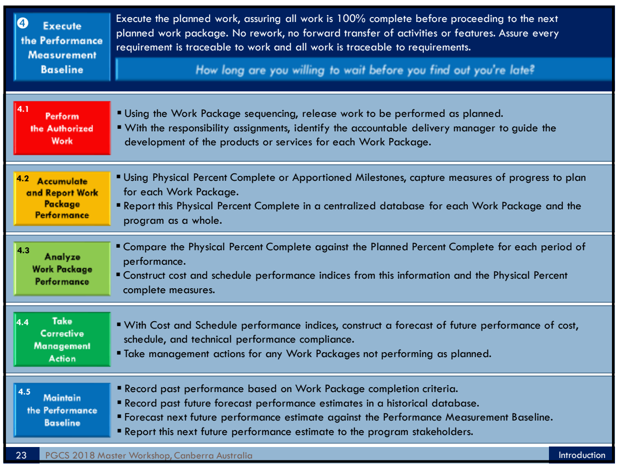

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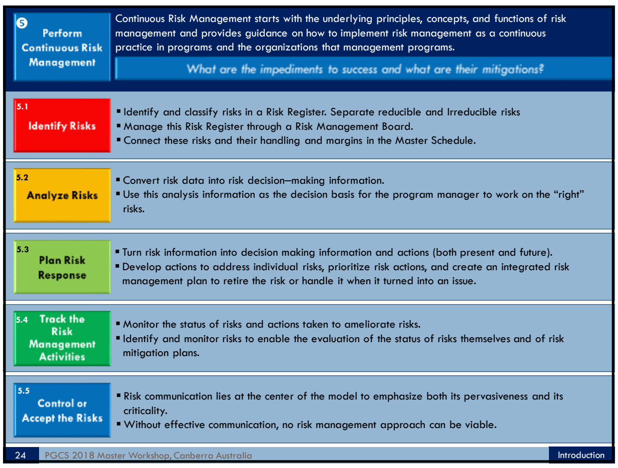

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What Does A Capability "Sound" Like?

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- 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.

Identifying Needed System Capabilities

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Abstracted from: "Capabilities–Based Planning – How It Is Intended To Work And Challenges To Its Successful Implementation," Col. Stephen K. Walker, United States Army, U. S. Army War College, March 2005

What Is a Requirement?

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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

Identifying Requirements†

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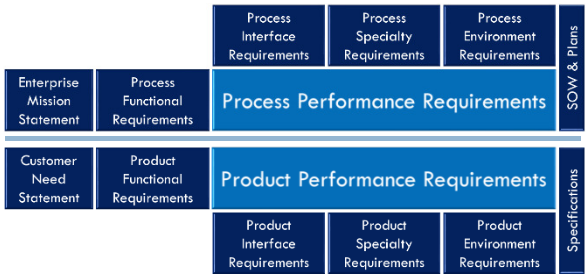

† *Systems Requirements Practices*, Jeffery O. Grady, McGraw Hill, 1993

What Does a Credible Based Plan and Schedule Look Like?

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- 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.

Establishing the Three Elements of the Performance Measurement Baseline

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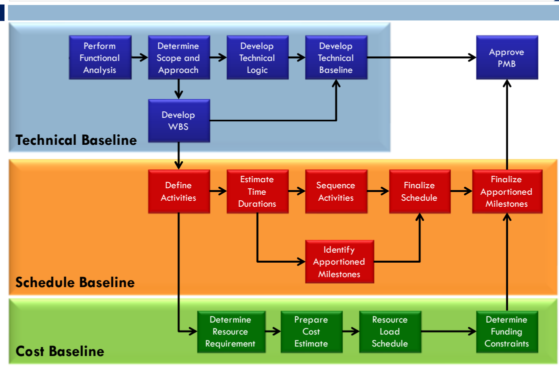

How Do We Know We Are Making Progress to Plan?

4 Introduction 31

- 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 s of that performance.

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Executing the Performance Measurement Baseline (PMB)

4 Introduction 32

- 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.

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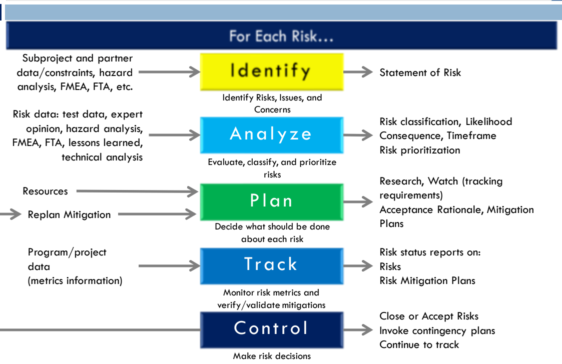
Perform Continuous Risk Management

5 Introduction 33



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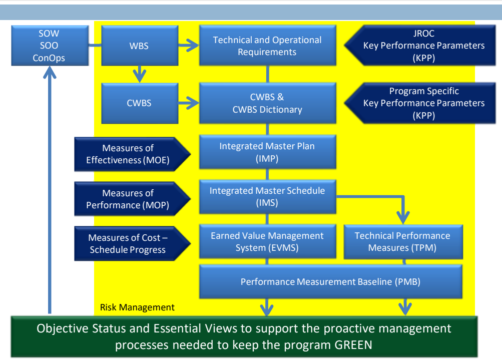
Integrating all the Parts into a Whole

Introduction 34



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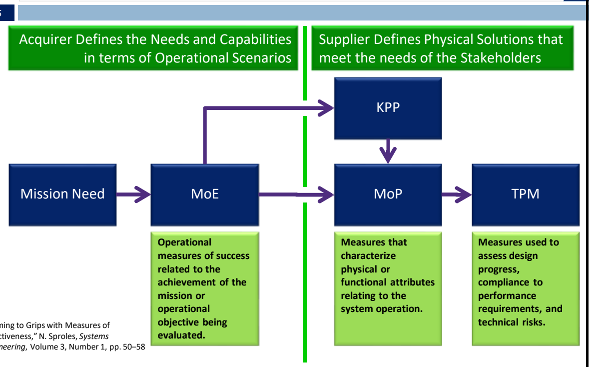
From Mission Capabilities to Done

Introduction 35



"Coming to Grips with Measures of Effectiveness," N. Sproles, *Systems Engineering*, Volume 3, Number 1, pp. 50–58

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4+1Critical Processes for Success

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Capabilities, Requirements & Deliverables	Program Architecture & Dependencies	Work Planning and Sequencing	Performance Measurement Baseline	Programmatic & Technical Risk Management
▪ Balanced Scorecard ▪ Concept of Operations ▪ Statement of Objectives	▪ Integrated Master Plan (IMP) ▪ Gaps ▪ Overlaps ▪ Interfaces	▪ Integrated Master Schedule (IMS) ▪ Schedule margin to protect critical deliverables	▪ Cost And Schedule Baseline ▪ WBS ▪ RAM ▪ Resource Loaded IMS	▪ Risk Registry ▪ Risk Handling Plans ▪ Contingency And Management Reserve
▪ Requirements Traceability	▪ Value Stream Mapping (VSM)	▪ Work Packages ▪ Planning Packages	▪ Technical Performance Measures (TPM)	▪ Risk Integrated With IMS ▪ Risk Trending
▪ Measures Of Effectiveness (MoE)	▪ Design Structure Matrix (DSM)	▪ Earned Value Management	▪ Measures Of Performance (MoP)	▪ Monte Carlo Simulation

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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

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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

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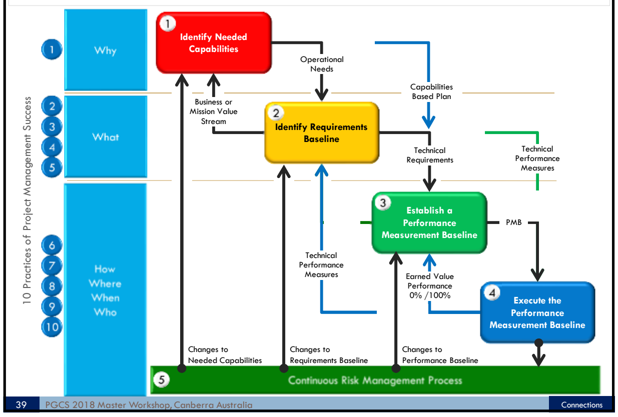
Connecting Five Process with Five Practices of Project Success



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10 Practices of Performance–Based Project Management®

Connections

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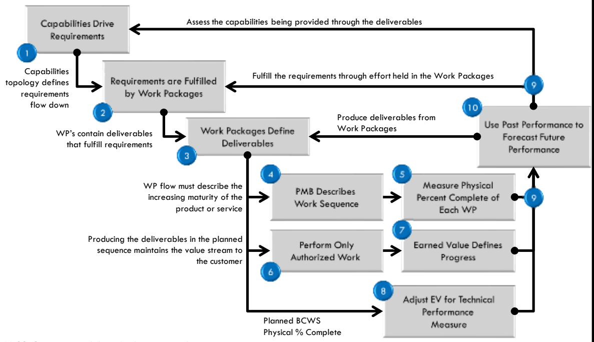

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Enough Show and Tell, Let's …

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A Quick Reminder of the 5 Principles

Connections

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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 well we encounter along the way?	Risk adjusted IMS
What are the units of measure 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

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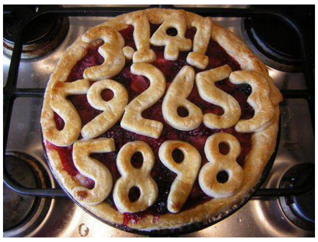
One More Reminder, Project Success is About Doing a Lot Things Right …

43 Connections

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



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

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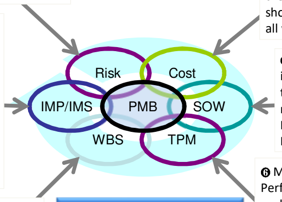
Integrating the Parts of a Credible Program Management System (PMS)

44 Connections

❸ Technical and Programmatic ***Risks*** Connected through the WBS, Risk Register, Plan and Schedule

❷ 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)

❶ The Products and Processes in a "well structured" decomposition, traceable to the deliverables



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

❹ Budget at the Work Package level, rolled to the Control Accounts showing cost spreads for all work in the IMS

❺ Deliverables defined in the SOW, traced to the WBS, with narratives and Measures of Performance (MoP)

❻ 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

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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

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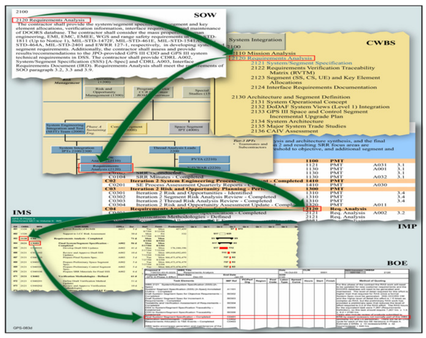
That are Connected in this Way

46 Connections



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1 The WBS is Paramount

47 Connections

- 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)

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2 The IMP Starts with the Buyer

48 Connections

- 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

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3 Natural Uncertainties and Event Based Risks†

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- 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 used the naturally occurring and Event Based in this introduction, but those terms are consider *operational* rather than mathematical.

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4 Costs Assigned to ***Packages of Work***

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- 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

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5 Statement of Work

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- 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

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6 Technical Performance Measures

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- 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

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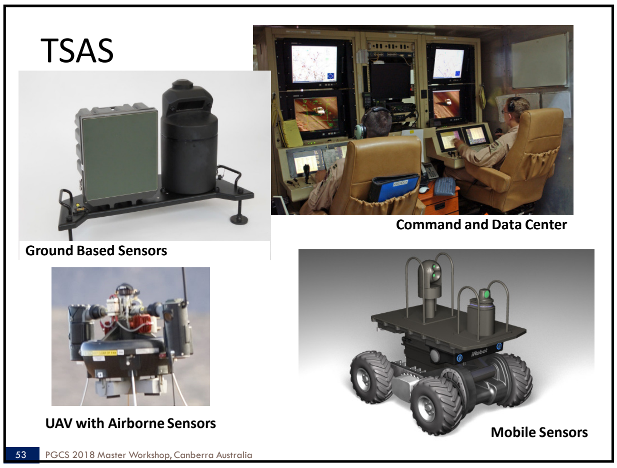

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Top Level Capabilities for Airborne Sensors

Connections

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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

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TSAS Performance Measures Derived from those Top Level Capabilities

Connections

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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 hours 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

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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 PGCS 2018 Master Workshop, Canberra Australia WBS

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

WBS

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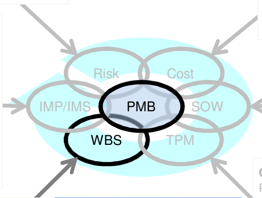
❸ Technical and Programmatic ***Risks*** Connected through the WBS, Risk Register, Plan and Schedule

❷ 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)

❶ The Products and Processes in a "well structured" decomposition, traceable to the deliverables



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What is the Work Breakdown Structure?

WBS

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- 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

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System Architecture Drives the WBS

WBS

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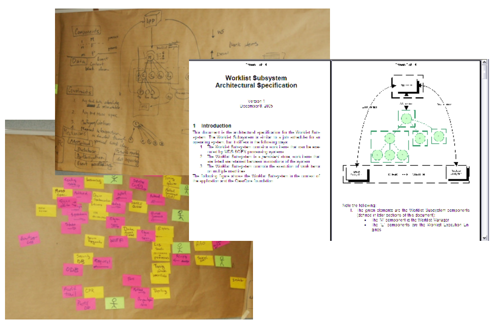

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Structure of the TSAS WBS

- 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

WBS

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Three WBS's for TSAS

Program WBS	Contract WBS	Subcontract WBS
High-Level (First 3 levels) Provides Program Structure Generally developed/controlled by Customer (Government)	Detailed (Levels 4+) Provides framework for Contract Work Packages and Costing Generally developed by Contractor Generally follows Program WBS	Detailed (Level 4+) Provides framework for Subcontract Work Packages and Costing Generally developed by Subcontractor Generally follows Contract WBS

WBS

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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

WBS

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Level 2 Unmanned Air Vehicle (UAV)

UAV with Airborne Sensors

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

WBS

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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

WBS

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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

WBS

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Level 4 UAV Avionics - MMS

WBS

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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

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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)

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Quick View of Building the IMP

IMP

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- 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

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

IMP

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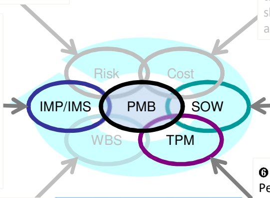
❸ Technical and Programmatic *Risks* Connected through the WBS, Risk Register, Plan and Schedule

❷ 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)

❶ The Products and Processes in a "well structured" decomposition, traceable to the deliverables



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

❹ Budget at the Work Package level, rolled to the Control Accounts showing cost spreads for all work in the IMS

❺ Deliverables defined in the SOW, traced to the WBS, with narratives and Measures of Performance (MoP)

❻ 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

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The Critical Purpose of the IMP

IMP

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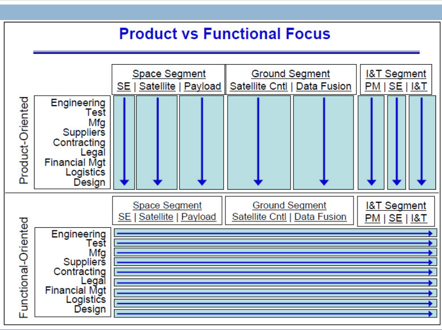

The IMP defines the connections between the Product maturity – Vertical – and the implementation of this Product maturity through the Functional activities – the Horizontal

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Next Step is the Build an Integrated Master Plan

IMP

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- 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

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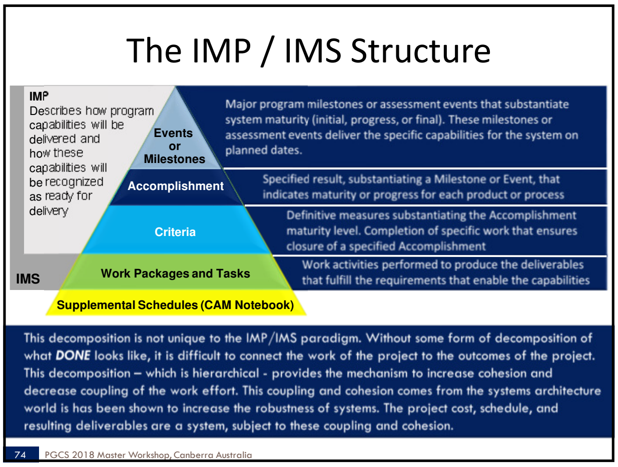

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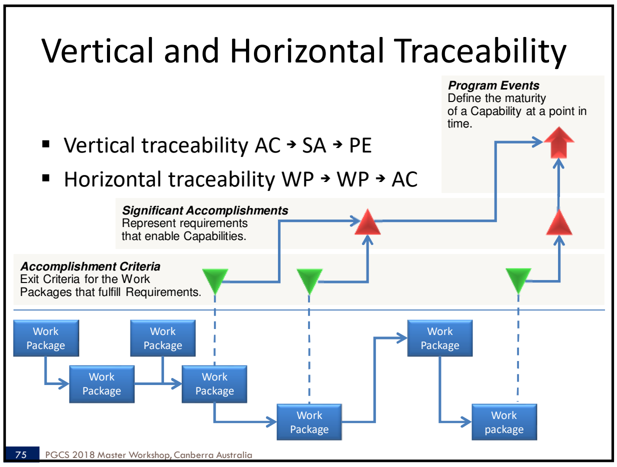

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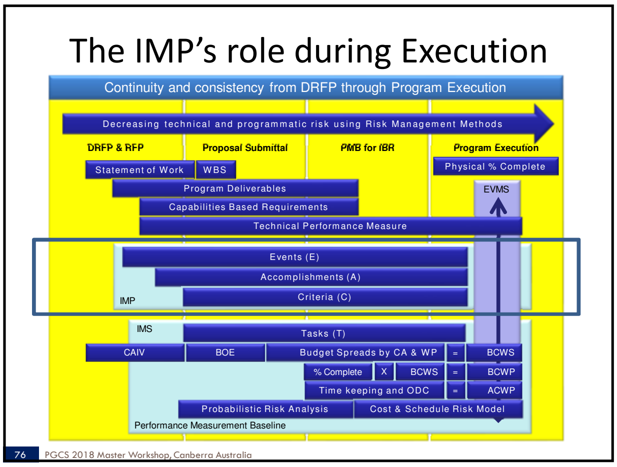

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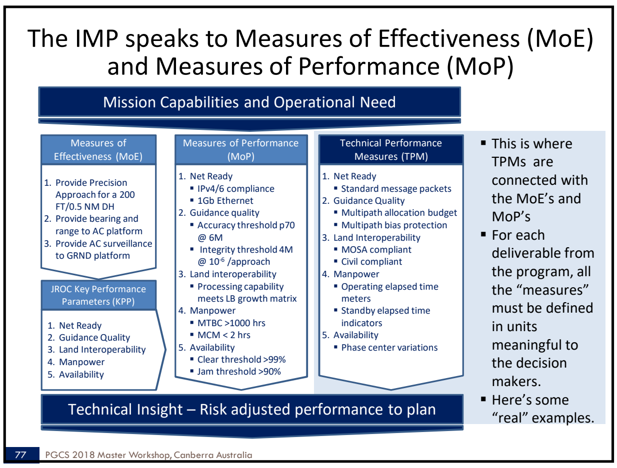

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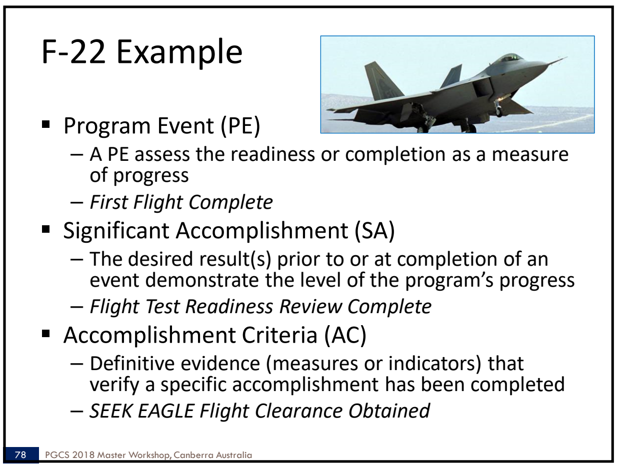

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The IMP's connection to the WBS

- 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

Work Breakdown Structure / 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	
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

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

IMP

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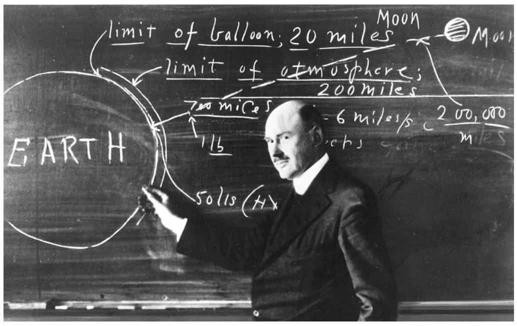

19 October 1899 Robert Goddard decided that he wanted to "fly without wings" to Moon.

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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.

Developing the Integrated Master Schedule from the Integrated Master Plan

81 PGCS 2018 Master Workshop, Canberra Australia IMS

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Quick View of Building the IMS

IMS

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- 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

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The Integrated Master Schedule

IMS

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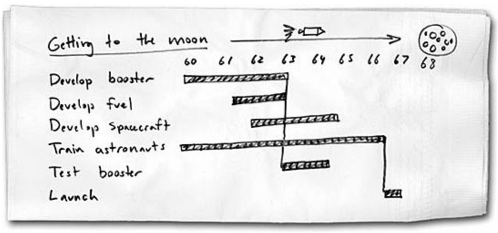
- The horizontal sequence of work activities that produce increasing maturity of the product or services delivered by the program



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A Credible Integrated Master Plan Must …

IMS

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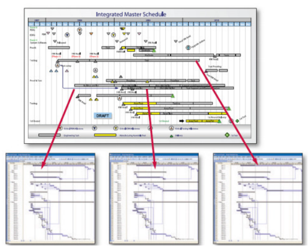
- Show what ***Done*** looks like through tangible evidence of success
- Show the order of the work needed to get to ***Done*** at each stage
- Define the needed resources to reach ***Done***
- Identify risks to ***Done*** and their handling
- Measure physical progress toward ***Done*** in units meaningful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



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Building the Integrated Master Schedule requires 10 Steps

IMS

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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

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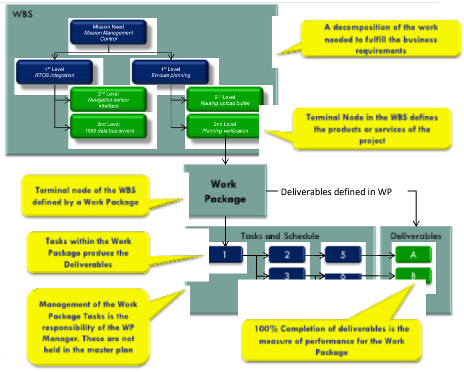
Back to the WBS It connects Work Packages in IMS to IMP

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



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The IMS Provides Visibility to …

IMS

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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 *Physical Percent Completion* of the program.

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Quantifiable Backup Data (QBD)

IMS

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- 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.

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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

89 PGCS 2018 Master Workshop, Canberra Australia Risk

89

Core Elements of Program Risk Management

Risk

90

- 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 Mikes and Robert Kaplan, Working Paper 13-063 January 13, 2014

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Uncertainties are things we can not be certain about.

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

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Some Words About Uncertainty

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- 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

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Some Words About the *Risk* that Results from *Uncertainty*

93

- Risk has Two Dimensions
  - The degree of possibility that an *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.

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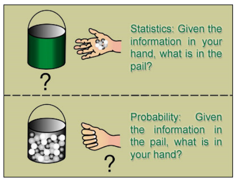
All Program Activities have Naturally Occurring (Aleatory) *Uncertainties*

94

- *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?*

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The Relationship Between Uncertainty and Risk

95

- ***Uncertainty*** is present when probabilities cannot be quantified in a rigorous or valid manner, but can 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***

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Taxonomy of Uncertainty and the Risk it Creates

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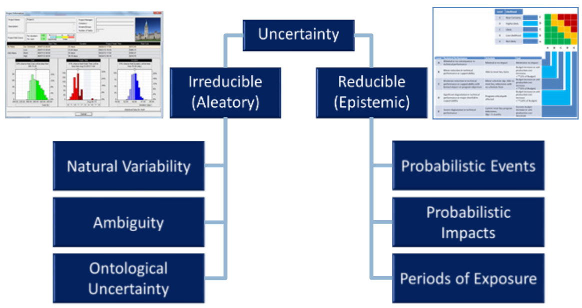

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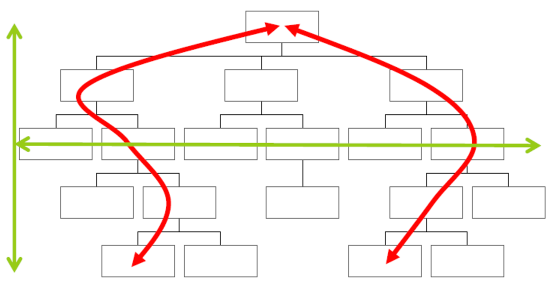
Remember – *WBS is Paramount* ? Risk Propagates Through the WBS

Risk 97



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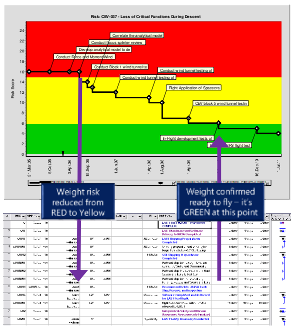
Connecting Epistemic Risk Retirement in the IMS

Risk 98

- 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.



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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.

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Root Causes of Risk Some are Reducible some are Irreducible

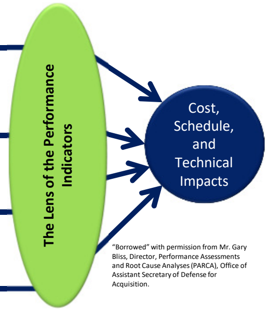
Risk 100

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



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

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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

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Beware the Black Swan

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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

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

Progress of Plan

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- 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*

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To Achieve Success …

Progress of Plan

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Here's where TPMs Start

Progress of Plan

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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

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

Progress of Plan

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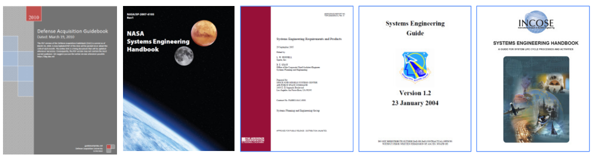
The starting point is not **EVM**, it's **Systems Engineering**

- 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



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Previous Approaches Using EV are Mostly Unsuccessful Connecting these Measures

Progress of Plan

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- 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
  - Variances are reporting beyond the widow of opportunity for correction

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TPMs have been around for 34 years

Progress of Plan

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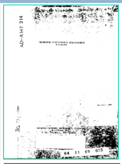
… the basic tenets of the process are the need for seamless management tools, that support an integrated approach … and "proactive identification and management of risk" for critical cost, schedule, and technical performance parameters.

— 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.

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Back to Technical Performance Measures

Technical Performance Measures do what they say,

Measure the Technical Performance

of the product or service produced by the program

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

TPM

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

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Measure of Effectiveness (MoE)

TPM

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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

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

112

Measure of Performance (MoP)

TPM

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

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

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Key Performance Parameters (KPP)

TPM

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

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

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Technical Performance Measures (TPM)

115

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

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

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Dependencies Between Measures

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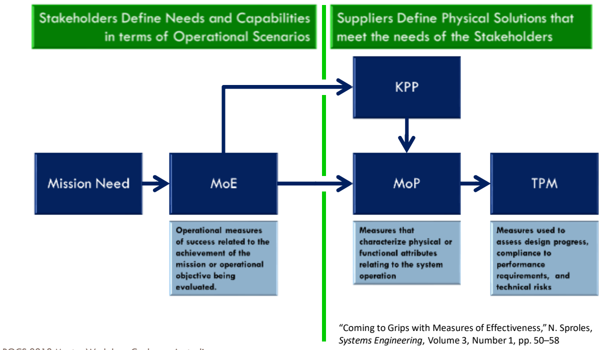

"Coming to Grips with Measures of Effectiveness," N. Sproles, *Systems Engineering*, Volume 3, Number 1, pp. 50–58

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"Candidates" for Technical Measures

117

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

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"Measures" of Technical Measures

118

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
Variances	▪ Demonstrated technical variance ▪ Predicted technical variance

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A Simple Method of Assembling the TPMs

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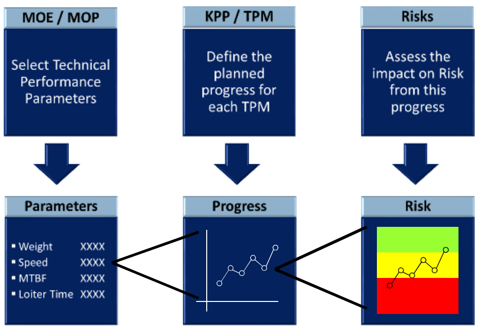

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TPMs from James Webb Space Telescope

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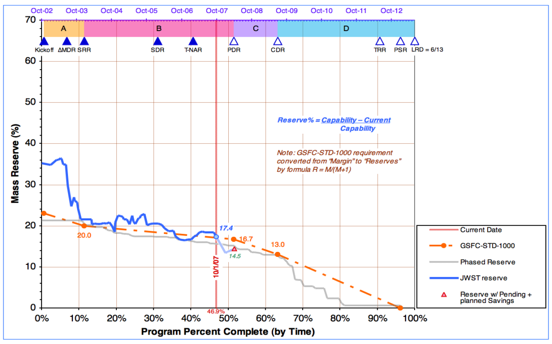

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TPMs from Chandra X–Ray Telescope

TPM

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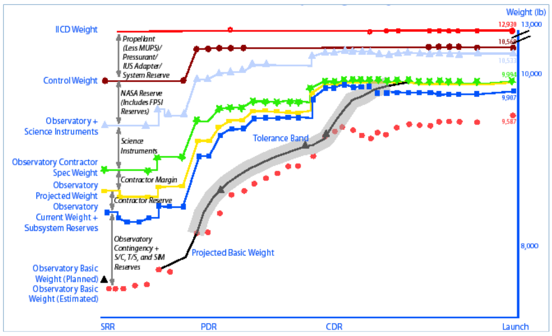

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TPMs Start With The WBS

TPM

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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

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What Do We Need To Know About This Program Through TPMs

TPM

123

- 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?

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Verifying Each TPM at Each Stage in the Program

TPM

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	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 1st flight – will this thing get off the ground?

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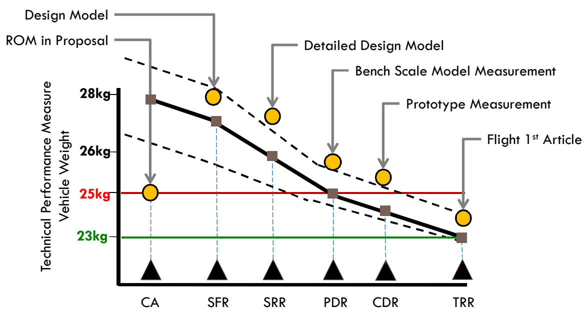
TPM Trends & Responses



EV Taken, planned values met, tolerances kept, etc.

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Dr. Falk Chart – modified

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The Assessment Of Weight As A Function Of Time

TPM

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- 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

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Raison d'etre for Technical Performance Measures

TPM

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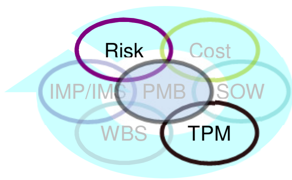
- The real purpose of Technical Performance Measures is to reveal Programmatic and Technical RISK and engage in the Risk Management Process



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Buying Down Risk with TPMs

TPM

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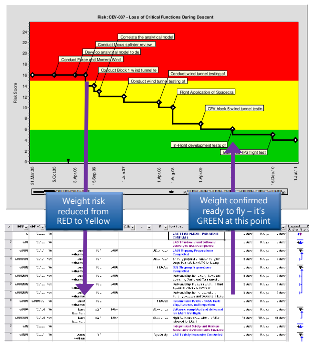

- "Buying down" risk is planned in the IMS.
- MoE, MoP, and KPP defined in the work package for the critical measure – weight.
- If we can't verify we've succeeded, then the risk did not get reduced.
- The risk may have gotten worse.

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Increasing Probability of Success Requires Risk Management

TPM

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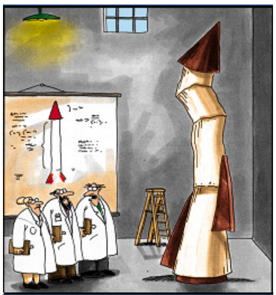
- Going outside the TPM limits always means cost and schedule impacts
- "Coloring Inside the Lines" means knowing the how to keep the program GREEN, or at least stay close to GREEN



So much for our strategy of winning through technical dominance

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Technical Performance Measures Checklist

TPM

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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

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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

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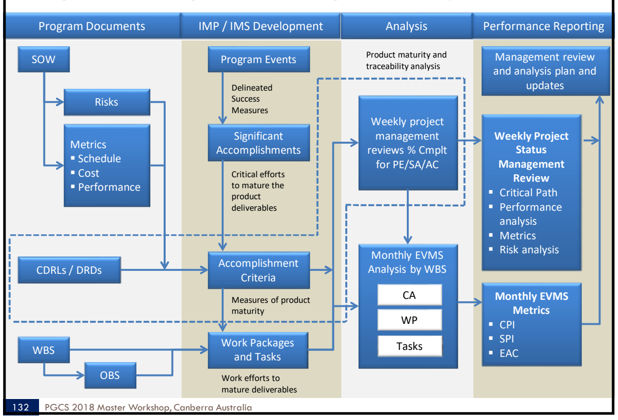
Integrated Program Management System (IPMS)



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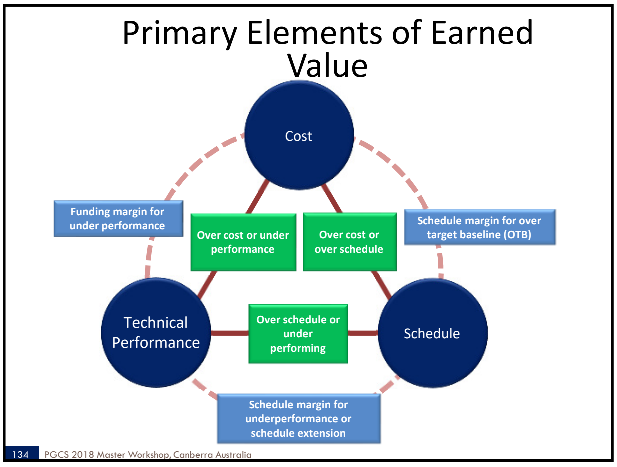

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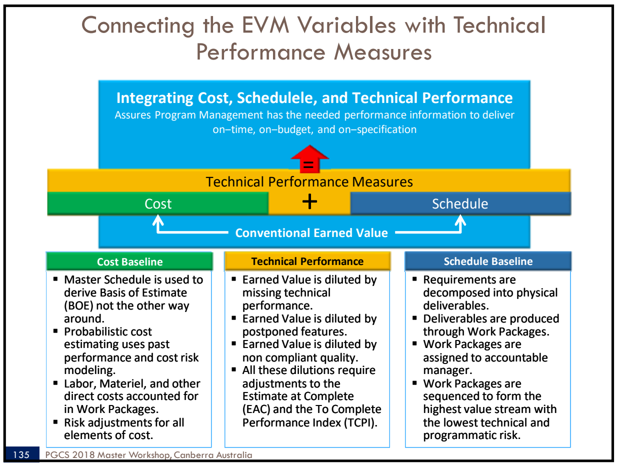

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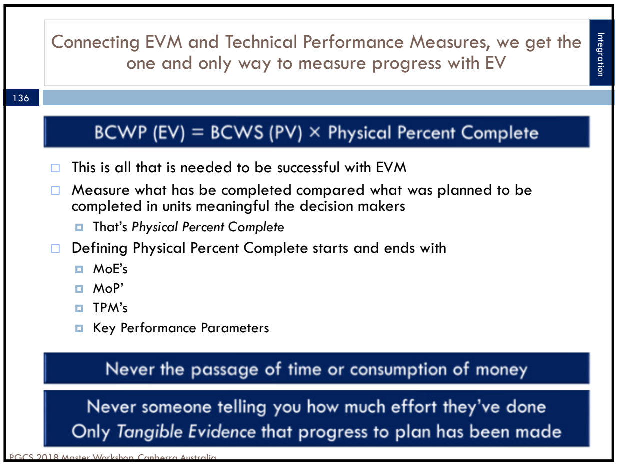

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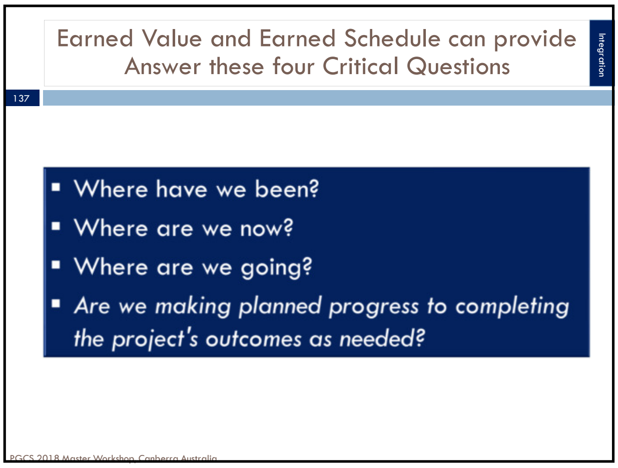

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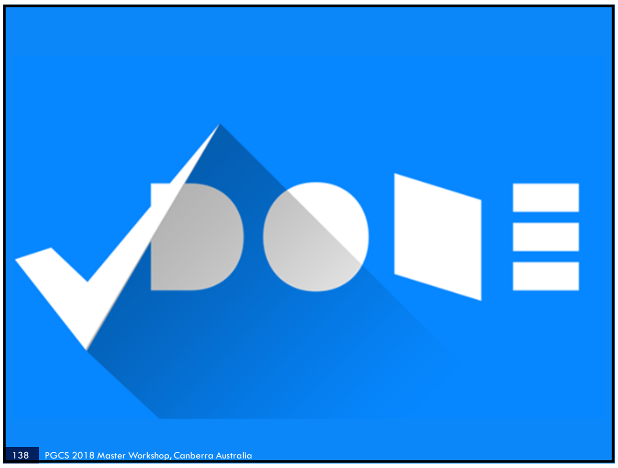

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"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.

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)

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Niwot Ridge Consulting, L.L.C.
4347 Pebble Beach Drive
Longmont, Colorado 80503
+1 303 241 9633
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