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FRAMEWORK FOR IMPROVEMENT OF PROGRAMME SCHEDULING AND PROJECT CONTROLS CAPABILITY

For AusConstructCo Construction Pty Ltd (ACC)

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Preamble

AusConstructCo is a Australian-based, tier 1 international Asia Pacific construction services company and is a leading builder in diverse market segments. The company has earned recognition for undertaking large, complex projects, fostering innovation, embracing emerging technologies, and making a difference for their clients, employees, and community.

With a staff of 1,200 employees, the company completes $5 billion of construction on 500 projects each year. AusConstructCo offers clients the accessibility and support of a local firm with the stability and resources of a multi-national organization.

Our Vision

AusConstructCo is a high value provider of global construction services and technical expertise.

And have decided that it wants to strive to be the best with World Class in Programming and Project Controls in the management of all its projects. To this end, it has been decided to establish a "Framework to uplift the skills required to implement the decision"

1 Introduction

This proposed framework when fully implemented will uplift AusConstructCo Project Programming and Project Controls Skills and Requirements

Our current practices are seen not to be delivering the best outcomes across all divisions and projects, like most businesses there are a wide range of project skills

To improve our skills, we need to know where we are now and where we want to be moving forward to.

Thus, to meet our vision we need to establish and set us apart from others in the market and to be well-respected project controls specialists who are skilled work force within AusConstructCo.

Why we haven't in the past?

Why should we invest in upskilling our Programming Capabilities? A skilled Programmer will add tremendous value to the project and team.

This document takes us through the engagement and requirements of a programmer and through the lifecycle of a project through establishment of education and training to include who, what, when and why to be responsible for the project control and programme scheduling. Competency will be assessed and tested through to additional training if required. The emphasis of the role of "Programmer" will shift as the project progresses touching all four elements of the "value proposition" discussed:

Historically AusConstructCo needs to bring Project Control into the Construction Division as highlighted in the "Working Smarter Case Studies" of March 2015 by Synergine.

The current business atmosphere (2018) within AusConstructCo Construction has been highlighted in the case study with the statement "There is a lack of consistent methodology at several important levels" Listed as:

- Programming
- Lack of scope management, programme (Programme)
- Lack of cost control
- Poor scope management
- Poor programme management
- Inefficient project risk analysis trend management
- Poor resource management, programme
- Document management, quality
- Poor project document management

1.1 Structure of this Document

Section 1 identified the issues and points = key content:

- Purpose of this document
- Assumptions
- Continual Improvement and Development – Areas of Focus
- Roles that perform programming duties
- How we are going to tackle the issues
- Programmer – what is the real definition?

Section 2 Highlights our current challenges / Capability Gaps:

- Provide examples = good vs bad (only 1 good and that is a bid)
- Areas that are out of scope of this framework

Section 3 What is the way forward – Introducing International Standards

- ISO 21500 Project Management Standard
- PMBOK - Project Management Body of Knowledge
- AS 4817:2018 - Earned Value Performance Measurements
- Introducing a Competency Framework - How to introduce these changes and adopt these standards
- Introducing the Process for upskilling programmers for P6 and Microsoft Project users

Section 4 merging upskilling into a ACC Governance Framework

- Step 1: Defining ACC governance operational model requirements
- Step 2: Designing ACC governance operational model
- Step 3: Implementing ACC governance operational model

1.2 Purpose

This document provides a framework guide for setting up a Programmer Capability Lifting program to succeed – through clear expectations and ownership.

Why are we doing this?

To have a successful implementation we need to separate into various components by

- Identify Current State – Programming skills within AusConstructCo Construction
- Current systems, processes and procedures that need to be adapted and/or adopted for a Major Project to become proficient. Including rapid Stat-up from Pre-Contracts (Bid) through the project lifecycle to Warranty.
- Develop and improved
- All processes, procedures, reporting, and methodologies required.
- Conduct End User Training including self-assessment and formal training
- Survey Monkey of Programming Tools usages and skills - Complete
- Interview of Programming KPIs
- Self- Assessment of Programming Skills
- Competency Test (System Based)
- Conduct User Training Primavera P6 16.2
- Conduct User Training Microsoft Project 2013
- Conduct User
- Convert Training Collateral
- Audit and Change Management
- Audit of Project captured with EPPM Server
- Identification of source to Audit MS Project Programmers

- Peer Review

1.3 Assumptions

It is imperative that we follow the existing Pre-Contracts model to ensure we are not recreating documentation. The Pre-Contracts documentation is the cornerstone which form the basis for the lift of all projects.

- (See Project Execution Plan – Template March 2016)
- (See Cost Breakdown Structure from FB Financial System Oracle (JDE)
- (See Work Breakdown Structure (WBS) 2017.

1.4 Continual Improvement and Development – Areas of Focus

We are tackling areas including Project Management Systems, processes and end user training which will enable better change management visibility which must be integrated and transparent from the Project level through to upper management and requires dedicated skilled resources to enable this. The Table below focussed on the Activities to be undertaken to enable this to happen.

Table 1 Areas of Focus - Lifting Programmers' Skills Capability

Activities to be Undertaken	Output Type	Source / Document Name	Suggestion of Process
Initial survey of current P6 users	Survey results	Survey money P6 users results	Initial survey conducted outputs provided basis for system upgrade
Develop, document and agree ACC scheduling framework	Document	Lifting programming skills capabilities	Part of this document
Develop and agree reporting requirements	Process		To be Defined in line with FCC governance model
Ensure Lean Construction adoption has been captured within project programs	Process	Lean Construction overview	Last Planner in Progress on 14 Projects
Rollout Mandated Project Reporting Standards meet the minimal Governance Requirements for planning and programming (WBS/CBS). Dependent on ACCGovernance Framework (TBA)	Process	1. Programming Health Check 2. Work Breakdown Structure 3. Glossary of Terms and Definitions	To be defined in line with Governance Model
Conduct audit of current project tools (P6 & MSP) and identify compliance gaps – Peer Review – Gap Analysis	Audit	Programmer Peer Review	Conduct 14 Point DCMA Health Check to each Project
Develop evidence-based competency assessment toll	Competency Tool	Programmer Self-Assessment Tool	Defined in Programming Roles & Responsibilities
Identify scheduling and project management competency required	Competency Tool	Programming Health Check Audit	Captured in Defining Programming Roles & Responsibilities
Develop evidence-based competency assessment tool	Competency Tool	Programming Health Check Audit	To be Trialled Developed on 14 Point DCMA

Activities to be Undertaken	Output Type	Source / Document Name	Suggestion of Process
Review current P6 configuration to ensure configuration supports framework and reporting requirements, cleanse database if necessary	System	P6 User Audit Results 20170308	Data Cleansing to be complete 31/3/2018 (70% complete)
Progressively migrate P6, MSP, MPI projects to common P6 database	System	P6 User Profile 20170308	Migration to be complete 31/3/2018 (90% complete)
Conduct audit of current project tools P6 and identify compliance gaps – Peer Review – Gap Analysis	System	Via proposed performance process for assessing programmers' current skills	14 Point Health Check
Conduct audit of current project tools MS Project and identify compliance gaps – Peer Review – Gap Analysis	System	Via proposed performance process for assessing programmers' current skills	14 Point Health Check
Design and implement other interfaces as required	System	PID for API with IT	JDE, Middleware, EcoSys / Reporting dashboards
Develop Long term training strategy and recruitment strategy	Training	To be Developed with Training & Development	Training Strategy
Develop customised training	Training	To be Developed with Training & Development	Training Plans
Deliver required end user training – scheduling concepts, P6, MPI, EVM	Training	To be Developed with Training & Development	Training Plans
Develop Communications Strategy with all Stakeholders	Communications	To be Developed with Training & Development	Training Comms Plan

2 Challenges

The following examples show us comparison of components of project which are offering us areas for us to improve upon of where we stand today.

2.1 Current Project Delivery Components within Infrastructure – Opportunities to Improve

Within AusConstructCo Construction Infrastructure today there are pockets of excellent that we aim for. Although once we have fully engaged utilised a true Project Control Methodologies then we can have identified and rectify areas of concern earlier than previously able to. Areas that Project Controls and Programming can identify if captured correctly could be the following.

Table 2 Project Delivery Components

Project Delivery Components			
This list shows some areas within Infrastructure Projects that we have from good to excellence although there are still projects that have room for improvement to enable better performance / reporting			
Budget Commercial Design Management Early Works	Clients Stakeholder Interactions Communications JV Deed Management	Culture Governance	Document Control Quality Integrated Management Systems
Procurement Management Reporting & Programme Risks & Assumption Management Scope Management Waste Management			

3 What is the way forward – Introducing International Standards - PMBOK

Once we know the skills are at a sufficient level we can start adding the earned value component to our programme report by utilising the tolls to capture resourcing and costing data from JDE and risk management to produce relevant and up to date real data from JDE to ensure that these is no manipulation or misinterpretation of the information.

EVM provides us with the methodology needed to integrate the management of project scope, Programme, and cost. It can play a crucial role in answering management questions that are critical to the success of every project, such as: Are we ahead of or behind Programme?

- How efficiently are we using our time?
- When is the project likely to be completed?
- Are we under or over our budget?
- What is the remaining work likely to cost?
- What is the entire project likely to cost?
- How much will we be under or over budget?

The project manager can use the EVM methodology to help identify

- Why do we schedule and what Scheduling Skills level do we need to ensure proper Programme management?
- Where problems are occurring; and whether they are critical or not:
- What it will take to get the project back on track.

3.1 PMBOK - Project Management Body of Knowledge

By ensuring the following tasks are carried out it meets the international standards of both BMBOK and AS4817

- Perform under consultant's working methods/standard requirements (especially working procedure, department working procedure, in accordance with Australian Standard AS 4817 “Project performance measurement using Earned Value
- “Integrated transparent visibility from Project through to upper management
- Requires dedicated skilled resources
- Structure CBS – WBS Confirmed
- Requires WBS Structure to aligned with JDE CBS Structure for all projects
- Requires specific resources (Costed within the project Structure – See JDE Plant, Labour, Materials, Costs

- Requires specific costs
- Tools to capture track and report on the data e.g. EcoSys/Prism
- Linkage between tasks & earned value data & earned value performance measurement process
- Decompose the project scope
- Assign responsibility
- Programme the work
- Assign objective measures of performance
- Set the performance measurement baseline
- Authorise and perform the work
- Accumulate and report performance data
- Analyse project performance data
- Take management action
- Maintain the baseline and Understand the contract and its requirements
- Definition of all Stakeholders
- Communications Strategy
- Project Control Governance (PCG) Meetings and Reporting

3.2 AS 4817 - Earned Value Performance Measurements

Use of the Australian Standard. Once we know the skills are at a sufficient level we can started adding the Earned Value component to meet the Australian Standard in the following steps:

- Step 1: Decompose the Project Scope
- Step 2: Assign responsibility
- Step 3: Develop time phased budget
- Step 4: Assign objective measures of performance
- Step 5: Set the performance measurement baseline
- Step 7: Authorise and perform the work
- Step 8: Accumulate and report performance data
- Step 9: Analyse project performance data e.g. Last Planner Report
- Step 10: Take management action
- Step 11: Maintain the baseline

3.2.1 Earned Value performance Management Plan (EVPM)

EVPM is designed to provide Senior Management with an accurate overview of corporate performance. It builds on the information provided by traditional scheduling techniques to plan and measure the overall productivity of a system or a project. EVPM through the Performance Measurement Baseline provides bottom line assessment as to whether the plan is being implemented effectively or not and highlights problems at an early stage allowing effective management intervention. It is an objective measurement of how much work has been accomplished on a project.

(A more detailed explanation of EVPM is found at Appendix C)

EVPM provides

- A complete range of cost management reports exist including
    - S-Curves
    - Cost performance
    - Cost Status
    - Cost Trends
    - Cost Variances
    - Charge out

- Calculation of EV ratio's including
- BCWS
- BCWP
- ACWP

This section documents how the project costs will be budgeted and controlled.

Cost Estimating

Describe the major items that will influence the cost of the project. This may include external purchases, contracts, staffing costs, etc. Describe how costs will be estimated, as well as managed to the original estimates. Describe the precision of cost estimation and reporting. For a software development project, be sure to identify what role the build/buy decision for software has on the cost estimating and cost budgeting.

Cost Budgeting

Describe how and when the project budget will be baselined. Indicate how the project expenditures will be tracked, i.e. whether the project expenses will be reported against a separate cost centre or placed under another existing budget area.

Cost Control

Describe how costs will be monitored in comparison to the originally baselined project costs, and how variances will be analysed and assessed for impact. It may be helpful to list what percentage of impact can be absorbed into the project without adverse effects. You may also list the range of budget impacts that will be tolerated but managed by the project team. (Include required steps such as an analysis of the root cause, strategy to bring the budget back into tolerance, etc.) Also, indicate budget constraints that would not be tolerated for the project, and that, if reached, would put the status of the project in jeopardy.

Earned Value Reporting

Describe reports that are required to evaluate the project's financial health, who is responsible for generating the information, the type of information required, distribution, etc.

3.3 Introducing a Competency Framework - How to introduce these changes and adopt these standards

The Competency Framework for Programmers is designed to be used in three ways:

By an individual programmer to help them to develop their competencies, apply those they have and identify development and training needs for those that need improving

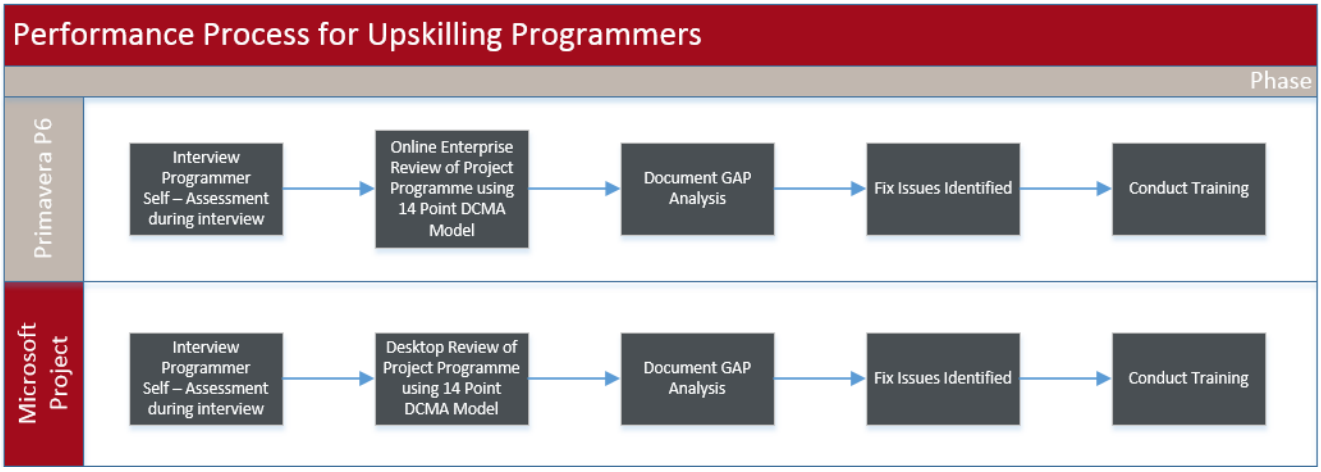
To enhance performance through setting out and agreeing the skills, knowledge and behaviours required by planners to do their job. This can be done both informally and as part of the appraisal process and goal setting process.

To support a Human Resources and Operations Manager in the programmer's resource planning by allocating expert staff to roles; by identify particular gaps in competencies and seeking to fill these through development and support for individuals: or through recruitment or the use of consultants.

To support via a systems perspective to ensure that the systems and their interactions are understood and ensure the Programmers understand the Outcomes, Inputs, Processes and Outputs to enable proper project reporting and analysis support to the Project Team

Successful completion of participation in the Self-Assessment Module. AusConstructCo will provided relevant training for participants with the in-depth knowledge and skills to:

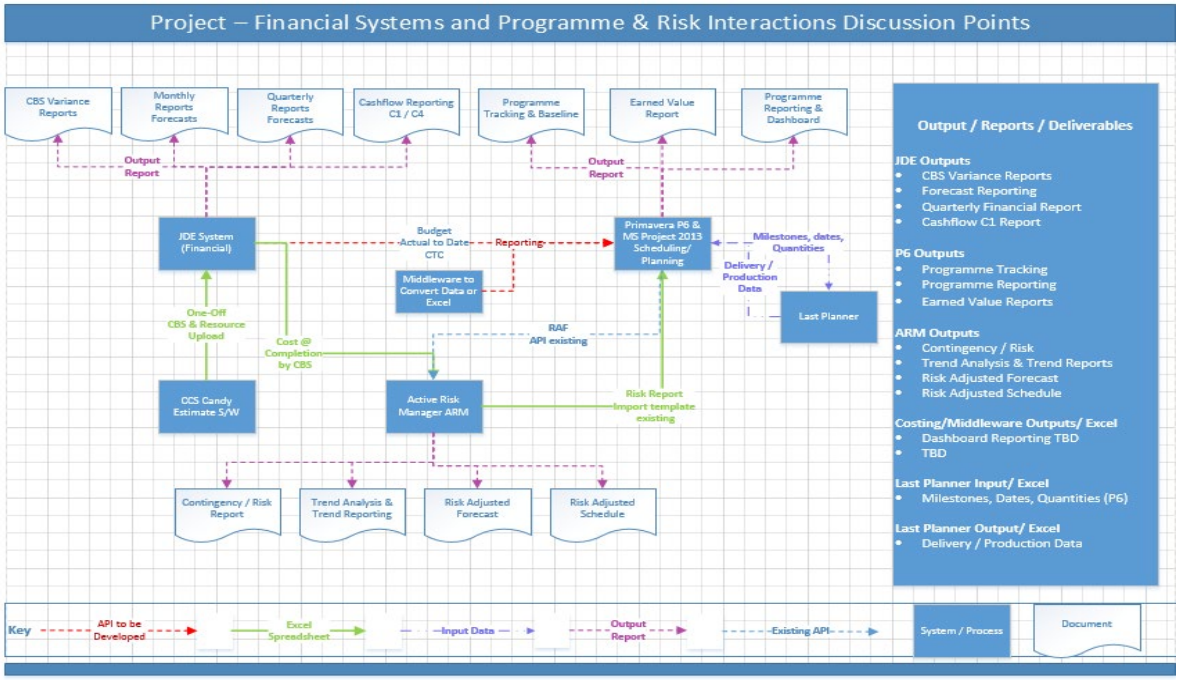
Figure 1 Introducing the high-level process for upskilling Programmers



3.4 Introducing the Process for upskilling programmers for P6 and Microsoft Project users

The following flowchart are the current and proposed interactions between FCC. Also shown relationships and out outputs from both systems and processes e.g. Last Planner.

Figure 2 Project Financial, Risk and Project Tracking Interactions



4 Proposing of steps to implement ACC Governance Framework

Following is three step models suggesting merging and enhance current AusConstructCo governance model. The decision to move forward on this will need to be decided at a board, accelerate level to but to commission these tasks to be carried out on their behalf as these are significant undertaking for any organisation.

In addition, it may be an iterative process, with aspects of the model subject to change or adjustment during or after the implementation, and in response to changing regulatory and/or business conditions. However, the

process outlined below represents one route towards enhancing governance at FC companies, and one that can be rationalised, planned, resources, monitored and evaluated via the Lean and/or Governance Framework itself.

Step 1: Defining AusConstructCos' governance operation model Requirements

Identify potential useful governance frameworks

Identified applicable regulatory and governance requirements

Consider governance scope and needs, such as B&I Infrastructure, South Pacific AusConstructCo Living at other commercial AusConstructCo business liens and those involving planned, contemplated and/or bid and processes

Define the current state of governance, as well as gaps and considerations

- Processes for Step 1
- Analyse peers at a summary level (for example, by means of their committee charters, which are often publicly available)
- Asses AusConstructCos' governance vis-ā-vis a governance maturity model
- Define and agree and mandate AusConstructCo governance glossary of terms

Step 2: Designing AusConstructCos' governance operating model

- Define the desired future-state for AusConstructCo headquarters, regional, global business, and control functions, such as risk, legal compliance, financial audit, and HR (See Appendix xxx)
- Define a change-management plan to institutionalise the attitudinal and behaviour changes needed to implement the model
- Detail design of governance operating model and its components
- Develop matrix defining key accountabilities across AusConstructCos
- Development matrix defining decision rights and escalation paths

Step 3: Implementing AusConstructCos' governance operating model

Create an implementation plan that:

- Defines standards and metrics by which success will be measured
- Maps governance requirements to organisational functions and business requirements
- Allocates resources to implement, per priorities and over time as requirements and resources permit
- Defines schedule and components of review process
- Implement AusConstructCos plan and maintain governance practices
- Evaluate the plan, implementation, and practice

Processes for Step 3

- Create an implementation plan in an electronic, visual format that enable the team to track progress on action steps and to log disposition of risk and related issues
- Obtain external assistance in creating a workable plan and format and in overseeing implementation, as necessary
- Asses AusConstructCos' governance vis-ā-vis a governance maturity model

5 Project Controls Definition

Project controls are the data gathering, management and analytical processes used to predict, understand and constructively influence the time and cost outcomes of a project or program; through the communication of information in formats that assist effective management and decision making

To set good project controls, you need to start at the beginning or at the project initiation phase. Your monitoring and controls should be based upon:

- Creating the Project Scope – Defining every aspect of the project at hand.

- Team & Task Structure – Deciding upon which teams will do certain tasks while developing an effective facilitation plan to ensure progress.
- Associated Risk & Risk Management Plan – Identify both acceptable and harmful risks, and prioritize and deal with risks in a risk management plan.
- Change Control Plan – Change is inevitable, so what will your change control process be? How will you deal with the human element in your change control plan?
- Status Monitoring – Whether it's daily or weekly in-person meetings or written status reports, you must have a way to grasp project progression.
- Effective Communication Plans – Set up lines of communication that are efficient. You also need to include stakeholder or client communication.
- Budgets & Deadlines – Keep track of associated costs and deadlines.
- Evaluation & Analysis – Is every element completed correctly as described in the project scope?
- Corrective Plans – If your analysis indicates that correction is needed, how will you plan for adjustments?
- Presentation Plan – Who will present the project and what sources (both internal and external) will be required?

Each one of these controls implemented into your projects must be monitored. No monitoring really means no control. The need for project control in every task or challenge given to you grows ever important, especially in the competitive world of project management.

6 Developing the Master Works Programs

6.1 The Form of a Master Works Program generally

The Master Works Program must:

- be clear and sufficiently detailed for the Project Services Manager to easily identify:
    - the Critical Path for the execution of the Works;
    - the responsible party for each Activity and Milestone;
    - all Activities that involve specific department, the specific department Project Manager, the Area Team Manager (the Independent Certifier, (if there one?) including the date by which the contractor requests any review by the department, the Project Manager or Independent Certifier (which must be consistent with the terms of the Agreement between Sydney Water and the Contractor);
    - all Activities or Milestones that are dependent on external third-party contractor events including the obtaining of approvals ("Precursor Events"); (Development Approval's?)
    - the nature, time for completion of, and the identity of any third-party contractor responsible for completing each Precursor Event; and
    - Activities comprising any Sub Program.
- contain a single overall start Milestone and a single overall finish Milestone.
- be in the form of a Logical Critical Path Network that enables the Critical Path to be calculated automatically by the computer software.
- use days as its Planning Unit (or such other period approved in writing by the Project Service Manager);
- contain Calendars which enable planned working and non-working periods in the future to be identified.
- demonstrate that all the Activities in the programs, apart from the start and finish Milestones, are logically Linked.
- provide a labour resource histogram that is consistent with the work depicted in the program.
- develop planned versus actual resource s-curves by phase.
- clearly identify:
- Activities, their order, duration and interrelationship.
- the durations and Total Float of all Activities.
- if known, the impact, and the estimated potential impact of any delaying events or circumstances; and

- any other matters which a material effect on the time may have required to complete the
- Works in accordance with the applicable Date for Completion.
- contain all other information reasonably requested by the Project Services Manager; and
- not contain, without prior approval by the Project Services Manager:
    - in respect of the Sub Programs only, any Activities of durations of longer than 20 Business Days.
    - any Free Float Constraints or Total Float Constraints.
        - any other programming Activities or methodologies which have the effect of creating false Criticality or constraining the program from reacting dynamically to changes.
    - any Logic Links containing negative Lags (except where a negative Lag is used to indicate the time for any action by the department);
    - Activities without finish Successors (except for the overall finish Milestone); or
    - Activities without start Predecessors (except for the overall start Milestone

7 Software Applications used for Project Planning and Scheduling

AusConstructionCo uses various Project Planning and Scheduling software for its various projects to comply with the client's specific requirements. These software packages are:-

- Oracle Primavera P6
- Microsoft Project
- Micro Planner X-Pert
- Deltek Open Plan
- Asta Power Project

How a Schedule is developed for each of the above applications will be defined using the first seven steps for Schedule Planning and Development as given by the AACEi Total Cost Management Standard 7.2. These steps are: -

1. Plan for Schedule Planning and Development
2. Identify Activities
3. Develop Activity Logic
4. Estimate Durations
5. Establish Schedule Requirements
6. Allocate Resources
7. Optimise Schedule

8 Developing a Schedule using Primavera P6

Oracle Primavera P6™ organizes project planning information based on hierarchical structures. Each structure consists of at least one root or base level and multiple sub or lower levels.

At the highest level the projects are typically organized around an 'Enterprise Project Structure' or grouping of the database of projects (i.e. type, clients, phasing, etc.). Projects are organized by common attributes based on the organizational requirements as well as internal organisational

Planning Considerations – project level or contractual organizational

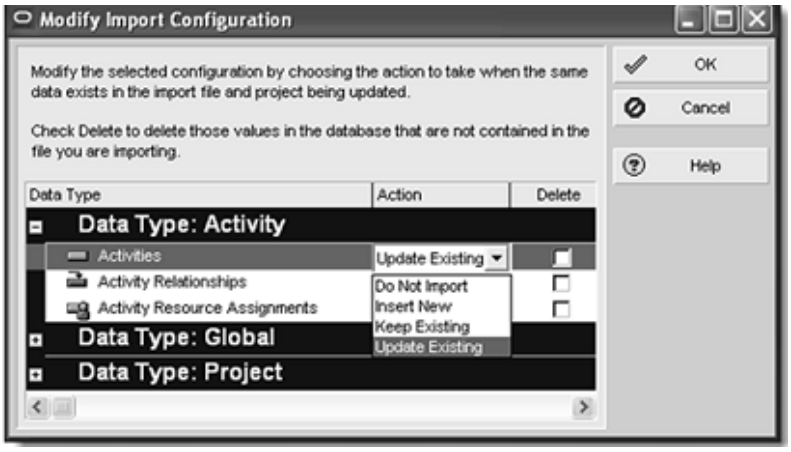
- Application Integration
    - Global/Project Structures
    - Project Definition and Coding
    - Work Breakdown Structure and Coding
    - Activity Code Structures (Global/Project)
    - Activity Structures (ID's and Naming Conventions)

- Resource / Cost Requirements
- Durations and Global/Project Calendars
- Calculation Rules
- Optimization and Reporting

Note: Need to make that consistency is maintained for

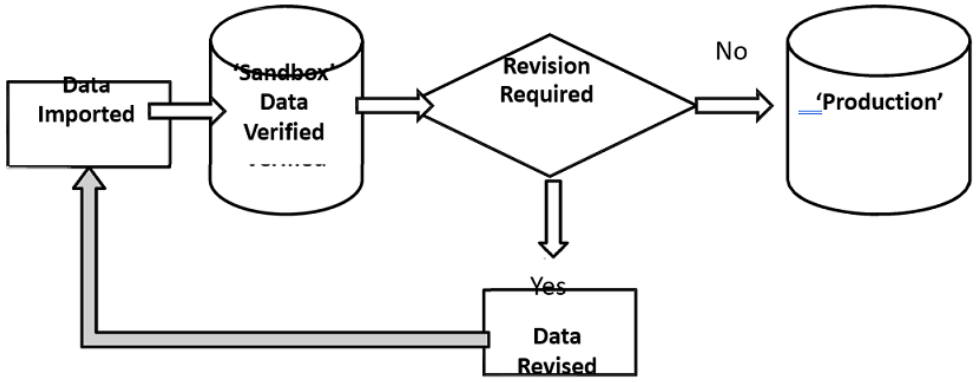
- Project Structures
- Global Structures
- Scheduling System Integration Considerations
- Export Format and Import Templates – XML/XER exports and Import Configurations

Figure 3 xxxxx



- Integration with Asta Power Project
- Integration with Microsoft Project
- Integration with other Primavera P6
- Organization of Databases within Primavera P6™
    - Production database
    - Intermediary database

Figure 4 xxxx



Appendix 1 - The Framework for Improvement of Programme, Scheduling and Project Controls Capability

The framework consists of 14 major components, sub-divided into learning topics as per the requirements for the Guild of Project Controls

Component 01 Project Programming Roles and Skills Requirements

Component 01-0 Managing Planning & Scheduling

Topic 01-01 - Introduction to Managing Planning & Scheduling

- History of Planning & Scheduling
- Enterprise Plan / Integrated Master Plan, Tender / Proposal Schedule
- Implementation / Integrated Master Schedule
- As-Built Schedule
- Arrow Diagram or Activity-on-Arrow Method
- Ladder Convention
- Precedence Diagram or Activity on Node Method
- Critical Path Method
- Bar or Gantt Chart vs. Time Scaled Logic Diagrams vs. Pure Logic Diagram
- Line of Balance / Velocity Diagram Method
- Linear Time & Location Method
- Rolling Wave Method
- Level of Schedule Detail– What, When & Who
- Process Map

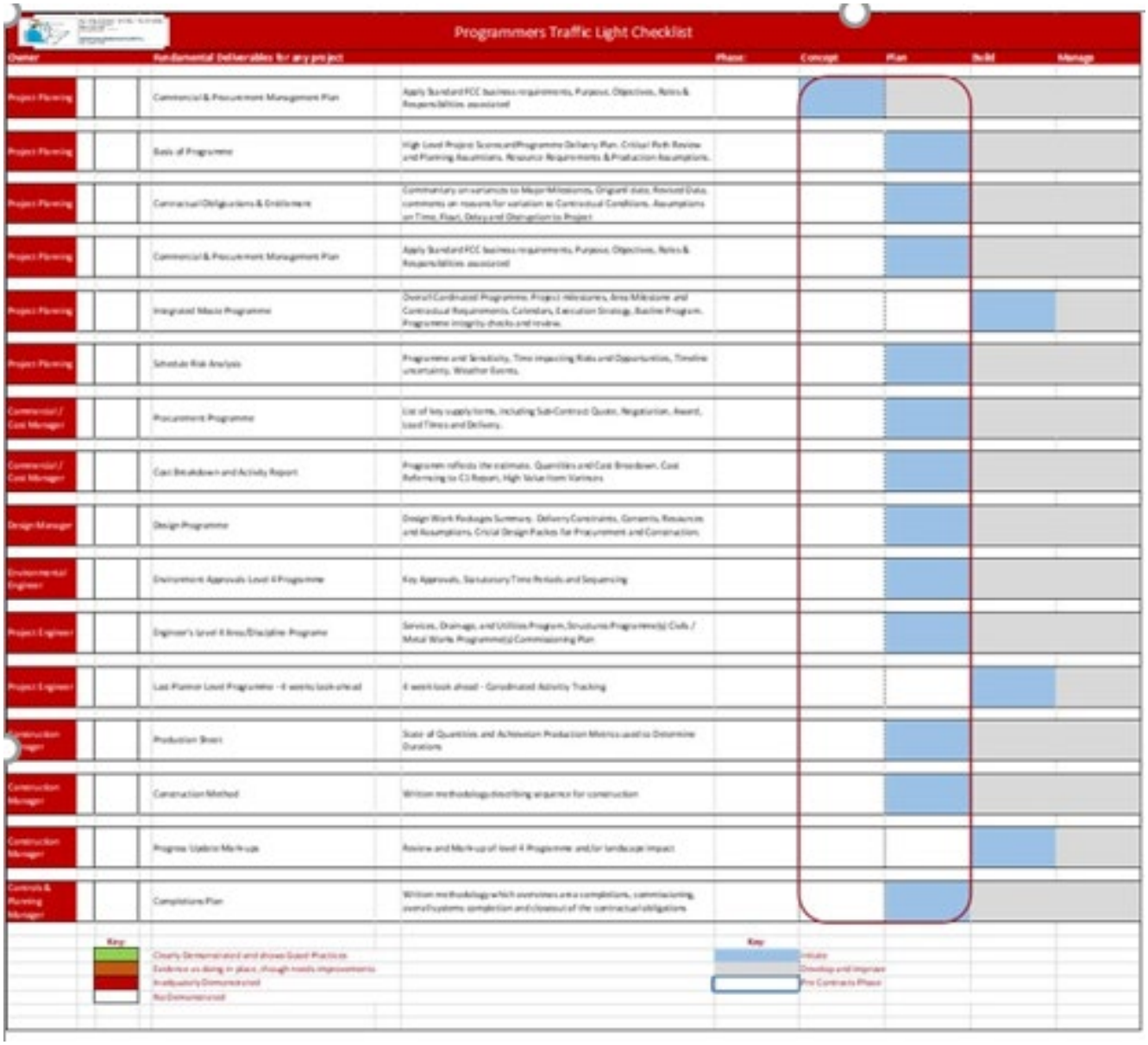
Topic 01-02 - Develop the Planning & Scheduling Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 01-03 - Defining Roles & Responsibilities of a Programmer

- The following defines those skills required for a programmer who must ask what, where, when, why and how when developing a programme
- The Programmer is engaged in the Bid/Tender process and is involved throughout the lifecycle of the project.
- The Programmers Traffic Lift Checklist shown below is used as a tool to ensure that the Planning fundamentals for any project have been captured throughout the lifecycle of the Project from Pre-Contracts through the Close-out.
- As is indicated it is the deliverable Ownership Traffic Lights, Reasons why and the outputs that these deliverables should contain. It also highlights what stage of a project is at when the Status Need has been entered to ensure this is the same as the bid process by stating exactly which steps they come in on, anything after that is a risk increase

Figure 5 Programmers Traffic Light Checklist



Topic 01-04 - What are the levels of programming skill, where do they fit in the skills matrix

The matrix below shows the levels and deliverables as presented by Guild of Project Control. It shows that the role of the Project Controls Specialist can start as early as the Pre-Contracts and throughout the lifecycle of a project including that of capturing and reporting of the cost/budget of projects within the programme, although traditionally it shows through the PMBOK as three stages it has been proven that capturing the financial situation is better to be done as part of the Programming.

Topic 01-04 -01 Planning vs Programming

Planning vs Programming = supporting the project leadership team to govern the strategy of the work process:

- How the control is to be made; Scope definition, WBS, Establish Codes
- What methods are to be used for design, procurement and construction.
- The strategy for subcontracting and procurement.
- The interface between the various participants.

- The zones of operation and their interface.
- To maximise at a high / long term level, as the work stream specialists will know how to do this at the weekly / daily activity level efficiency of the project strategy with respect to cost and time.
- Risk and opportunity management.

Topic 01-04 -02 Post Planning Activities of a Programmer

Once the planning stages are complete, the Programmer will assist positions responsible for project execution to determine:

- The duration of the activities.
- The parties to perform the activities:
- The resources to be applied to the activities
- The methods of sequencing one or more activities in relation to other activities, and communication and reporting formats, timing etc. Last Planner: Linking milestones from the master programme to the Last Planner method to ensure detailed activity planning and tracking achieves the programmed milestones
- Skilled programmers can fulfil both the Project Planning and Programming functions and all three roles defined below, trainee programmers normally start in a “monitoring and controlling” role, then progress to developing the execution programmer initially A Programmer is usually engaged at the early stages within the Bid/Tender process and is involved through the lifecycle of the projects.

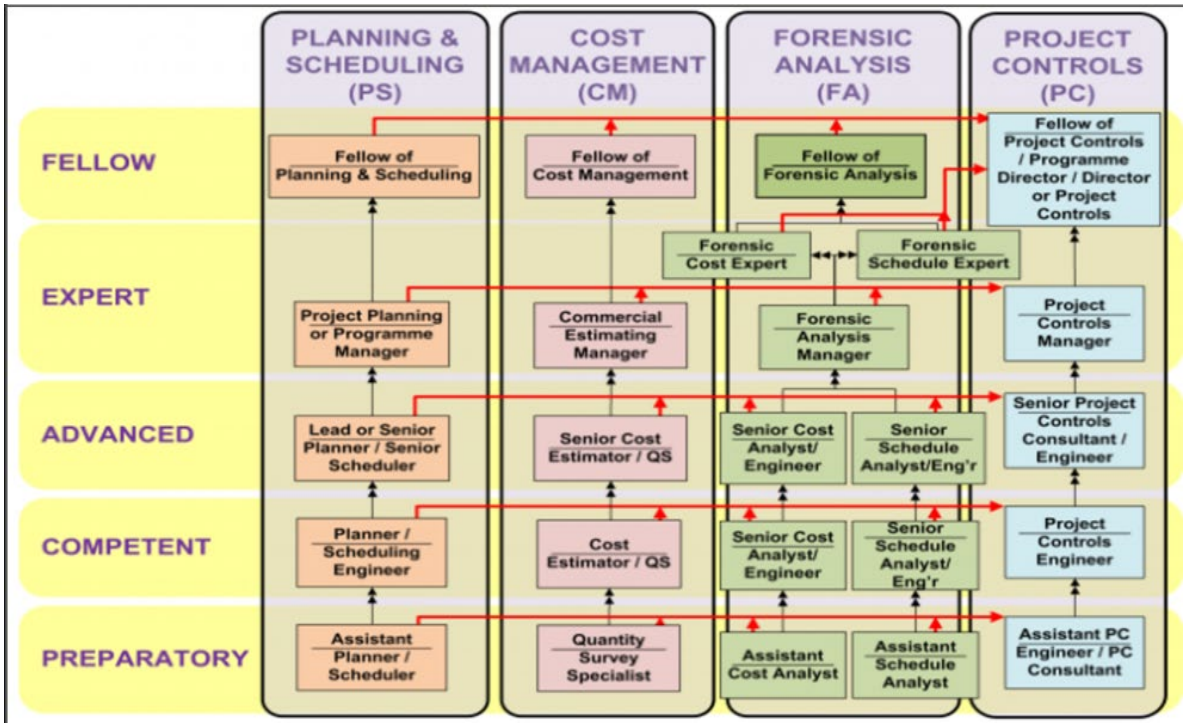
Topic 01-04 -03 How to Gauge Programming Competency

Clearly defined role, responsibility and outputs. Including how, when and what skills a programmer must have and at what level Sequencing is efficient using the DCMA 14 point criteria as a basis to ensure that:

- Milestones are achievable within budget
- Milestones are measurable
- Milestones are published

Currently Cost Management (CM) and Forensic Analysis (FA) have not been present within projects

Figure 6 Source: The Guild of Project Controls



Topic 01-04 -05 The Normal Roles and Stages of a Programmer

As the project and Programmer evolve through these three phases below, the core attributes of 'good programming practice remain unaltered. Key differences are in the appropriate level of detail to be incorporated in the Programme, the degree of certainty that can be attributed to the estimates used to develop the Programme and the role played by the Programmer.

Table 3 Roles and Stages of a Programmer

Planning Stages	Reasons	Skill Level
Commitment Planning (Feasibility Planning PMBOK).	Information is scarce, the Programmer works with the project bid team to 'paint a time picture' of the project, develop a strategy for delivery and gain consensus. Generally, the Programmer is the key 'time management expert' in this phase of the project.	Expert or Project Manager
Execution Scheduling (Initiation & Planning PMBOK)	Developing the agreed project implementation Programme. The Programmer is now in a facilitating role assembling information from the project team (and frequently sub-contractors). The information is 'owned' by the project team. The Programmer's role is to integrate and test the information provided by the team for logic, common sense and completeness by asking the right questions. The Programmer remains totally responsible for the integrity of the scheduling tool and the Programme data (or project Programme model).	Basic with Support from Expert or Project Manager
Performance Control (Execution, & Monitoring & Controlling PMBOK) During	During the execution of the project work the Programmer is in a support role; he/she maintains the Programme, optimises change outcomes and advises the project team on performance. The status and update processes are the mechanism by which the Programmer maintains the Programme model and influences the project team Updating programmes based on data from Last Planner production reports. The Programmer should be alert to changes, variations in scope and trends that may influence project outcomes and advise the project management team of his/her observations, findings and recommendations e.g. Monitoring the Last Planner meetings and outputs to ensure effective planning for delivery of milestones on time.	Basic with Support from Expert or Project Manager

Topic 01-04-05-01 What are the key processes that Programmer needs to be competent in?

- A skilled Programmer will add value to the project team in several ways. The emphasis will shift as the project progresses through its life cycle but all four elements of the 'value proposition' discussed:

Topic 01-04-05-01 -01 Durations, effort, sequence, and dependencies

- Determining the duration, effort, sequence, and dependencies of tasks as the basis for the project programme (Based on the project scope and involving inputs from the project team)

Topic 01-04-05-01 -02 Methods and Techniques

- Applying appropriate methods, techniques, and tools to create the project Programme and time management plan.

Topic 01-04-05-01 -03 Scope and Objectives

- Ensuring the project Programme includes all tasks and activities necessary to achieve the scope and objectives of the project.

Topic 01-04-05-01 -04 Confirm Agree Objectives Capture

- Balancing the time objective of the Programme with resource and cost constraints to develop an optimum solution and agreeing the solution with the project team.

Topic 01-04-05-01 -05 Resource Levelling

- Undertaking various resource levelling, smoothing, and optimizing processes, usually assisted by the scheduling software tool, to meet project objectives. Including having a thorough understanding of the limitations of the techniques and the algorithms and options embedded in the selected scheduling tool.

Topic 01-04-05-01 -06 Integrating Programme and Risk Management

- Integrating the Programme and risk management systems to ensure all planned mitigation activities are properly incorporated into the Programme (including having an appreciation of the overall risk management processes).

Topic 01-04-05-01 -07 Earned Value

- Integrating the Programme and Earned Value management systems to provide the effective transfer of data from the Programme to the EVM systems Programme (including having an appreciation of the overall Earned Value management processes).

Topic 01-04-05-01 -08 Proper Software Tool Usage – Skilled Users

- Ensuring that the scheduling software tools are used correctly (and that the Programmer has been adequately trained in their use).

Topic 01-04-05-01 -09 Stakeholder Approval

- Gaining approval of the project Programme from stakeholders10 and assisting the project manager to gain approval from higher project authorities.
- A competent Programmer support by professional software will be able to develop and maintain programmes totalling approximately 2,000 – 2,500 fully resourced and costed activities per programmer. This is driven by the programmer's ability, the nature, complexity, and length of the projects (2).

Topic 01-04-06-01 -What are the characteristics of a Great Programmer?

- In each role, the Programmer's specific skills are his/her ability to:

Topic 01-04-06-01 -01 Technically skilled in new technologies

- Envision the shape and flow of the project's work in '4D' – the three physical dimensions + time. This is important in both soft-projects (how the work fits together) and hard-projects (how the elements fit together)

Topic 01-04-06-01 -02 Analytical Skills

- Synthesise information from disparate sources into an integrated and 'sensible' Programme, Analyse and validate this preliminary Programme against the overall project objectives,

Topic 01-04-06-01 -03 Good working interpersonal and facilitation skills

- Work with the project team to optimise and refine the Programme (with the Programmer using his/her special skills to identify and suggest options, test 'what-if' scenarios, etc.) until an agreed Programme has been developed,
- Effectively communicate the outcome of the Programme development (or update) process by presenting targeted and relevant information from the Programme in elegant and effective formats, i.e., reporting the right information to the right stakeholder at the right time!
- Responsible for designing an effective time envelope for interrelated Assist the various project stakeholders, and the project manager, understand and manage the project from a time perspective.

Topic 01-04-06-01 -04 Skills and competencies for programmers / planners

Creative vision

- Producing creative and innovative strategies and solutions.
- Making lateral connections.
- Aesthetic and design awareness and critique.

Project management

- Defining objectives.
- Delivering- making it happen given constraints.
- Resource management, including financial and personnel management and use of information technology.
- Process management and evaluation.

Problem solving

- Problem definition.
- Data-collection, investigation and research.
- Quantitative and qualitative analysis and appraisal.
- Weighing evidence and evaluation of alternative solutions.
- Decision making.

Leadership

- Inspiring and motivating others at all levels.
- Leading by example – displaying enthusiasm, tenacity, flexibility, and self-motivation.
- Embracing and leading through change.
- People and organisational management.
- Coaching and mentoring.

Collaborative and multidisciplinary working

- Partnership working - engaging with all professionals employed in the creation of sustainable communities and the built environment.
- Creating an environment where information is shared.
- Effective networking.

Communication

- Written, oral, graphic, and multi-media communication.
- Listening actively.
- Using appropriate communication methods tailored to the audience.
- Managing misinformation.
- Internal communication and information sharing
- Community involvement and facilitation.

Stakeholder management & conflict resolution

- Identifying stakeholders and customers, and awareness of how these groups can change.
- Relationship building.
- Negotiation, mediation, and advocacy.
- Understanding the dynamics of conflict and how to achieve agreement.

Topic 01-04-05 Identify / Capture all Schedule Activities

- Schedule Development Meetings
- Determine Level of Detail, Project Phasing, Weather & Other Constraints
- Finalise Work Breakdown Structure & Control Accounts
- Responsibility Assignment Matrix (RAM)
- Identify the Schedule Activities & Capture All Effort
- Activity Names
- Frag Nets / Templates
- Activity Codes
- Additional Schedule Coding Structures

Topic 01-04 -06 Create the Logical Relationships & Sequence Activities

- Schedule Development Meetings
- Determine Level of Detail, Project Phasing, Weather & Other Constraints
- Finalise Work Breakdown Structure & Control Accounts
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- Activity Codes
- Additional Schedule Coding Structures
- Level of Effort
- Path Convergence

Topic 01-04 -07 Assigning Resources to all Activities

- Resource Dictionaries
- Resources, Effort and Productivity
- Assigning / Loading Activities with Resources

Topic 01-04 -08 Calculate the Duration of Each Activity

- Estimating Durations (Analogous, Parametric, Three Points, Bottom Up)
- Time vs Cost Trade-offs
- Learning Curves
- Using Calendars
- Activity Attribute Checklist

Topic 01-04 -09 Calculating Float and the Critical Path

- The Critical Path and the Longest Path
- Definitions of Total Float and Free Float
- Calculating Float
- Multiple Paths
- Reasonableness of Float
- Schedule Lag Drag Problem and Solution

Topic 01-04 -10 Validate the Critical Path & Completion Dates

- Characteristics of a Reliable Schedule
- Tools & Techniques for validating the Critical Path and Completion Dates
- Common Barriers Impacting a Valid Critical Path and Completion Dates
- Optimise the Schedule for Imposed Parameters
- Imposed Constraints

Topic 01-04 -11 Validate Horizontal and Vertical Integration

- Schedule Interfaces & Horizontal Traceability
- Summarising, Rolling Up / Down & Vertical Traceability

Topic 01-04 -12 Conducting a Schedule Risk Analysis

- Dealing with Risks and Uncertainties
- Duration Risk & Uncertainty
- Monte Carlo Simulation
- Network Logic Risk & Uncertainty
- Merge Bias or Merge Points
- Schedule Contingency Approaches
- Prioritizing Risks
- Probabilistic Branching

Topic 01-04 -13 Baselining and Communicating the Schedule

- Develop Written Basis and Schedule Narrative
- Communicate the Schedule
- Benchmark & Freeze the Schedule Performance Measurement Baseline

Topic 01-04 -06 Identify / Capture all Schedule Activities

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- Network Logic Risk & Uncertainty
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- Prioritizing Risks
- Probabilistic Branching

Topic 01-04 -14 Baselining and Communicating the Schedule

- Develop Written Basis and Schedule Narrative
- Communicate the Schedule
- Benchmark & Freeze the Schedule Performance Measurement Baseline

Component 02 Managing Resources

Topic 02-01 - Introduction to Managing Resource Acquisition / Allocation

- Introduction, Overview & Process Map

Topic 02-02 - Develop the Resource Policies & Procedures Manual

- Formatting Organisational Standard Operating Procedure
- Writing the Organisational Standard Operating Procedure
- Maintaining and Updating Organisational Standard Operating Procedure

Topic 02-03 - Acquiring Manpower for the Project

- Local Hire Requirements / Minority Set Asides
- Safety, Health and the Environment (SH&E)
- Unions vs Non-Union, Contingent Workforce, “Independent Contractor” status
- Calculating Labour Productivity, Factors impacting labour productivity
- Learning Curves, Types of Labour, Span of Control, Matrix Management
- Labour Restrictions, Hours Worked per Day / Week
- Comparing Insource Labour vs Outsource Labour costs

Topic 02-04 - Acquiring Materials for the Project

- Terms of Sale, Types of Material, Renewable vs Non-Renewable vs Recyclable Materials
- “Just in Time” material delivery, Inventory Control / Management

Topic 02-05 - Acquiring Equipment for the Project

- Optimum Sizing & Selection of Equipment
- Cost of Client ownership
- Purchase (Own) or Lease or Rent? Types of Lease
- Salvage Value, Depreciation

Topic 02-06 - Allocating Resources

- Resource Types, Splittable, Non- Splittable, Force Finish, Consecutive Start and Finish
- Corporate Norms and Historical Records, Resource Databases, Resource Dictionaries
- Resource Priorities
- Resources, Effort and Productivity
- Assigning / Loading Activities with Resources

- CPM Schedule Analysis and Resource Limitations
- Automatic Resource Levelling, Manual Resource Levelling
- Material Supply Schedule Adjustment, Material Levelling
- Funding Schedule Adjustment and Cost Levelling
- Time Constrained Resource Scheduling Tools & Outputs
- Resource Constrained Scheduling Tools & Outputs
- Labour Analysis using Resource Loaded Schedules / Histograms

Component 03 Managing Scope

Topic 03-01 - Introduction to Managing Scope

Topic 03-02 - Developing the Scope Management Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 03-03 - Validate Stakeholder Expectations

- Validation (vs. Verification)
- Assumption Testing
- Risk Profiling

Topic 03-04 - Creating the Work Breakdown Structure

- Decomposition
- Standardized WBS Structure to ISO 21511 Standards (when released)
- Building Information Modelling (BIM)

Topic 03-05 - Creating the Control Accounts

- The Creating the Control Accounts Process
- Responsibility assignment matrix (RAM) or Responsibility Accountability Charts (RACI)
- Work Authorization

Topic 03-06 - Accepting Completed Deliverables

- Physical Inspections (work must be physically complete)
- Quality Assurance / Quality Control
- Contractual “shall” Clauses
- Substantial Completion vs. Substantial Performance
- Beneficial Use or Beneficial Occupancy
- Punch Lists / Snag List / Defects List
- Certificates of Completion / Certificates of Final Acceptance

Component 04 Managing Contracts

Topic 04-01 - Introduction to Managing Contracts

Topic 04-02 - Develop the Contracting Policies & Procedures Manual

- Formatting Organisational Standard Operating Procedure
- Writing the Organisational Standard Operating Procedure
- Maintaining and Updating Organisational Standard Operating Procedure

Topic 04-03 - Select Project Delivery Method / Contract Type

Contract Types

Project Delivery Methods

Topic 04-04 - Tendering & Bidding the Project

- Tendering - Clients Perspective
- Bid Shopping/Bid Peddling

- Reverse Auctions
- Filed Sub Bids or Nominated Subcontractors
- Tendering - Contractors Perspective
- Contractors Cost Estimating, Budgeting and Bidding Process
- Contractor Bidding Strategies and Gamesmanship
- Agreement
- Notice to Proceed (NTP)

Topic 04-05 - Managing the Contract (Client & Contractor)

- What is a Contract? Enforceable Contract
- Types of Authority, Kinds of Contracts?
- Change, Notification
- Liquidated Damages Clauses
- Breach of Contract, what are the DEFENSES to a Breach of Contract claim
- Termination, Types of Monetary Damage Awards
- Types of Delays Clauses
- Submittal of Deliverables for Acceptance
- Invoicing / Getting Paid Under the Contract
- Security of Payments Acts per State
- Substantial Completion vs Substantial Performance, Punch Lists or Snag List
- Beneficial Use or Beneficial Occupancy
- Certificate of Completion / Certificate of Final Acceptance

Topic 04-06 - Close Out the Contract (Client & Contractor)

- Guarantees and Warranties
- Letters of Final Acceptance
- Bonds and Release of Bonds
- Change Orders, Variations, Claims and Back Charges Resolved
- Training, Operating Manuals and Operator Training Completed
- Spare Parts, Keys, Security Badges handed over to Client

Component 05 Managing Project Cost Estimating & Budgeting

Topic 05-01 - Introduction to Managing Cost Estimating & Budgeting

- History & What is a Cost Estimate
- Challenges Facing Both Client and Contractor Cost Estimators
- Types of Cost Estimates and Their Uses
- Cost Estimating Processes (Clients and Contractors)
- Cost Estimating & Budgeting Process Map

Topic 05-02 - Develop Cost Estimating & Budgeting Policies & Procedures Manual

- Formatting Organisational Standard Operating Procedure
- Writing the Organisational Standard Operating Procedure
- Maintaining and Updating Organisational Standard Operating Procedure

Topic 05-03 - Define the Estimates Purpose and Scope of Work (Client)

- Team Cost and Scheduling Meetings
- Determine Level of Detail, Project Phasing, Weather & Other Constraints
- Finalise Work Breakdown Structure & Control Accounts & Responsibility Assignment
- Cost Estimating Templates, Activity Codes & Additional Schedule Coding Structures

Topic 05-04 - Creating the Clients Cost Estimate (Top Down)

- Standardized WBS Structures, Source of the Cost Data, Assumptions/Constraints
- Major Changes, Project Information, Cost Estimating Software

- Conceptual Screening - (GPC Level 1 Cost Estimate)
- Capacity Factored Method, Parametric Modelling or Parametric Estimate
- Analogy or Cost Estimate Relationship (CER) or Cost Estimating Model (CEM)
- Expert Opinion Technique
- Study or Feasibility- (GPC Level 2 Cost Estimate)
- Life Cycle Cost/Costing, Calculating the Total Life Cycle Cost (LCC)
- Equipment Factored Cost Estimating, Percentage or Ratio Factored Cost Estimate
- Value Analysis/Value Engineering
- Budget, Authorization or Control (GPC Level 3 Cost Estimate)
- Client Baseline, Client Estimate, Bid or Tender Estimate (GPC Level 4 Cost Estimate)

Topic 05-05 - Define the Estimates Purpose & Interpret the Scope of Work (Contractor)

- Team Cost and Scheduling Meetings
- Value Analysis/Value Engineering
- Determine Level of Detail, Project Phasing, Weather & Other Constraints
- Finalise Work Breakdown Structure & Control Accounts
- Standardized WBS Structures, Responsibility Assignment Matrix (RAM)
- Cost Estimating Templates (Contractors)
- Source of the Cost Data, Assumptions/Constraints
- Major Changes

Topic 05-06 - Developing the Contractors Cost Estimate (Bottom Up)

- Bill of Quantities / Bill of Materials
- Contractor Cost Baseline, Bid or Tender- (GPC Level 5 Cost Estimate)
- What is Activity Based Costing, Components of Activity Based Costing, Case Study
- Producing the “S-Curve”
- Level of Effort
- Using Activity Based Management
- Using the Cost Estimate and Actual Costs of Work Performed (Cost Variance)

Topic 05-07 - Validate the Time & Cost Trade-Offs

- Assumption Testing & Sensitivity Analysis
- Monte Carlo Simulation, PERT Analysis & Cost vs Time Trade Offs (Optimization)

Topic 05-08 - Validating Horizontal and Vertical Integration

- Schedule & Cost Interfaces & Horizontal Traceability
- Summarising, Rolling Up / Down & Vertical Traceability

Topic 05-09 - Conducting A Cost Risk Analysis

- Dealing with Risks and Uncertainties
- Duration Risk & Uncertainty
- Monte Carlo Simulation
- Network Logic Risk & Uncertainty
- Merge Bias or Merge Points
- Schedule Cost Contingency Approaches
- Prioritizing Risks
- Probabilistic Branching

Topic 05-10 - Baselining and Communicating the Cost Estimate/Cost Budget

- Communicate the Cost Estimate/Cost Budget
- Develop Written Basis and Cost Estimate/Cost Budget Narrative
- Benchmark & Freeze the Schedule & Cost Performance Measurement Baseline

Component - 06 Project Controls Management

Topic 06-01 - Introduction to Project Controls Management

- Enterprise Organizational Strategies
- Organizational Policies, Practices and Procedures, Stakeholder Expectations
- The Asset Lifespan, The Portfolios of Assets, Portfolios of Projects
- The Project Life Span & The Project Controls Life Span
- Involvement of Cost Engineer / Business Analyst / Systems Engineering
- The Decision Support Packages (DSP) & The Go / No Go Decision
- The Phases of The Asset and Project Life Span / Life Cycle
- Continuous Process Improvement / Components Learned
- Centre of Excellence / Centre of Competency, Project Controls Career Path
- An Effective Project Controls Organization Structure & Project Controls Process Map

Topic 06-02 - Project Controls Policies & Procedures Manual Development

- Formatting Organisation Standard Operating Procedures
- Creating Organisational Standard Operating Procedures
- Maintaining and Updating Organisational Standard Operating Procedures

Topic 06-03 - Project Controls Plan Development

- Project Controls Plan / Process Inputs

Topic 06-04 - Executing the Project Controls Plan

Topic 06-05 - Controlling the Project Controls Plan

- Managing / Controlling the Plan to Control the Project

Topic 06-06 - Close Out the Project Controls Plan

- Component 7 Introduction to Earned Value Management (EVM)

Topic 7-01: Introduction to EVM

- Utilisation of ISO 21508 WBS Standards and AS 4817:2018

Topic 07-02: Scope Definition

- Define the project scope of work for the implementation of Earned Value Management.

Topic 07-03: Control Account Establishment

- Establishment of Control Accounts for Earned Value Management process to manage the project performance

Topic 07-04: Scheduling an Earned Value Project

- Scheduling requirements of an earned value management system in a project.

Topic 07-05: Cost Budgeting

- Cost budgeting process and elements of a contract budget used for measuring and monitoring the cost & schedule performance.

Topic 07-06: Establishing the Performance Measurement Baseline (PMB)

- Performance Measurement Baseline (PMB) the steps involved in its development

Topic 07-07: EVM Data Collection

- Three key Earned Value Management data to be collected & recorded to assess the project status and performance

Topic 07-08: Actual Costs

- Methods of collecting the project incurred costs

Topic 07-09: Progress Measurement

- Commonly used progress measurement techniques in selecting the techniques for measuring the progress in the projects

Topic 07-10: Performance Measurement

- How the Earned Value data can be used to monitor the status of the project.

Topic 07-11: Cost & Schedule Forecasting

- Illustration of various forecasting metrics available to forecast the project's final cost and schedule completion

Topic 07-12: EVM Reporting

- Developing various reporting methods for communicating and presenting the EVM data

Topic 07-13: Variance Analysis

- Dealing with project variances to bring the project back on track.

Topic 07-14: Baseline Revisions and Change Control

- Managing changes and incorporating approved changes in project's scope, schedule, budget, and baseline

Topic 07-15: Project Close-out

- Elements of proper project closeout. Summary of the step-by-step process in employing Earned Value Management on projects

Component 08 Managing Risk & Opportunity

Topic 08-01 - Introduction to Managing Risk & Opportunity

- The Meaning of Risk & Opportunity,
- Risk & Project Controls and Managing Scope & Quality
- The Risk & Opportunity Management Process
- The Risk & Opportunity Register

Topic 08-02 - Develop the Risk & Opportunity Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 08-03 - Identify Risks / Opportunities

- The Work Breakdown Structure
- Primary and Secondary Risk Analysis
- Brainstorming or Expert Opinion
- Force Field or SWOT Analysis
- Risk / Opportunity "Triggers" or Early Warning Signs
- Risk / Opportunity Categories, Risk / Opportunity Client
- Internal vs. External Risk / Opportunity
- Systemic vs. Project Risk / Opportunity

Topic 08-04 - Assess, Categorize, Prioritize and Quantify Risks or Opportunities

- Estimated Monetary Impact, Amount at Stake or Consequence
- Quantitative Probability of Event Occurring
- PERT Formula (Project or Program Evaluation and Review Technique), The z Tables
- Expected Monetary Value (EMV)
- Monte Carlo Simulation
- Ranked Ordering Using Expected Monetary Value

Topic 08-05 - Risk / Opportunity Response Strategies and Tactics

- Risk: Avoidance, Transfer, Reduction / Mitigation & Risk Acceptance
- Opportunity: Exploit, Enhance, Spreading / Sharing, Ignore & Buffers vs Contingency
- Decision Trees Using Expected Monetary Value

Topic 08-06 - Risk / Opportunity Monitoring and Control

- Statistical Process Control Charts (SPC)

- Pareto Analysis
- Process Capability Analysis
- Accuracy vs Precision vs Reliable Data
- Contingency Draw Down Graphs

Component 09 Managing Project Progress

Topic 09-01 - Introduction to Managing Project Progress

Topic 09-02 - Developing Progress Measurement Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 09-03 - Capturing Progress & Updating the Schedule

- Measure Physical Progress
- Capture Actual Cost of Work Performed
- Status and Update the Schedule with Progress

Topic 09-04 - Assessing and Interpreting Progress Data

- Isolate Progress from Logic Changes
- Assess Trends Achieved & Performance Analysis
- Perform Critical Path, Near-Critical Path & Non-Critical Path Analysis

Topic 09-05 - Project Performance Forecasting

- Check Schedule Accuracy, Assess Milestones & Completion Dates
- The Periodic Progress Report
- Required Decisions by Client

Component 10 Managing Project Change

Topic 10-01 - Introduction to Managing Project Change

Topic 10-02 - Develop Managing Change Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 10-03 - Managing Change - The Client's Perspective

- Building Information Modelling (BIM)
- Integrated Project Delivery (IPD) Approach
- Front End Loading (FEL)
- Internal Change Request or Internal Change Order
- Change Control Boards
- Benefit Cost Analysis
- Multi-Attribute Decision Making

Topic 10-04 - Managing Change- The Contractor's Perspective

- Contractual Terms and Conditions
- Costing and Pricing Change Orders
- Adding Change Orders to the CPM Schedule
- Analysing and Reporting Change Order Impacts Using the CPM Schedule
- Rebaseline CPM Schedule
- Billing against completed Change Order Work

Topic 10-05 - Configuration Management

- Basic Configuration Management

- Advanced Configuration Management
- Online Configuration Management
- Integrated Configuration Management

Component 11 Managing Project Databases

Topic 11-01 - Introduction to Managing Project Databases

Topic 11-02 - Develop Managing Project Databases Policies & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 11-03 - Designing the Project Database

- Designing Database Codes
- Designing Database Structures

Topic 11-04 - Creating the Project Database

- Cost & Productivity Database Home Page/Demographics
- “Section Learned” Databases
- Source of Legal Databases
- Additional Cost & Productivity Databases

Topic 11-05 - Updating and Using the Project Database

- What Fields to Update?
- “Real” or “Constant” currency using Purchasing Power Parity
- Construction Cost Indices
- Statistical Process Control Charts
- Learning Curves, Productivity and Cost Adjustment Factors

Component 12 Managing People

Topic 12-01 - Introduction to Managing People

Topic 12-02 - Develop Project Controls Career Path Development Plan

- Career Path Progression
- Knowledge and Competencies Assessment Map
- Competency of Training Providers and their Trainers

Topic 12-03 - Developing Individual Competencies

- Inter-personal Skills
- Intra-personal Skills
- Technical Competencies of Project Controls Professionals
- Measuring and Assessing Competency
- Communications
- Monitoring and Controlling Communications

Topic 12-04 - Developing Management Competencies

- Understanding Management Theory
- Management Pioneers
- Modern Functions of Management
- Defining Management ‘soft skills’
- Decision Support and Decision Making

Topic 12-05 - Developing Organisational Competencies

- Organizational Culture
- Creating and Marinating a Corporate Culture

- Project Management Offices
- Supporting the Project Management Team

Topic 12-06 - Identifying and Engaging Stakeholders

- Stakeholders Identified Defining “Success”
- Stakeholder Theory
- Six Types or Categories of Stakeholder
- Ethics for Project Control Professionals
- Use of the Logical Framework Approach
- Negotiation

Component 13 Performing Project Forensic Analysis

Topic 13-01 - Introduction to Performing Forensic Analysis

Topic 13-02 - Develop the Forensic Analysis Process & Procedures Manual

- Formatting the Standard Operating Procedure
- Writing the Standard Operating Procedure
- Maintaining and Updating the Standard Operating Procedure

Topic 13-03 - Conduct the Preliminary Analysis

- Record Keeping, RFI / TQ Status Reports
- Design / Procurement Status
- Short Term Programmes and Method Statements
- Labour Allocation Sheets, Progress Photos
- Progress Reporting / Requirements of Progress Report
- Notice of Delay / Impacts and Disruption Registers
- Method Statements / Phasing Diagrams
- Information Available, Quality Assurance or Control Records
- Information from Witnesses of Fact

Topic 13-04 - Organise the Schedule Analysis

- Selection of Experts
- The As-Planned Programme or Schedule
- The As-Built Programme or Schedule and As-Built Records
- he Use of Critical Path Analysis
- The Use of Window Periods in Analysis
- Acceleration and Mitigation
- Choosing a Delay / Impact Analysis Methodology
- As-Planned vs. As-Built Methodology
- Contemporaneous Period Analysis Methodology
- As-Planned-Impacted or Impacted-As-Planned Methodology
- Time Impact Analysis Methodology
- Collapsed As-Built Methodology
- Disruption, Productivity, and Other Analyses

Topic 13-05 - Damage Analysis Phase

- Calculation of Actual Costs, Losses and Damages
- Preparing Documenting & Submitting the Expert Report
- Counterclaims & Rebuttals

Topic 13-06 - Settlement Negotiations Phase

- Partnering
- Integrated Project Delivery
- Effective Negotiations Techniques

Topic 13-07 - Formal Disputes Resolution

- Settlement Conference
- Mediation
- Dispute Review Board (DRB)
- Neutral Advisor

Component 14.0 Glossary of Terms & Reference Links

Reference	Description
Aconex	A web-based electronic document management system (EDMS) that has been adopted by AusConstructCo Construction
Activity	An element of work performed during a project. An ACTIVITY normally has an expected duration, an expected cost, and expect resource requirement. ACTIVITIES can be subdivided into tasks.
Actual Cost (AC)	The cost incurred and recorded in accomplishing the work performed. (Also known as Actual Cost of Work Performed (ACWP)).
Approved	Accepted for use, with or without conditions attached, but with implication that compliance requirement has either been achieved or waived
Authorised	Permission given to be used, with or without conditions attached, but without implying compliance to any standard or satisfying any requirement
Authority	The PMBOK (PMI) states that the PM has the authority to spend approved funds acquire resources and do the necessary activities to ensure the successful delivery of project outcomes. This authority is delegated after the approval of the document that 'formally authorises a project and which documents initial requirements that satisfy the stakeholder's needs and expectations.
Baseline	Original approved Plan for a project, CONTROL ACCOUNT, WORK PACK OR ACTIVITY), PLUS OR MINUS APPROVED SCOPE CHANGES. Usually used with a modifier (e.g.: cost BASELINE, Programme BASELINE, and PERFORMANCE MEASUREMENT BASELINE).
Budget	A cost target, based on the planned resource requirements (e.g. labour, plant, material, OTHER DIRECT COSTS and possibly INDIRECT COSTS), for a given scope of work the BUDGET is used for performance measurement and management purposes and general remains static unless there is a variation in the scope of work or other approved changes. It MAY be expressed in terms of dollars, labour hours, or other measurable units.
Budget at Completion (BAC)	The total authorised BUDGET for accomplishing the project scope of work. It is equal to the sum of all allocated BUDGETS plus any UNDISTRIBUTED BUDGET (MANAGEMENT RESERVE is not included). The BUDGET AT COMPLETION will form the PERFORMANCE MEASUREMENT BASELINE as it is allocated and time-phased in accordance with project Programme requirements
Cadence	Cadence is the cycle of activities to maintain connection and momentum.
Commercial Acceptance (CA)	Commercial Acceptance when the Design and Construction (D&C) activities other that Minor Defects and the Finalisation Works are complete and the delivery the Project deliverable has commenced
Competent Person	A person who has acquired the knowledge, skills and attitudes to perform a job task or function to a pre-determined standard
Continuous Improvement	The culture revolves around seeking to improve current state, continuously. Constantly measuring and seeking opportunities to build better. or
Collaborative Leadership	Collaboration is a hallmark of high performing teams. Respect for people is the basis for collaborating in delivering value. Without collaboration inefficiency is usually high, and morale weak
Constraint	Applicable restriction that will affect the performance of the project. Any factor that affects when an ACTIVITY can be Programmed.

Reference	Description
Control Account	A management control point at which BUDGETS (resource plans) and ACTUAL COST are accumulated and compared to EARNED VALUE for management control purposes. A CONTROL ACCOUNT is a natural management point for planning and control since it represents the work assigned to one responsible organisational element on one project WBS element.
Control of Hazards	The process of Elimination, Isolation or Minimisation of significant hazards
Corrective Action	Changes made to bring expected future performance of the project in line with the plan (i.e. the BASELINE).
Cost Variance (CV)	The algebraic difference between the EARNED VALUE and the ACTUAL COST. CV = EV - AC
Critical Path	The series of ACTIVITIES that determine the duration of the project in a deterministic model the CRITICAL PATH is usually defined as those ACTIVITIES WITH FLOAT less than or equal to a specified value, often zero. It is the longest path through the project.
Critical path Method (CPM)	The CRITICAL PATH METHOD (CPM) is one of several related techniques for doing project planning. CPM is for projects that are made up of a number of individual "activities." If some of the activities require other activities to finish before they CAN start, then the project becomes a complex web of activities.
Customer First	All activity must be oriented on delivering what the customer values. Waste occurs when non-value adding activity consumes resources
Direct Costs	The costs or resources expended in the accomplishment of work which are directly charged to the relevant work.
Earned Value (EV)	The value of completed work expressed in terms of the BUDGET assigned to that work. (Also known as BCWP – Budgeted Costs of Work Performed). Or
Earned Value Performance Measurement (EVPM)	EVPM requires the PMs: Determine what work is to be done, by whom, and when Establish realise resource requirements for the work Objectively measure work achievement and record associated cost Report any significant deviation from the plan Forecast the completion date and cost; and Plan and implement CORRECTIVE ACTION plans and authorise scope changes. EVPM requires that planning includes the establishment of clear objectives for achievement and demands that progress in monitored to measure any deviation from the plan. It encourages PMs to be objective in plan, assessment of progress, use of resources and forecasting of future progress. The value of completed work expressed in terms of the BUDGET assigned to that work. (Also known as BCWP – Budgeted Costs of Work Performed)
Enterprise Project Management	Enterprise Project Management (EPM), in broad terms, is the field of organisational development that supports organisations in managing integrally and adapting themselves to the changes of a transformation. Enterprise Project Management is a way of thinking, communicating and working, supported by an information system that organises enterprise's resources in a direct relationship to the leadership's vision and the mission, strategy, goals and objectives that move the organization forward.
Environmental Incidents	Any occurrence or event that either creates or has a reasonable possibility of creating any of the following: pollution of the atmosphere, waterway, or soil physical damage to heritage or sacred property or sites of cultural significance disturbance of native fauna damage to natural or planted vegetation other than that nominated in the contract documents unnecessary disruption to normal life patterns of people whether travellers, pedestrians, occupants or the like

Reference	Description
Estimate at Complete (EAC)	The expected total cost of an ACTIVITY, a group of ACTIVITIES, or the project when the defined scope of work has been completed. It equals ACTUAL COST to a point in time plus estimated costs to completion (ESTIMATE TO COMPLETE) EAC= AC + ETC
Estimate at Complete (EAC)	The expected total cost of an ACTIVITY, a group of ACTIVITIES, or the project when the defined scope of work has been completed. It equals ACTUAL COST to a point in time plus estimated costs to completion (ESTIMATE TO COMPLETE) EAC= AC + ETC
Frequency Rate	The number of Lost Time Injuries multiplied by 100,000, divided by number of man hours worked
Gantt Chart	Graphic display of activities in the (Programme) represent by bars charts
Governance	The governance and organisational structure put in place for projects, programs and portfolios is vital to be able to deliver to time, on cost, with the desired quality, but more importantly to deliver to stakeholder expectations and facilitate effective communication.
Governance model	What is meant by the term “Governance”? Governance is a framework within which project/program decisions are made. Governance is multifaceted, and a well-structured governance model provides: Consistent Clear roles, responsibilities, and accountabilities Consistent Clear reporting Clear information flows Clarity of stakeholders Clear scope Clear procurement processes Clear financial authorities Ethics Dispute and conflict resolution escalation channels Obvious delivery model overlays Apparent meeting Programmes
Float	The amount of time that an ACTIVITY can be delayed from its early start without delaying the project finish date. FLOAT is a mathematical calculation and can change as the project progresses and the programme is updated.
Framework	Broad overview, outline, or skeleton of interlinked items which supports a particular approach to a specific objective and serves as a guide that can be modified as required by adding or deleting items.
Governance	The framework of rules and practices by which a board of directors ensures accountability, fairness, and transparency in a company's relationship with its all stakeholders (financiers, customers, management, employees, government, and the community). The corporate governance framework consists of (1) explicit and implicit contracts between the company and the stakeholders for distribution of responsibilities, rights, and rewards, (2) procedures for reconciling the sometimes conflicting interests of stakeholders in accordance with their duties, privileges, and roles, and (3) procedures for proper supervision, control, and information-flows to serve as a system of checks-and-balances.
Hazard	A source or situation with potential for harm in terms of human injury or ill health, damage to property, damage to the environment or a combination of these.
Hazard Identification	The process of recognising that a hazard exists and defining its characteristics
Hazard Assessment	The overall process of determining whether a hazard is significant.
Health & Safety Incidents	Any occurrence or event that either creates or has a reasonable possibility of creating any of the following: Injury to any person Significant damage to the works on property Significant damage to plant or vehicles on the site

Reference	Description
Health Monitoring	Monitoring of individuals for the purpose of identifying changes in health status that may be due to occupational exposure to a hazard
Hold Point	A point in the progress of the work beyond which further work may not proceed without approval from the appropriate authority.
Incident	Any unplanned or undesired event resulting in, or having a potential for injury, illness, damage or other loss.
Indirect Costs	The cost for common or joint objectives which cannot be identified specifically with a project or ACTIVITY. Also referred to as “overhead costs” or “Burden”.
Induction	The process by which new employees are introduced to and acquainted with their job and the new workplace. It involves providing the employees with details about organisational safety policies, procedures, duties, accountabilities, and activities.
Injury	Any injury sustained by a person in the office or on the work site.
Integrated Management System	Combination of all plans, procedures, processes under one umbrella
Issue	Topic or point that is in question or dispute, matter that is not settled or clear. Best practices are to state it as a question
KPI	A clear indicator of the specific measurable activity or result that may be used to assess project performance. Targets or ranges of performance may be attributed to KPI’s
KRA	An area of project operations in which the project team’s performance is of significant interest to Client, AusConstructCo Construction and/or other key stakeholders. A KRA does not, however, provide any indication of the scope of activities or results that are used to measure this performance
Lean Foundation Beliefs	At its foundation are the core beliefs, the development of which prepares a group of people for successful application of Lean. Note they are clearly aligned to the FB value
Lost Time Injury	Any incident that involves a person losing one full shift of work.
Management Reserve (MR)	Am amount of the total BUDGET withheld for management control purposes rather than designated for the accomplishment of a specific ACTIVITY or set of ACTIVITIES
Material Safety Data Sheet	Documented information which clearly identifies a hazardous substance and states the precautions to be taken for the safe storage and use of the substance, and the health hazards associated with the substance.
May	Indicates the existence of an option.
Milestone	A significant activity or event in the project, usually completion of a major deliverable.
Network Diagram (Programme)	A Programme format in which the ACTIVITIES and MILESTONES are represented along with the interdependencies between ACTIVITIES. It expresses the logic of how the project will be accomplished. NETWORK DIAGRAMS are the basis for CRITICAL PATH analysis, a method for identification and assessment of Programme priorities and impacts.
Objectives	Overall goals in terms of performance, arising from the Quality, Safety, Environmental and Training policies that AusConstructCo Construction sets itself to achieve.
OPEX Alignment	The Lean house aligns coach and practitioner action to the FB OPEX 10 Pillars Model. The Core of the model is the same as the apex of the Lean House. Unlike Operating Cost (OPEX) (at this time), Lean Construction will not take over existing functions of Health and Safety (Pillar 1 Safety & Wellbeing), Quality Assurance (Pillar 9) or Pillar 4 Environment & Sustainability. These functions have existing teams and methods dedicated to the achievement of excellence. Additionally, Service and Inventory Management do not match the Construction Value Chain (we have no repeatable products that are stored & distributed). Additional to the 10 Pillars Construction has a need to focus on Planned Delivery roughly aligned to Pillar 2 ‘Deployment of Objectives). Because the Construction

Reference	Description
	project is finite in duration and bespoke to its clients and environmental needs, design and planning are a major function and skillset in their own right – deserving specific attention.
Other Direct Costs (ODC)	Usually the remaining DIRECT COSTS, other than labour and materials, such as travel supplier and computer costs.
Performance Measurement Baseline (PMB)	The total time-phased BUDGET plan against which project performance is measured. It is the programme for expenditure of the resources allocated to accomplish project scope and programme objectives and is formed by the BUDGETS assigned. The PERFORMANCE MEASUREMENT BASELINE also includes BUDGETS for future scope assigned to UNDISTRIBUTED BUDGET. MANAGEMENT RESERVE is not included in the PMB as it is not yet designated for specific work scope.
PPE	Personal Protective Equipment which includes any clothing, equipment and substance designed to be worn by a person and to protect the person from the risks of injury or disease
Planned Value (PV)	The sum of the BUDGETS for worked programmed to be accomplished within a given time. (Also called Budgeted Cost of Work Programme- BCWS).
Probity	Strict adherence to a code of ethics based on undeviating honesty, especially in commercial (monetary) matters and beyond legal requirements.
Procedure/ Instruction (P or I)	A document that defines who, what, when, where, and how activities are implemented and controlled and the requirement to produce specific records. To the relevant extent, it will include both managerial and technical aspects of the activity. (A Procedure is a procedure.)
Process	An activity using resources and managed in order to enable the transformation of inputs into outputs.
Process Control Plan	Used to management technical and administrative processes for an activity. Process Control Plans [PCPs] provide a means to determine the following: • Logic of a process. • Inspection, test, hold/witness points in a process. • Method & criteria related to inspection & tests. • Frequency of inspection & tests. • Records to be generated to verify inspection & tests. • Prime responsibility for inspection & test activity. • Checklists, forms & other formats to record inspection & test
Product	The result of any process.
Programme Alignment	Given there are other strategic programmes it is necessary to de-conflict the commonalities in what these programmes are trying to achieve. The following e.g. Lean OPEX Alignment, Wave initiatives that will need to work together to create a Great AusConstructCo's
Programme Goals	Programme goals are the responsibility of the BU leadership teams. The current FY17 planned targets for this programme are
Project	A project is a temporary endeavour undertaken to create a unique product or service.
Project Budget	The total BUDGET for the project including all allocated BUDGET, MANAGEMENT RESERVE, and UNDISTRIBUTED BUDGET.
Project Governance	Project governance is the system and structure to support the decision-making about a project. The governance framework outlines who has responsibility and authority to make decisions and ensures there is clearly defined accountability for all aspects of a project. It is the link between, and support for, the governance decisions made by Government and the work of the project team to deliver the project and its outcomes.
Project Management	Is the process of using proven tools and techniques to manage the scope, time and cost of a project?

Reference	Description
Project Management Plan (PMP)	
Project Sponsor (PS)	The PS is the effective link between the organisation's senior executive body and the management of a project. The Sponsor is also a core member of the project steering committee usually the Chair. In addition to being an experienced executive well versed in the details of organisational stakeholder and client requirements and relationships, the sponsor needs to have experience in project management. The SRO is having accountability and responsibility for a project
Quality Assurance (QA)	
Quality Control (QC)	The action required to determine that specified requirements are being achieved. Likely activities include checking, reviewing, measuring, testing, inspecting, and documenting a satisfactory result.
Request for Information (RFI)	
Responsibility	Responsibilities relate to duty or obligation that an individual (or group) has the ability or authority to act or decide on one's own, without supervision
Risk	The possibility or likelihood of an event occurring resulting in injury or loss Or An event or condition that may occur and it may have a positive or negative impact on the project. How to determine Priority (See Risk Model) Impact – what is the impact if this risk was to occur Probability – what is the likelihood this risk will occur Actualised – what to do if the risk has happened
Risk Strategies	Mitigation – how to reduce impact and if possible, probability Avoidance – how to avoid or eliminate the cause Transference – shifts impact and transfer risk to a third part Acceptance – no plans – willing to accept consequences
Programme Variance (SV)	A metric for the Programme performance on a project. It is the algebraic difference between EARNED VALUE and PLANNED VALUE. SV = EV – PV A position value indicates an 'ahead of Plan' situation while a negative value indicates 'behind plan'.
Safety Induction	The process by which new employees are introduced to and acquainted with their job and their new workplace
Scope	A paragraph describing the characteristics of a project and sum of the product or services. If a date is a driver or budget is a driver put this in the scope definition? It is equally important to have a paragraph or bullets on what is out of scope, this may be difficult in the beginning of the project but as the project develops this will become clearer.
Shall	Indicates that a statement is mandatory/
Special Purpose Vehicle (SPV)	Get a good description from Joe White (Name a position not a person)
Steering Committee	In governance models the terms project steering committee, project control boards or project board are used interchangeably. For more complex investments an overall project control board ACCGroup – SPV may be established with sub committees that deal with individual project elements
Subcontractor	Any person or company who contracts with AusConstructCo Construction to complete tasks on their behalf.
Subject Matter Expert (SME)	Is a person who exhibits the highest level of expertise in performing a specialised job, task, or skill within a company!

Reference	Description
	Functional teams are usually formed through SME expertise
Tolerances	Tolerances are the limits placed on authority. Tolerance is a permissible deviation from a plan's target which is usually set for time and cost.
Training	It is recommended that training to be organised in Governance, Programming and Lean to name just a few to enable AusConstructCos to move forward at the necessary role level
Undistributed Budget (UB)	BUDGET associated with specific work scope or project changes which has not yet been incorporated into the time-phased BUDGET.
Validation	The process of confirming by examination that the intended user requirements have been satisfactorily achieved. Usually the examination occurs on completion of the works but, with design, may occur at the end of that stage.
Variance at Completion (VAC)	Algebraic difference between BUDGET AT COMPLETION and ESTIMATE AT COMPLETION. VAC = BAC - EAC
Verification	The process of confirming and documenting compliance to specified acceptance criteria. In practice it is usually a follow on action to quality control by another person or organisation.
Wave Governance (Accelerate Program)	Governance is achieved through applying standard metrics through a reporting tool which can be entered into WAVE for higher level outcome reporting.
WBS (Work Breakdown Structure	A Hierarchical division of project work depicting the breakdown of work scope for work authorisation, tracking and reporting purposes. An accompanying dictionary of WBS elements scope definitions MAY be necessary to clearly identify and segregate the work scope of each. A representation of deliverables: each level presents more detail and definition in line with JDE Great tool in planning or layout out the project programmer and can assist in identifying stakeholders.
Witness Point	A point in the progress of the work where the option of attendance for witness of inspection/test may be exercised by the nominated party. If this option is not exercised work may continue.
Work Instruction (WI)	
Work Package (WP)	An ACTIVITY or set of ACTIVITIES

Appendix 2 - Lean Construction

Introduction

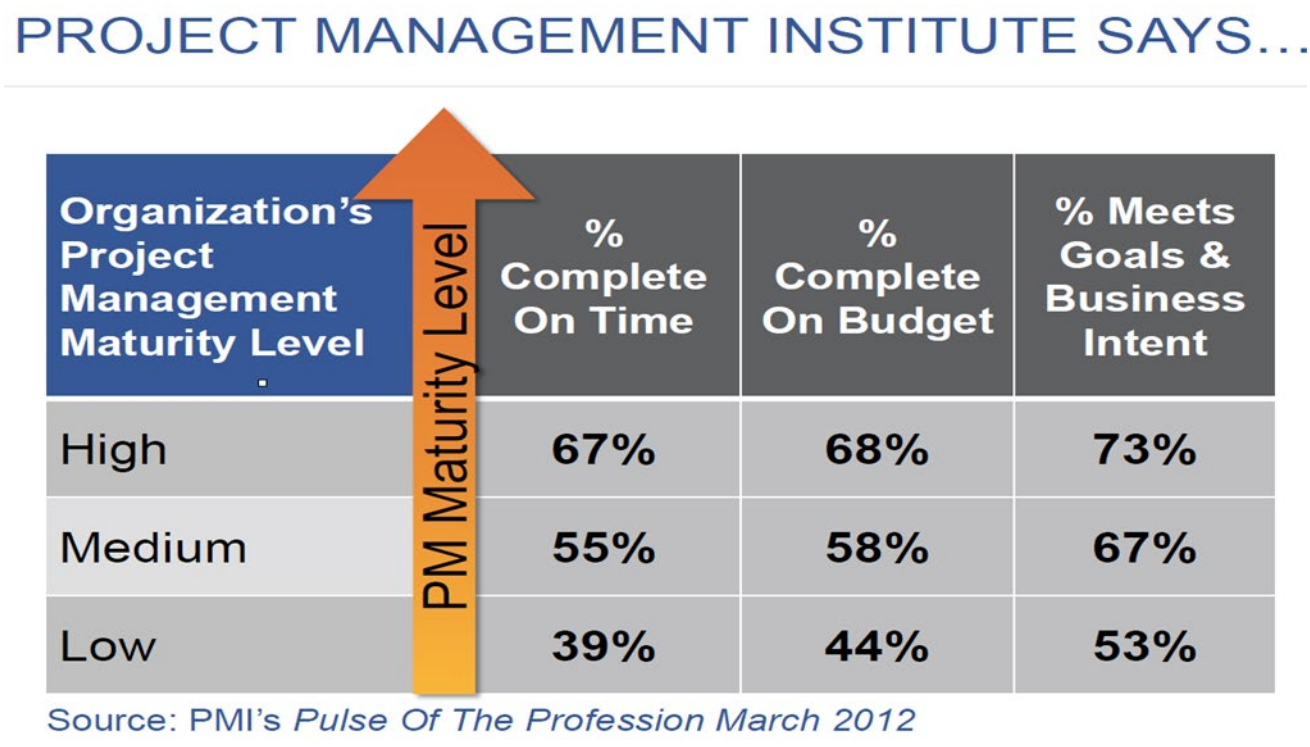
The use of Lean Construction techniques to prevent wastage and with a proper duration allowed to provide in depth planning and scheduling and cost controls with appropriate peer reviews and audits for all major projects will no doubt improve the rate of success in delivery.

A recent report on the international Construction industry by the PMI indicates that internationally the money wasted on typical major construction projects has fallen to $USD 97 million ($NZ 138 million) for every $USD1 billion invested in projects, it used to be an average of $USD122 million per $USD1 billion. However, projects in New Zealand / Australia currently are on average are wasting $USD108 million for every $USD1 billion spent. The report surveyed over 225 major projects in New Zealand and Australia.

To overcome wastage Lean Construction has been introduced in the past few years, LEAN is a manufacturing philosophy that removes non-value adding activity and changes all stakeholders in the value chain. LEAN Construction is the adaption of LEAN to project delivery. It is an excellent framework with which to deliver a transformation in construction productivity for major Australian large dollar value projects

AusConstructCo also needs the assistance of methodologies like Lean Construction especially Last Planner which will assist us moving forward. The planned works well into the Project Controls space which the Site Engineer/s are usually the project owner whereas the Programme is owned the Project Manager.

Figure 7 Project Management Institute Says....



Combating Wastage

As previously stated, combating wastage in major or indeed any project can be aided by the effective use of Lean Construction Techniques.

What are "LEAN" Construction Techniques?

It is "A way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value." Koskela, L., Howell, G., Ballard, G., and Tommelein, I. (2002). "The Foundations of Lean Construction." Design and Construction: Building in Value, R. Best, and G. de Valence, eds., Butterworth-Heinemann, Elsevier, Oxford, UK.

Benefits of Lean Construction

ACC embraces a Lean management approach, and a culture that emphasizes collaboration, reliability of scheduling and delivery of the most value - from the client's perspective - while consuming the fewest resources. Beginning with pre-construction and continuing nonstop throughout all phases of a project, Lean principles drive the efficient delivery of our services.

Lean culture emphasizes re-imagining and eliminating waste in all forms and creating predictable, reliable workflows. On projects that develop and maintain a Lean culture of continuous improvement, our project teams have experienced improvements in design team and trade contractor relationships, communication, scope definition, coordination, cost, and schedule performance.

Some fundamental principles of Lean are:

- Define value from the customer's perspective
- Understand the value stream of all steps in the process used to create the product
- Reduce waste
- Ensure a smooth flow of value-added activities
- Prefabricate and modularize building systems
- Utilize collaborative pull scheduling to provide each internal and external customer what they want, when they request it
- Seek perfection by committing to continual improvement in all areas of the process

ACC will implement lean thinking to establish a clear definition of the client's needs, including scope and hand-off criteria of all trade specialists, and rigorous management of hand-offs between trade specialists. Based on a Master Schedule with key milestones, stakeholders develop the specific plan for each phase in a collaborative scheduling workshop. The object is to keep the construction and sub-contractor teams working on well-defined deliverables at a reliable and predictable pace and to eliminate re-work and waiting.

ACC will also use 3D and 4D modelling as Lean tools; to model client's process flows and discover conflicts in design documents, shop drawings, and coordination drawings. We will also model site logistics issues and the sequence of construction looking for ways to improve the flow of work by all parties.

Appendix 3 – Earned Value Performance Management

Earned Value Performance Management (EVPM) is designed to provide Senior Management with an accurate overview of corporate performance. It builds on the information provided by traditional scheduling techniques to plan and measure the overall productivity of a system or a project. EVPM through the Performance Management Baseline provides focus on the bottom-line assessment as to whether the plan is being implemented effectively or not and highlights problems at an early stage allowing effective management intervention. It is an objective measurement of how much work has been accomplished on a project.

Earned Value Performance Management is an objective measurement of how much work has been accomplished on a project.

Using the Earned Value Performance Management process, senior management and other members of management can easily compare how much work has been accomplished. It enforces the discipline of planning upon the project manager, as well as the budgeting, resourcing and scheduling of authorised work scope in a time phased plan. This disciplined approach will provide management with the Budgeted Cost of Work Scheduled.

The time-phased plan shows the incremental cost of resources and produces a cumulative cost curve against time and is defined as the Performance Measurement Baseline. As work is progressed and or reported completed it is “earned” using the same selected budget duration or time. Earned Value compared with the Planned Value provides a work accomplished against plan. Thus, any variation between the plan and the actual is defined as a “Schedule Variance’ or a “Cost Variance”

The corporate accounting system should provide an accumulation of actual costs for the project in hand. The Actual Cost of Work Performed is then compared with the Earned value to denote any under or over run to the project.

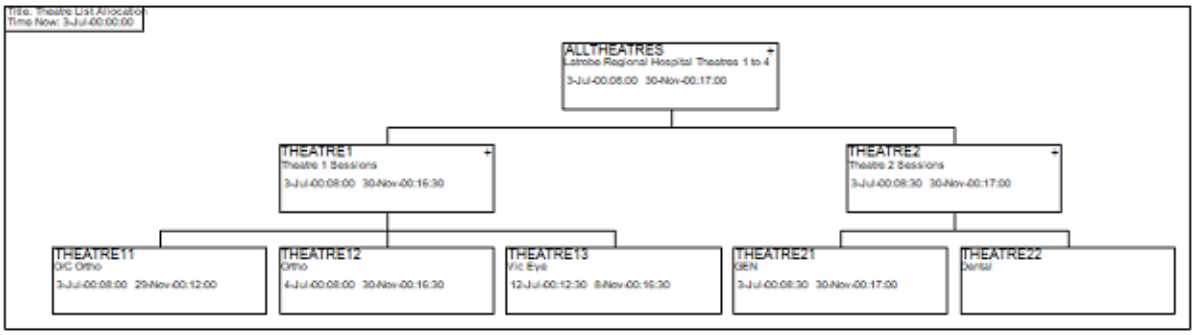
The Budgeted Cost of Work Scheduled (PV) the Earned Value (EV) and Actual Cost of Work Performed (AC) provide objective metrics of performance which enable management to carry out trend analysis and evaluate the cost estimate at completion, better known as Estimate at Completion at all levels of the project.

Additional variances are calculated to provide management with a set of cost and time performance metrics to enable them to confidently predict the successful outcome of the project.

Earned Value improves on the "normally used" spend plan concept (budget versus actual incurred cost) by requiring the work in process to be quantified. A major element in the definition of work to be measured is the Work Breakdown Structure

A Work Breakdown Structure (WBS) may be used to segregate the work scope requirements of the program into definable product elements and related services and data. The WBS is a direct representation of the work scope defined in the program statement of work and breaks that work scope into appropriate elements for cost accounting and work authorization. It is a multi-level hierarchical breakdown that shows how program costs are summarised from the lower elements to the total program level. The extent of decomposition and levels in the WBS will be determined by program management needs and contractual arrangements. How a WBS is created is defined in AS 4817:2006. Part of the WBS developed during the trial is shown in Figure 8 below.

Figure 8 WBS developed during the trial



Thus, by implementing the earned value process, management can simply compare how much work has been completed against the amount of work planned to be accomplished. Earned Value requires the project manager to plan, budget and schedule the authorized work scope in a time-phased plan. The time phased plan in the form of a critical path network is the incremental "planned value" culminating into a performance measurement baseline. As work is accomplished, it is "earned" using the same selected budget term. Earned Value compared with planned value provides a work accomplished against plan. A variance to the plan is noted as a schedule or cost deviation.

Normally the established accounting system provides accumulation of actual cost for the project. The actual cost is compared with the earned value to indicate an over or under run condition.

Planned Value, Earned Value, and Actual Cost data provides an objective measurement of performance, enabling trend analysis and evaluation of cost estimate at completion within multiple levels of the project.

Earned Value Performance Management should be applied to every project where the owners of the final product wish to ensure that the expended resources were used efficiently. On major projects the application of good project management tools will aid in the selection of the right course when managers need to make financial and time allocation decisions.

The key elements of performance measurement are:

1. The measurement of absolute figures or just variance does not give an indication of the status of the project.
2. The value of the work obtained for the effort and resource consumed is the only true measure of project progress.
3. The use of the WBS allows the project manager to focus on the parts of the project that are showing the greatest deviation. Care should be taken when considering the project. Often large negative deviations in one area are smothered by cumulative small positive deviations in other areas.
4. Performance measures can be used to predict the final success, or otherwise, of the project at completion. Trend analysis is a vital component of the project manager's toolbox.
5. Performance analysis is dependent on the accuracy of the tracking measures used. The only effective progress monitoring system is one in which physical deliverables are accepted against agreed quality criteria.
6. Before implementing EVPM it is important that all members of the project team understand the principles and interpretation of results.
7. Beware of the calculation of the Estimate to Complete (ETC) of a project or task using the reduced formula.
8. The procedural elements required in the implementation are
    - The processes involved in implementing a EVPM system in the hospital sector
    - Developing the Work Breakdown Structure

- Developing the plan
- Establishing a resource driven schedule
- Accounting for various cost types What Earned Value provides
- Work progress
- Relationship of planned cost and schedule to actual achievement
- Valid, timely, auditable results
- Basis for Estimate at Complete (EAC)
- Summaries developed at the lowest practical WBS level
- Cost and Schedule Earned Value
- The metrics required to measure project progress and status are:
- Planning Package schedule status
- Budget at Completion
- Budgeted Cost of Work Scheduled or Budgeted Cost of WIES Scheduled
- Budgeted Cost of Work Performed or Budget Cost of WIES Performed
- Actual Cost of Work Performed or Actual Cost of WIES Performed
- Estimate at Completion
- Estimate to Completion

9. For cost/performance measurement to work certain systems must exist. They are:
    - A time-based plan, i.e. a schedule
    - A work breakdown structure
    - A costs collection system
    - An objective method of assessing progress
    - A responsibility/authority

Appendix 4 – Applying Earned Value Performance Management Analysis to a Project using MS Project

Earned Value Performance Management analysis provides answers to questions like, "Is there enough money left in the budget?" and "Will the project finish on time?"

What is earned value performance management analysis?

The basic elements of Earned Value Performance Management are three essential values calculated for each task:

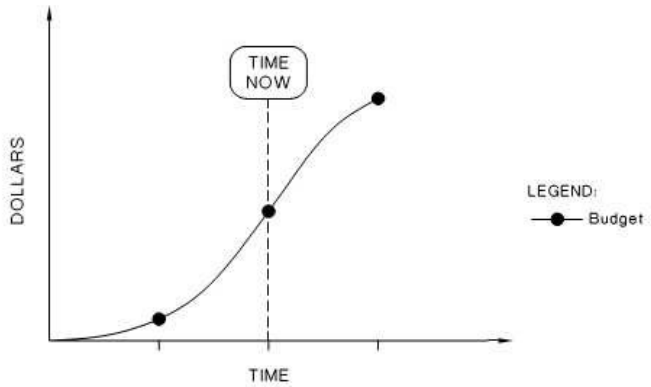
- The budgeted cost of tasks as scheduled in the project plan, based on the costs of resources assigned to those tasks, plus any fixed costs associated with the tasks. This is known as "the budgeted cost of work scheduled," BCWS or now known as Planned Value (PV) is the baseline cost up to the status date chosen. For example, the total planned budget for a 4-day task is $100 and it starts on a Monday. If the status date is set to the following Wednesday, the PV is $75.
- The actual cost required to complete all or some portion of the tasks, up to the status date. This is the actual cost of work performed (ACWP) or now known as Actual Cost (AC) For example, if the 4-day task incurs a total cost of $35 during each of the first 2 days, the AC for this period is $70 (but the PV is still $75).
- The value of the work performed by the status date, measured in currency, this is literally the value earned by the work performed and is called the budgeted cost of work performed (BCWP or Earned Value as it is now known (EV). For example, if after 2 days 60% per cent of the work on a task has been completed, you might expect to have spent 60 per cent of the total task budget, or $60.

Earned Value Performance Management is always specific to the status date. The user can select the current date, a date in the past, or a date in the future it is usual, to set the status date to the date when the updated project progress is from. For example, if the current day is Tuesday, 10/09/13, but the project was last updated with progress on Friday, 6/09/13 set the status date to Friday, 6/09/13.

An example of how to analyse project performance with Earned Value Performance management a task has a budgeted cost (PV) of $100, and by the status date it is 40 per cent complete. The earned value (EV) is $40, but the scheduled value (PV) at the status date is $50. This indicates that the task is behind schedule—less value has been earned than was planned also that the task's actual cost (AC) at the status date is $60, perhaps because a more expensive resource was assigned to the task. This will indicate that the task is also over budget—more cost has been incurred than was planned. This analysis technique is a very powerful management tool for the Project Manager. The earlier in a project's life cycle such discrepancies are identified between AC, EV and PV, the sooner action can be taken to alleviate the problem.

One common way of visualizing the key values of Earned Value Performance management is the use of an S-curve. An S-Curve is a simple chart showing a steady accumulation of cost over the lifetime of a project as shown below in Figure 9

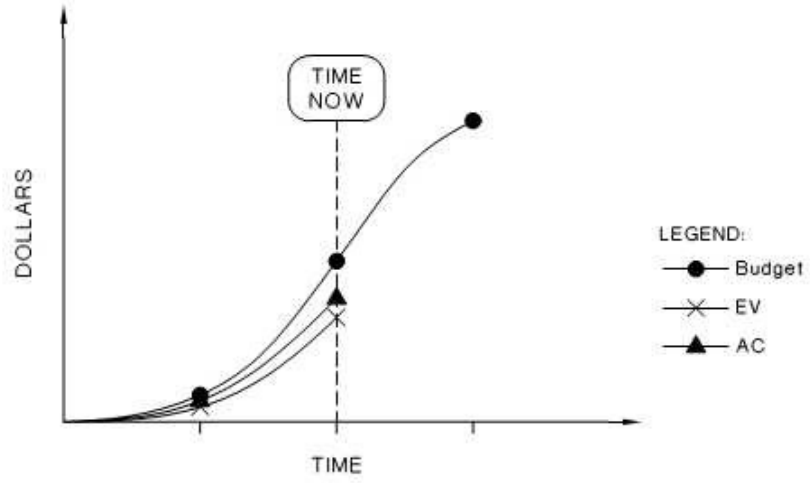
Figure 9 Simple S-Curve



- The vertical y-axis shows the projected cumulative cost for a project.
- The horizontal x-axis shows time.
- The planned budget for this project shows a steady expenditure over the lifetime of the project. This line represents the cumulative baseline cost.

After work on the project has begun, a chart of the key values of Earned Value Performance Management may look like this:

Figure 10 Earned Value Performance Management



- The status date determines the values MS Project calculates.
- The actual cost (AC) of this project has exceeded the budgeted cost.
- The earned value (EV) reflects the true value of the work performed. In this case, the value of the work performed is less than the amount spent to perform that work.

What does earned value performance management measure?

In addition to measuring PV, AC, and EV, Earned Value Performance Management measures:

- Cost variance (CV)—the difference between a task's estimated cost and its actual cost (the formula CV = PV - AC). In the previous example where the total planned budget for a 4-day task is $100 and it starts on a Monday. When the status date is set to the following Wednesday, the PV is $75, the AC for this period is $70, and the EV is $60. In that case, the task's CV is -$10.
- Schedule variance (SV)—the difference between the current progress and the scheduled progress of a task, in terms of cost (the formula SV = EV - PV). In the example above, the task's SV is -$15.
- The cost performance index (CPI)—the ratio of budgeted costs to actual costs (the formula CPI = EV / AC). In the example above, the task's CPI is about .86, or 86 per cent.
- The schedule performance index (SPI)—the ratio of work performed to work scheduled (the formula SPI = EV / PV). In the example above, the task's SPI is .80, or 80 per cent.
- The to complete performance index (TCPI)—the ratio of the work remaining to be done to funds remaining to be spent as of the status date, or budget at completion (the formula TCPI = [BAC - EV] / [BAC - AC]).

Understanding Earned Value

Earned value indicators that are variances or ratios, help to determine if there is enough money left in the budget and if the project will finish on time.

Variances, such as a cost variance (CV), can be either positive or negative:

- A positive variance indicates that the project is ahead of schedule or under budget. Positive variances might enable the reallocation of money and resources from tasks or projects with positive variances to tasks or projects with negative variances.
- A negative variance indicates that the project is behind schedule or over budget so need to take action. If a task or project has a negative CV, may have to increase the budget or accept reduced profit margins.

Ratios, such as the cost performance index (CPI) and the schedule performance index (SPI), can be greater than 1 or less than 1:

- A value that is greater than 1 indicates that the project is ahead of schedule or under budget.
- A value that is less than 1 indicates that the schedule is behind or over budget. For example, an SPI of 1.5 means that only 67 per cent of the planned time has been taken to complete a portion of a task in a given time period, and a CPI of 0.8 means that 25 per cent more time has been spent on a task than was planned.

Example of Earned Value Performance Measurement

Using tasks on an actual ICT project will be used as an example; Earned Value will be used to monitor the status of the project. The table below provides the planned data for work and cost for twelve months of the project. The cost figures are calculated from the daily rates of the programmers; all numbers have been rounded and simplified for clarity. For simplicity, the PV can be considered as the Planned Cumulative Cost

Figure 11 Earned Value Performance Measurement

Plan	31-Jan-14	28-Feb-14	31-Mar-14	30-Apr-14	31-May-14	30-Jun-14	31-Jul-14	31-Aug-14	30-Sep-14	31-Oct-14	30-Nov-14	31-Dec-14
Monthly Work	50	100	150	150	150	150	150	150	150	150	100	50
Cumulative Work	50	150	300	450	600	750	900	1050	1200	1350	1450	1500
Monthly Cost	500	1000	1500	1500	1500	1500	1500	1500	1500	1500	1000	500
BCWS	500	1500	3000	4500	6000	7500	9000	10500	12000	13500	14500	15000

task. These figures directly provide the AC and the EV. The remaining Earned Value fields are then calculated, and these give the project manager a month by month indication of the status of the project.

The following is a summary of what occurred in the project each month for the first six months and the table below shows the Earned Value figures resulting from this status

An explanation of the meaning of the data in the table below each month: -

January 2014

Actual Work (AC = 300) less than Planned (i.e. AC < PV). The schedule is slow but the EV is on target (i.e. SV% < 100 but CV% = 100 because EV = AC. The reason for this is due to the fact that the project was slow in commencing mobilization of resources.

February 2014

Work exactly as Planned, the Schedule is still not on target, but EV is. The Project Manager allocated extra hours at the weekend to mitigate some of the delayed schedule.

March 2014

Work for the month is greater than Planned; the schedule does not recover as much it should. At this time the budget has over run, and the schedule is still behind. The Project Manager has once again approved additional hours to be worked

April 2014

Work greater than Planned; the schedule has recovered to target date. No additional work is required

May 2014

Work slightly more than Planned (some tasks were underestimated). The project is on Schedule

June 2014

Work continued as Planned, the Schedule was maintained

Figure 12 % complete vs. physical % complete effects on earned value

Actual		31-Jan-14	28-Feb-14	31-Mar-14	30-Apr-14	31-May-14	30-Jun-14
Monthly Cost		500	1000	1500	1500	1500	1500
BCWS		500	1500	3000	4500	6000	7500
BCWP (EV)		300	1000	1600	1600	1500	1500
ACWP		300	1000	1800	1800	1600	1500
Cum EV		300	1300	2900	4500	6000	7500
Cum ACWP		300	1300	3100	4900	6500	8000
CV		0	0	200	-400	-500	-500
CV%		100%	100%	93.60%	91.80%	92.30%	93.7
SV		200	200	-100	0	0	0
SV%		60%	87%	96.70%	100%	100%	100%
BAC		15000	15000	15000	15000	15000	15000
EAC		15000	15000	15200	15600	16100	16600
CAC		15000	15000	16034	16333	16250	16000

% complete versus physical % complete effects on earned value?

Project allows each task to use either per cent complete value or physical per cent complete value for earned value calculations related to EV. (Remember, other values are calculated from EV, so the choice affects the entire Earned Value Performance management.)

- Per cent complete may be calculated by MS Project or entered directly, depending on how actual work. is tracked
- Physical per cent complete is always entered directly. Use physical per cent complete when per cent complete would not be an accurate measure of real work performed or remaining work

A simple example of how the two values may differ a project of building a brick wall that consists of 1000 bricks stacked 5 high. The first row of 200 bricks can be laid in 20 minutes, but the second row would take 25 minutes because of having to lift the bricks up one row higher, so it takes a little longer. The third row would take 30

minutes, the fourth 35 minutes, and the last row would take 40 minutes to lay—150 minutes total. After laying the first three rows, the project could be said to be 60 per cent

physically complete (have laid 600 of 1000 bricks). However, only 75 of 150 minutes have been spent; so in terms of duration, the job is only 50 per cent complete.

Depending on how the work is paid for—how the value is earned (by the brick or by the hour) - may choose the per cent complete value or the physical per cent complete value to properly reflect this in the Earned Value Performance Management.

Which earned value ratios are shown and / or calculated in MS Project?

MS Project will show the following:

- Actual cost of work performed (AC) (previously known as Actual Cost of Work performed) shows actual costs incurred for work already performed by a resource on a task, up to the project status date or today's date. Normally Project correlates actual costs with actual work. Only if actual costs are entered independent of actual work or change resource pay rates will actual cost be out of step with scheduled cost.
- Budget at completion (BAC) shows an estimate of the total project cost.
- Budgeted cost of work performed (PV) shows how much of the budget should have been spent given the actual duration of the task. EV is also referred to as "earned value." Note that MS Project calculates EV at the task level differently than it does at the assignment level. For best results, use the task-level EV values, which are the values Project rolls up to summary task and the project summary task EV values. This value is calculated for each individual task but analysed at an aggregate level (typically at the project level).
- Budgeted cost of work scheduled (PV) shows how much of the budget should have been spent in view of the baseline cost of the task, assignment, or resource. PV is calculated as the cumulative time phased baseline costs up to the status date or today's date. (Budgeted cost values are stored in the baseline fields, or if multiple baselines have been saved, in fields Baseline1 through Baseline10.)
- Cost variance (CV) shows the difference between the budgeted cost of work performed (BCWP) on a task and its actual cost (actual cost of work performed or AC). If the CV is positive, the cost is currently under the budgeted (or baseline) amount; if the CV is negative, the task is currently over budget.
- Schedule variance (SV) shows the difference between the budgeted costs of work performed (EV) and the budgeted cost of work scheduled (PV). If the SV is positive, the project is ahead of schedule in cost terms; if the SV is negative, the project is behind schedule in cost terms.
- Variance at completion (VAC) shows the difference between the budget at completion (BAC) and the estimate at completion (EAC). In Project, the EAC is the Total Cost field and the BAC is the Baseline Cost field from the associated baseline.
- Cost performance index (CPI) is the ratio of budgeted, or baseline, costs of work performed to actual costs of work performed (EV/AC).
- Cumulative cost performance index (CPI) is the sum of the EV for all tasks divided by the sum of the actual costs of work performed (AC) for all tasks. Cumulative CPI is often used to predict whether a project will go over budget and by how much.
- Schedule performance index (SPI) is the ratio of work performed to work scheduled (EV/PV). SPI is often used to estimate the project completion date.
- Estimate at completion (EAC) is the expected total cost of a task or project, based on performance as of the status date. EAC is also called forecast at completion, and is calculated like this: EAC = AC + (BAC - EV) / CPI.
- To complete performance index (TCPI) is the ratio of remaining available budget to be spent to the remaining scheduled cost as of the status date. TCPI is calculated like this: TCPI = (BAC - EV) / (BAC - AC). A TCPI value greater than 1 indicates good projected performance for remaining work; less than 1 indicates poor projected performance.

Where in MS Project is earned value data located?

Earned value information can be seen in any sheet view by applying the Earned Value table or the Earned Value Cost Indicators table.

- The Earned Value table shows the ratios PV, EV, AC, SV, CV, EAC, BAC, and VAC. Use this table to see consolidated earned value information, including the key variance fields. Use EAC, BAC, and VAC to evaluate the difference between the scheduled and budgeted costs. Compare CV, which shows the difference between the budgeted and actual cost? of work, with SV, which shows the difference between the budgeted cost of work and the actual cost of work.
- The Earned Value Cost Indicators table shows you PV, EV, CV, CV%, CPI, BAC, EAC, VAC, and TCPI. Use this table to analyse cost variances. Check the CPI and TCPI to see how the project is progressing against its budget and it shows the rate of work compared with the expected rate. If CPI is less than 1, then less is getting done per dollar than planned. The TCPI indicates how much of an increase in performance needed on the remaining tasks in order to keep within budget.

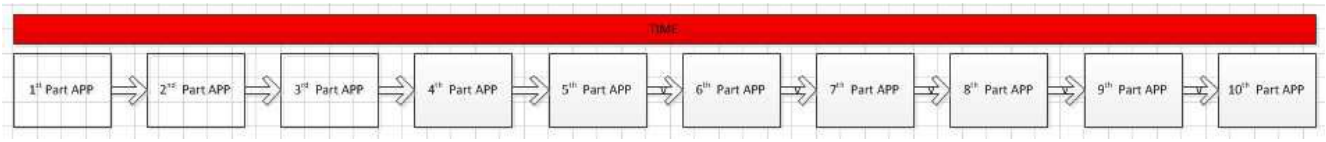
Appendix 5 – Applying Earned Value Performance Management Analysis to a Project using Primavera P6V16.2

To illustrate how Primavera 6 V16.2 runs EVPM a small ICT scenario will be shown through a series of Actions which need to be performed to produce the desired results

Scenario

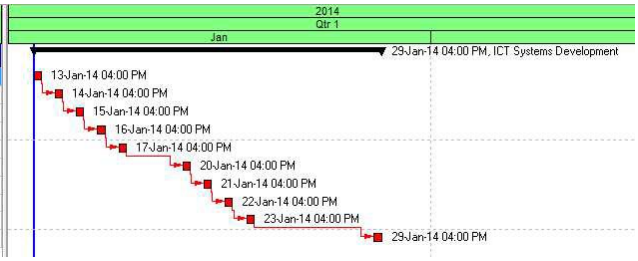
An ICT software vendor has an app to produce for a client that consists of ten sub-apps, each which will take 1 per day and cost $1000.00 day. Thus, the total cost for this work will be $10,000.00

The project plan is shown below: -

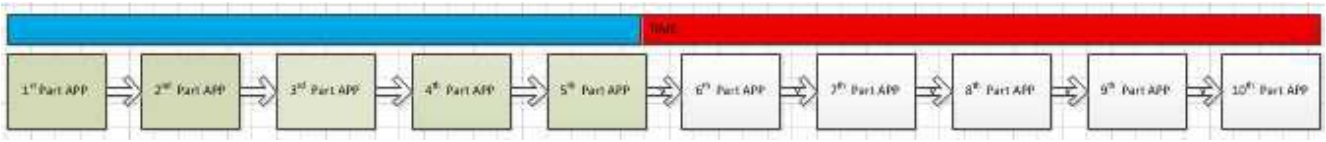


The P6 input data is shown below with a basic Time Analysis

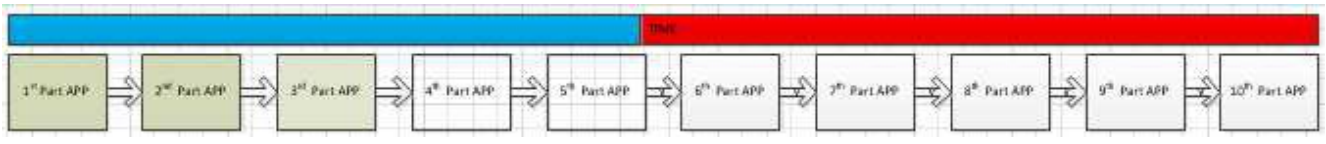
Activity ID	Original Duration	Activity Name	Remaining Duration	At Completion Duration	Schedule % Complete	Start	Finish
ICT Syste	10d		10d	10d	0%	13-Jan-14 08:00 AM	29-Jan-14 04:00 PM
ICT1010	1d	First Part App	1d	1d	0%	13-Jan-14 08:00 AM	13-Jan-14 04:00 PM
ICT1020	1d	Second Part App	1d	1d	0%	14-Jan-14 08:00 AM	14-Jan-14 04:00 PM
ICT1030	1d	Third Part App	1d	1d	0%	15-Jan-14 08:00 AM	15-Jan-14 04:00 PM
ICT1040	1d	Fourth Part App	1d	1d	0%	16-Jan-14 08:00 AM	16-Jan-14 04:00 PM
ICT1050	1d	Fifth Part App	1d	1d	0%	17-Jan-14 08:00 AM	17-Jan-14 04:00 PM
ICT1060	1d	Sixth Part App	1d	1d	0%	20-Jan-14 08:00 AM	20-Jan-14 04:00 PM
ICT1070	1d	Seventh Part App	1d	1d	0%	21-Jan-14 08:00 AM	21-Jan-14 04:00 PM
ICT1080	1d	Eight Part App	1d	1d	0%	22-Jan-14 08:00 AM	22-Jan-14 04:00 PM
ICT1090	1d	Ninth Part App	1d	1d	0%	23-Jan-14 08:00 AM	23-Jan-14 04:00 PM
ICT1100	1d	Tenth Part App	1d	1d	0%	29-Jan-14 08:00 AM	29-Jan-14 04:00 PM



After five days, has elapsed, 5 parts of the app have been successfully completed, and $5,000.00 has been expended, which means that the Planned Value - (PV) to date is $10,000.00 - $5,000.00 =$5,000.00



However, suppose only three parts have been successfully completed by Day 5, the Earned Value – (EV) = $3,000.00



In addition, at Day 5 there has been a cost overrun, only 3 parts have been completed, but instead of costing $1,000.00 as originally quoted, each part cost $2,000.00.

This will mean the Actual Cost – (AC) – ($2,000.00 x 3 Day) = $6,000.00

The three-major ratios of Planned value (PV), Earned value (EV) and Actual Cost (AC) can be realised, At day 5

1) (PV) = $5,000.00

2) (EV) = $3,000.00

3) (AC) = $6,000.00

- Thus, at day 5, the ratios are

1. (EV) – (PV) = Scheduled Variance
   a. i.e. 300 – 500 = -200

      i. Behind Schedule

2. `(EV) – (AC) = Cost Variance
3. $3000.00 - $6000.00 = -$3000.00

      i. Over Budget

The Schedule Performance and Cost Performance Indices

The Schedule Performance Index is an index which indicates what was Earned versus what was Planned, if the index is less than1, it indicates that the program is behind schedule. However, if the index is greater than 1 it indicates that the program is ahead of schedule. The schedule performance index is defined as

SPI = EV / PV

Therefore, in the example above SPI is 3000.00 / 5000.00 = 0.6

The Cost Performance Index is an index which indicates what was Earned versus the Actual Cost, if the index is less than1, it indicates that the program is over budget. However if the index is greater than 1 it indicates that the program is behind budget. The schedule performance index is defined as

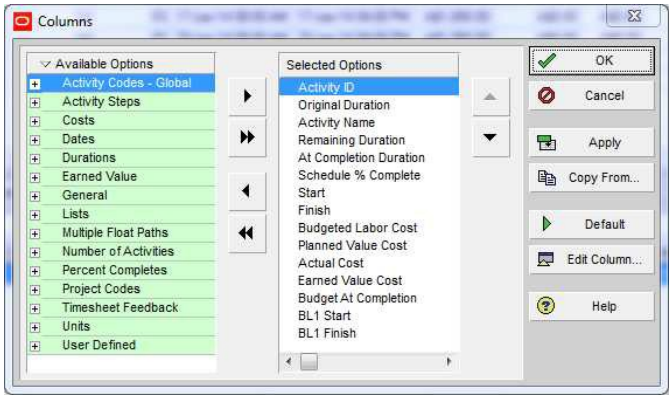
CPI = EV / AC

Therefore, in the example above CPI is 3000.00 / 6000.00 = 0.5

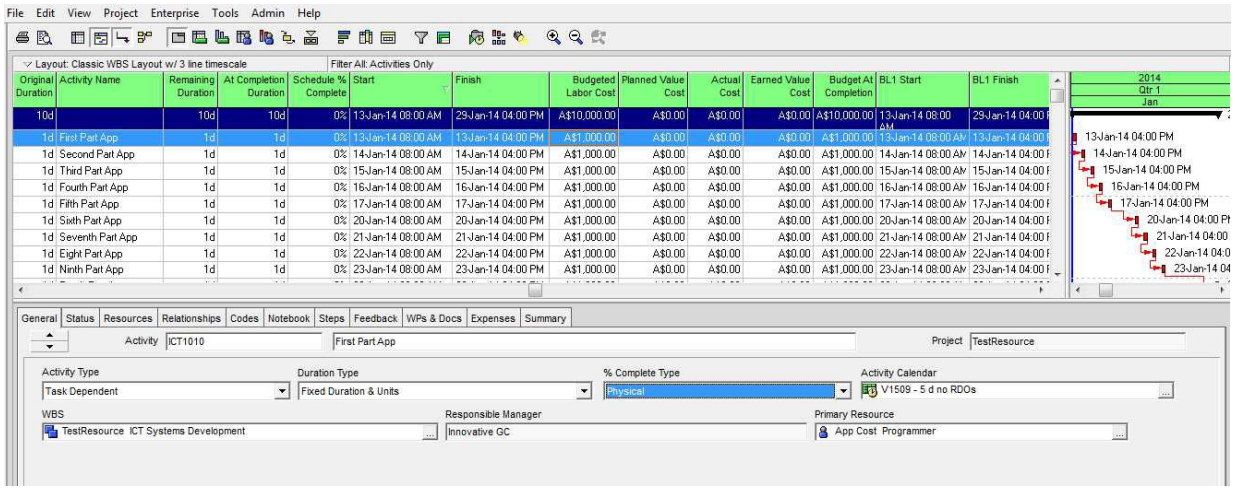
Inputting the above scenario into Primavera 6 V16.2

Action 1: Enter the data from the scenario into Primavera plan the normal way and schedule the data as usual

Action 2: Create a layout showing the Earned Value columns as follows:



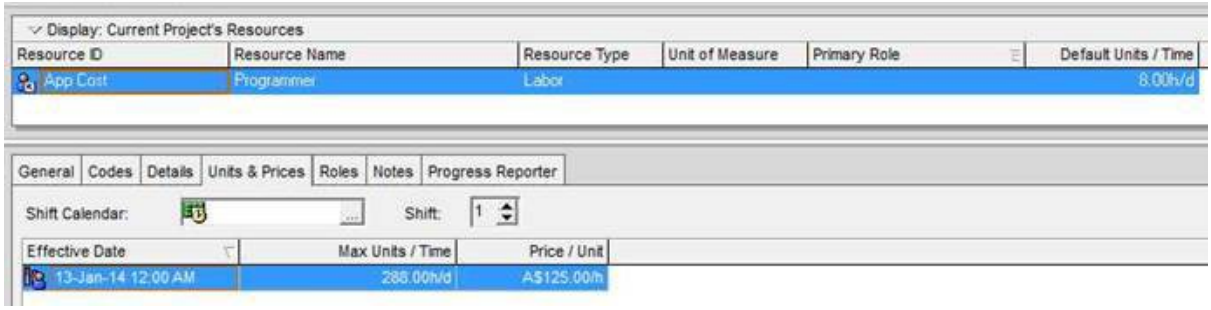
The initial Earned Value Costed Schedule in P6 is shown below:

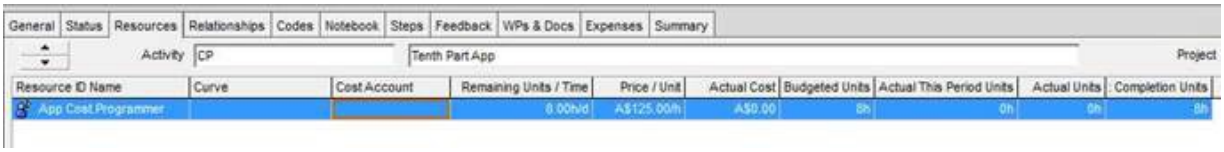


The %Complete Type must be changed from the default “Duration” to Physical and the Resource Assignments

Action 3: Add the Resource Codes and Assigned to activities

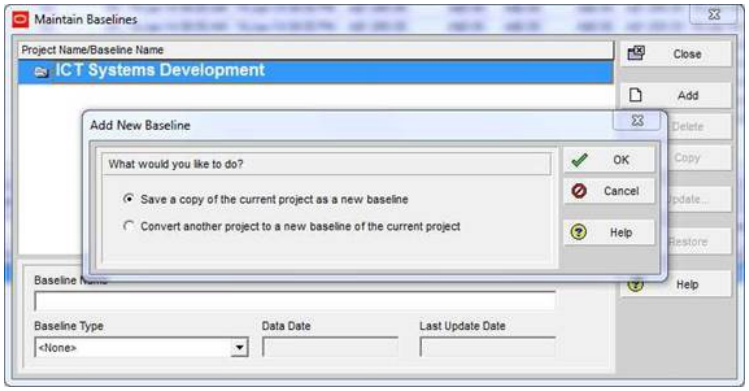
Create each resource that will be allocated during the project, by providing in the usual way in P6 a resource name, code and rates / unit and amount available shown below



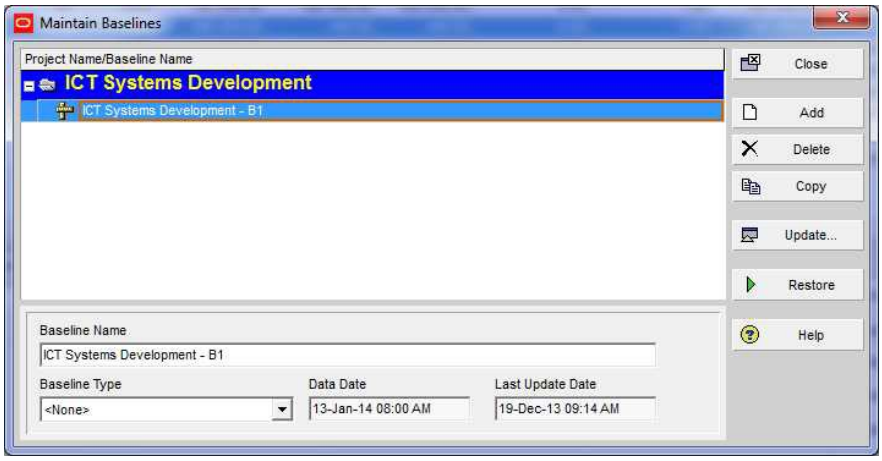


Action 4: Establish the Baseline

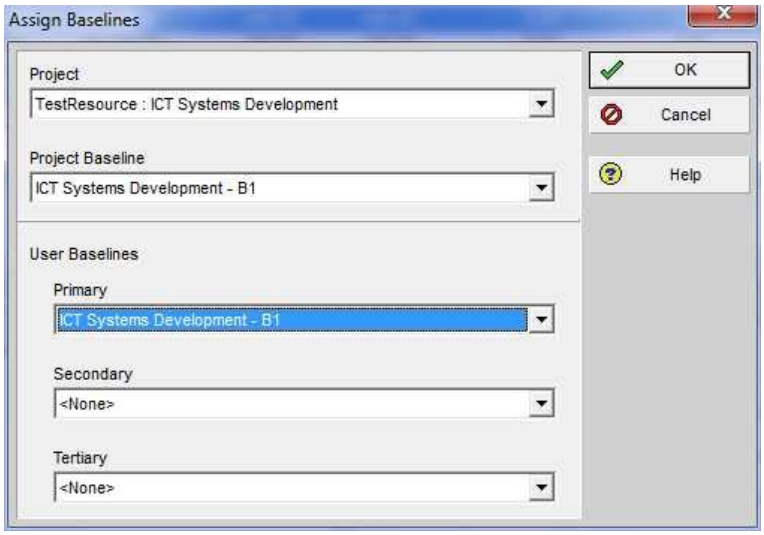
Click Add to add a new baseline



Action 5: Name the Baseline



Action 6: Assign the Baseline as defined in the "Maintain Baseline" dialog (above) for use in the Earned Value Analysis ratios



Action 7: First Progress status- Day 5 Status input – Report Physical % Complete

Day 5 update date is now 20-Jan-14

The actual status to be reported is as follows

Activity Id	Actual Start Date	Actual Finish Date	Actuall Hrs Worked
ICT1010	13-Jan-14	13-Jan-14	16h
ICT1020	14-Jan-14	14-Jan-14	16h
ICT1030	15-Jan-14	15-Jan-14	16h

Having entered the data, press F9, Schedule and update the Data Date to 20-Jan-14

Action 8: Actual Resource Actual Usage Report

Having run the schedule analysis in the usual way, the EV report is as shown below:-

Layout: Earned Value Performance Management Analysis Filter All: Activities Only

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Planned Value Cost	Earned Value Cost	Actual Cost	Cost Performance Index	Schedule Performance Index	Budget At Completion	Estimate To Complete	Estimate At Completion Cost
ICT Systems Developmen		12d	7d	50%	A$5,000.00	A$3,000.00	A$6,000.00	0.50	0.60	A$10,000.00	A$7,000.00	A$13,000.00
ICT1010	First Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1020	Second Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1030	Third Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1040	Fourth Part App	1d	1d	100%	A$1,000.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1050	Fifth Part App	1d	1d	100%	A$1,000.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1060	Sixth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1070	Seventh Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1080	Eight Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1090	Ninth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1100	Tenth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00

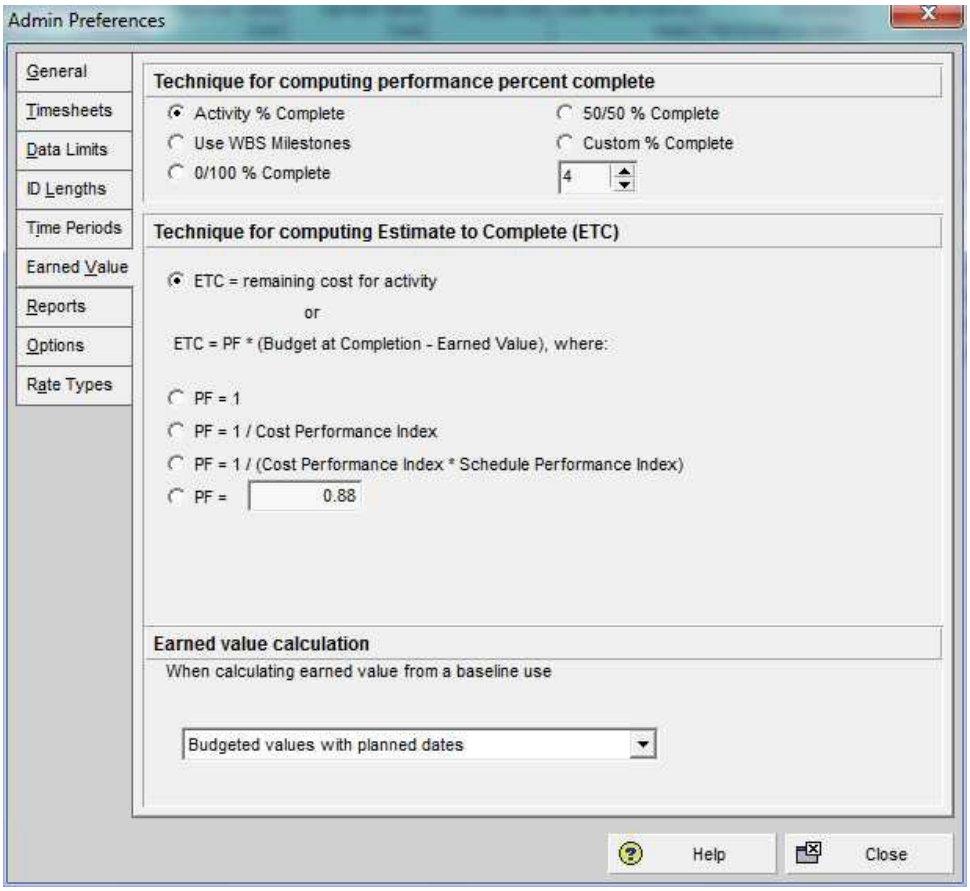
Having carried out the schedule analysis, the Earned Value Analysis indicators are shown below: -

- Cost Performance Indicator (CPI)
    - The baseline showed that $5,000.00 worth of work should have been completed by day 5 (Planned Value Cost)
    - At the Data Date of 20-Jan-14, the Actual Cost (AC) is $6,000.00 which has achieved only $3,000.00 worth of work (Earned Value Cost)
    - This indicates that the project is over budget
- Schedule Performance Indicator (SPI)
    - The baseline indicates that 50% worth of work should be complete by day 5. However, the Performance % Complete (Actual Labour Units) indicates only 30% has been achieved.
    - This indicates that the project is behind schedule The CPI and SPI indicate the project efficiency to date
- Cost Performance Indicator indicates the amount of Physical Work completed versus the dollars spent to accomplish the work
    - CPI = (EV) / (AC)
        - 3000.00 / 6000.00 = 0.5
- Schedule Performance Indicator indicates the amount of physical work completed versus the amount of planned work
    - SPI = (EV) /(PV)
        - 3000.00 / 5000.00 = 0.6

Layout: Earned Value Performance Management Analysis | Filter All: Activities Only

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Planned Value Cost	Earned Value Cost	Actual Cost	Cost Performance Index	Schedule Performance Index	Budget At Completion	Estimate To Complete	Estimate At Completion Cost
ICT Systems Developmen		12d	7d	50%	A$5,000.00	A$3,000.00	A$6,000.00	0.50	0.60	A$10,000.00	A$7,000.00	A$13,000.00
ICT1010	First Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1020	Second Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1030	Third Part App	1d	0d	100%	A$1,000.00	A$1,000.00	A$2,000.00	0.50	1.00	A$1,000.00	A$0.00	A$2,000.00
ICT1040	Fourth Part App	1d	1d	100%	A$1,000.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1050	Fifth Part App	1d	1d	100%	A$1,000.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1060	Sixth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1070	Seventh Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1080	Eight Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1090	Ninth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00
ICT1100	Tenth Part App	1d	1d	0%	A$0.00	A$0.00	A$0.00	0.00	0.00	A$1,000.00	A$1,000.00	A$1,000.00

Calculating the “Estimate to Complete” generally equals the remaining costs from the data date to the project end date



Appendix 6 – The Basic Framework for Improvement Programme, Scheduling and Project Controls Capability

The Framework consists of the following 14 Components, which are decomposed into "Topics" for easier learning these are defined in the Appendix

Component 01 MANAGING PLANNING & SCHEDULING

Topic 01-01 - Introduction to Managing Planning & Scheduling

Topic 01-02 - Develop the Planning & Scheduling Policies & Procedures Manual

Topic 01-03 - Identify / Capture all Schedule Activities

Topic 01-04 - Create the Logical Relationships & Sequence Activities

Topic 01-05 - Assigning Resources to all Activities

Topic 01-06 - Calculate the Duration of Each Activity

Topic 01-07 - Calculating Float and the Critical Path

Topic 01-08 - Validate the Critical Path & Completion Dates

Topic 01-09 - Validate Horizontal and Vertical Integration

Topic 01-010 - Conducting a Schedule Risk Analysis

Topic 01-011 - Baselining and Communicating the Schedule

Component 02 MANAGING RESOURCES

Topic 02-01 - Introduction to Managing Resource Acquisition / Allocation

Topic 02-02 - Develop the Resource Policies & Procedures Manual

Topic 02-03 - Acquiring Manpower for the Project

Topic 02-04 - Acquiring Materials for the Project

Topic 02-05 - Acquiring Equipment for the Project

Topic 02-06 - Allocating Resources

Component 03 MANAGING SCOPE

Topic 03-01 - Introduction to Managing Scope

Topic 03-02 - Developing the Scope Management Policies & Procedures Manual

Topic 03-03 - Validate Stakeholder Expectations

Topic 03-04 - Creating the Work Breakdown Structure

Topic 03-05 - Creating the Control Accounts

Topic 03-06 - Accepting Completed Deliverables

Component 04 MANAGING CONTRACTS

Topic 04-01 - Introduction to Managing Contracts

Topic 04-02 - Develop the Contracting Policies & Procedures Manual

Topic 04-03 - Select Project Delivery Method / Contract Type

Topic 04-04 - Tendering & Bidding the Project

Topic 04-05 - Managing the Contract (Client & Contractor)

Topic 04-06 - Close Out the Contract (Client & Contractor)

Component 05 MANAGING PROJECT COST ESTIMATING & BUDGETING

Topic 05-01 - Introduction to Managing Cost Estimating & Budgeting

Topic 05-02 - Develop Cost Estimating & Budgeting Policies & Procedures Manual

Topic 05-03 - Define the Estimates Purpose and Scope Of Work (Client)

Topic 05-04 - Creating the Clients Cost Estimate (Top Down)

Topic 05-05 - Define the Estimates Purpose & Interpret the Scope Of Work (Contractor)

Topic 05-06 - Developing the Contractors Cost Estimate (Bottom Up)

Topic 05-07 - Validate the Time & Cost Trade-Offs

Topic 05-08 - Validating Horizontal and Vertical Integration

Topic 05-09 - Conducting A Cost Risk Analysis

Topic 05-10 - Baselining and Communicating The Cost Estimate/Cost Budget

Component - 06 PROJECT CONTROLS MANAGEMENT

Topic 06-01 - Introduction to Project Controls Management

Topic 06-02 - Project Controls Policies & Procedures Manual Development

Topic 06-03 - Project Controls Plan Development

Topic 06-04 - Executing the Project Controls Plan

Topic 06-05 - Controlling the Project Controls Plan

Topic 06-06 - Close Out the Project Controls Plan

Component 7 Introduction to Earned Value Management (EVM)

Topic 7-01: Introduction to EVM

Topic 07-02: Scope Definition

Topic 07-03: Control Account Establishment

Topic 07-04: Scheduling an Earned Value Project

Topic 07-05: Cost Budgeting

Topic 07-06: Establishing the Performance Measurement Baseline (PMB)

Topic 07-07: EVM Data Collection

Topic 07-08: Actual Costs

Topic 07-09: Progress Measurement

Topic 07-10: Performance Measurement

Topic 07-11: Cost & Schedule Forecasting

Topic 07-12: EVM Reporting

Topic 07-13: Variance Analysis

Topic 07-14: Baseline Revisions and Change Control

Topic 07-15: Project Close-out

Component 08 MANAGING RISK & OPPORTUNITY

Topic 08-01 - Introduction to Managing Risk & Opportunity

Topic 08-02 - Develop the Risk & Opportunity Policies & Procedures Manual

Topic 08-03 - Identify Risks / Opportunities

Topic 08-04 - Assess, Categorize, Prioritize and Quantify Risks or Opportunities

Topic 08-05 - Risk / Opportunity Response Strategies and Tactics

Topic 08-06 - Risk / Opportunity Monitoring and Control

Component 09 MANAGING PROJECT PROGRESS

Topic 09-01 - Introduction to Managing Project Progress

Topic 09-02 - Developing Progress Measurement Policies & Procedures Manual

Topic 09-03 - Capturing Progress & Updating the Schedule

Topic 09-04 - Assessing and Interpreting Progress Data

Topic 09-05 - Project Performance Forecasting

Component 10 MANAGING PROJECT CHANGE

Topic 10-01 - Introduction to Managing Project Change

Topic 10-02 - Develop Managing Change Policies & Procedures Manual

Topic 10-03 - Managing Change - The Client's Perspective

Topic 10-04 - Managing Change- The Contractor's Perspective

Topic 10-05 - Configuration Management

Component 11 MANAGING PROJECT DATABASES

Topic 11-01 - Introduction to Managing Project Databases

Topic 11-02 - Develop Managing Project Databases Policies & Procedures Manual

Topic 11-03 - Designing the Project Database

Topic 11-04 - Creating the Project Database

Topic 11-05 - Updating and Using the Project Database

Component 12 MANAGING PEOPLE

Topic 12-01 - Introduction to Managing People

Topic 12-02 - Develop Project Controls Career Path Development Plan

Topic 12-03 - Developing Individual Competencies

Topic 12-04 - Developing Management Competencies

Topic 12-05 - Developing Organisational Competencies