Project Controls EXPO
Melbourne, Australia

Six Elements of Project Controls

BIO of Lance Stephenson

CET, PMP, CCP FAACE, MRICS

- Director of Operations, AECOM
- Strategic Leader; Tactical Subject Matter Expert in Operational / Capital Program / Project Delivery...

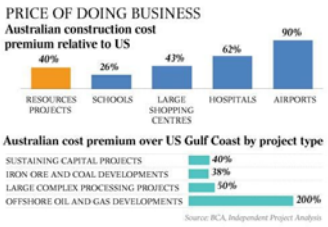
Over 35 years of international experience; executed over $25 BN of projects over my career.

Key note Speaker, author, contributor & educator: technical papers, RPs, CEN, TCM Framework, S&K

Local project costs 40pc above the US

- AUSTRALIA has become such a high-cost and low-productivity nation that resources projects are now 40 per cent more expensive to deliver here than in the US, jeopardizing an investment boom that is crucial to propping up the national economy.

Local project costs 40pc above the US



Productivity is so poor work that takes one hour in the US takes 1.35 hours in Australia - meaning labour is 35 per cent less productive.

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Value of Project Controls

- Tangible benefits are hard to quantify… but experience indicates tangible benefits in the range of 2 to 3 times the cost… intangible benefits are potentially greater
- Tangible benefits illustrated by:
  - Identifying alternative, lower cost sources for equipment and materials
  - Detecting non-optimum execution strategies
  - Quantifying the impact of productivity and manpower growth trends
  - Uncovering unfavorable trends with adverse impacts

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Value of Project Controls

- Intangible benefits achieved through:
  - Control consciousness on project teams
  - Control of changes
  - Early identification of potential overruns / schedule delays for timely corrective action

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Seminar Overview

- Introductions
- Seminar Objectives
- My Role / Your Role

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Seminar Objectives

- Explore basic project management and control principles
  - Evolved over many years
  - Applicable to both small and large projects
  - Adoptable to all types…petrochemical, mining, commercial
- Provide you with expanded knowledge base
  - Working knowledge of control principles / methodology
  - Increase your delivery effectiveness
  - Improve execution of you project
- Better Understanding Project Controls
  - Lessons Learned
  - Value Add of Project Controls

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About the Project Controls Seminar

- My Role
  - Provide basic material on topics
  - Lead discussion
  - Answer Questions
- Your Role
  - Contribute your ideas
  - Share your experiences
  - Explore applicability of material to your work situation
  - Feedback
- High degree of interaction will increase value of seminar

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Project Management Basics

- Defining Objects & Priorities
- Project Planning (Stages & Phases)
- Organizational Relationships

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Defining Objectives

- Asset Objectives
  - Design Optimization
  - ROI / IRR
  - Maintainability
  - Reliability
  - Operability

Asset Management
- Life-cycle costing

- Project Objectives
  - Complete project within budgeted funds
  - Complete project when specified
  - Ensure the project meets all quality aspects as defined
  - Ensure safe performance of work by all participants

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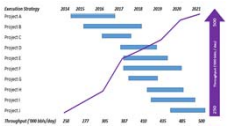
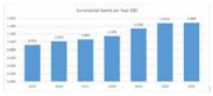
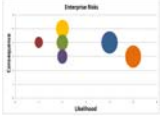
Defining Objectives

Portfolio / Program Management ensures that each project within the portfolio / program has satisfied the required conditions based on the assessed risks and financial protocols (supports the prioritization of the suite of projects and assist in defining the overall portfolio)





Fund Management ensures that the overall funding strategy is defined, communicated and understood. Fund management also supports the financial assessment of the suite of projects



Risk Management ensures that the overall risk strategy is defined, communicated and understood and will evaluate the projects against the enterprise risk matrix and provide recommendations

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Defining Priorities

Right Projects at the right time with the right resources…

- Balance of spending (critical needs vs. market growth)
  - Sustainability Projects (equal spend o 4% depreciation per yr)
  - Growth Projects

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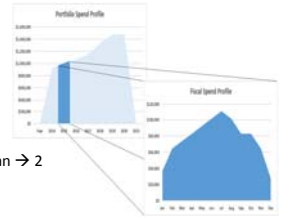
Defining Priorities

Right Projects at the right time with the right resources…

- Business Planning
  - 10 yr plan → 20 yr plan
- Strategic Planning
  - 5 yr plan → 10 yr plan
- Fiscal Planning
  - Monthly →Qrtly plan → 1 yr plan → 2 plan



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Defining Priorities

- Complete project within budgeted funds (Costs)
- Complete project when specified (Schedule)
- Establish and maintain standards to assure a safe and operable plant (Quality)
- Insure safe performance of work by all participants (Safety)

Not all equal…vary with owner's priorities

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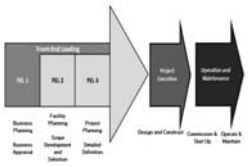
Objectives vs. Priorities

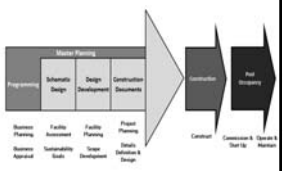
- Clear delineation of owner's objectives is a very important factor in successful project management
- Typical objectives to be considered:
  - Cost
  - Schedule
  - Quality (Reliability, Maintainability, Operability)
- Translate objectives into measurable and attainable goals
- Prioritization of objectives are critical… execution decisions require evaluation of tradeoff

Project Planning, what is required?

Process Industry



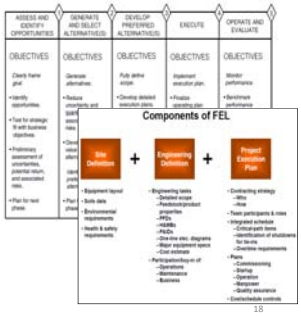
Commercial Industry



The commercial delivery model may change based on procurement strategy (i.e. Design-Build, Design-Bid-Build)

Project Planning, what is required?

- Depending on the delivery model, understand the requirements and deliverables to support the execution of the project.
- Typical objectives to be considered:
  - Site Definition
  - Engineering Definition
  - Execution Planning



Project Planning & Organizational Relationships

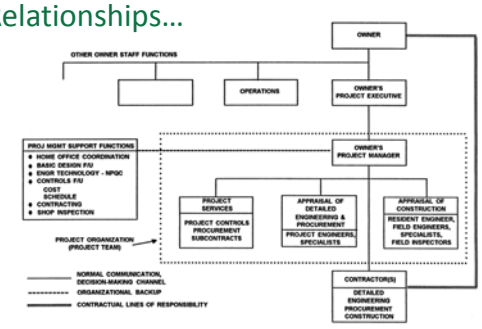
Three major functions involved in a project… planning… project execution… operations…

1. Planning… evaluates feasibility and defines the project… arranges / appropriates funds

Project Planning & Organizational Relationships

2. Project execution… represented by the Client during detailed definition and execution phases… awards contract(s)… approves expenditures… monitors / appraises / guides contractor performance
   - Project team staffed with PM/PE/FE/PCS during engineering and construction
   - Supported by non-process quality control and other home office specialists
   - Contractors(s)…independent "third party" under contract to client… performs E/P/C… works through project team
3. Operations… starts up facility… completes performance tests… ensures work completed to an acceptable operating standard

Relationships…



	Functional	Weak Matrix	Balanced Matrix	Strong Matrix	Projectized
Description	Traditional organization with a direct supervisor.	The PM and FM share responsibility, with the FM having more authority.	The PM and FM share responsibility, with each having equal authority.	The PM and FM share responsibility, with the PM having more authority.	Projects do not exist under functional departments. The PM has sole management authority.
Authority of project manager	Very low.	Low.	Low to medium.	Medium to high.	High.
Resource availability	Very low.	Low.	Low to medium.	Medium to high.	High.
Project manager involvement	Part-time.	Part-time.	Full-time.	Full-time.	Full-time.
Staff involvement	Part-time.	Part-time.	Part-time.	Full-time.	Full-time.
Advantages	The FM holds accountability for the project.	The PM gets some authority to manage the project.	The PM and FM share the responsibility of the project.	The PM gets more authority to assign resources and manage the project.	The PM has full authority to staff and manage the project.
Disadvantages	The PM holds little or no authority.	The FM can see the PM as a threat and cause conflict.	The PM and FM can be confused about who manages what.	The FM may feel out of the loop.	The PM holds accountability for the project.

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Traditional Project Team Activities

- Project Management
  - Develop project execution plan (PEP)
  - Implement PEP
  - Continuous monitoring / appraisal to meet objectives
- Project Team
  - Responsible for success of project execution
  - Single point contact with contractor
  - Interprets job specification
  - Monitors and appraises project and contractor's performance
  - Provides additional guidance where necessary

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Traditional Project Team Activities

- Project Team is responsible for its actions… Must monitor and appraise
  - Monitor to understand what's being done… passive
  - Appraises to assess actuals against expectations… active
    - Encourage contractor self-appraisal
    - Conduct independent assessments

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Project Controls Specialist

- Project Controls… a shared task… responsibility of all personnel
- Project Controls Specialist (PCS)… expert on cost and/or schedule matters… support change management & forecasting
  - Large projects… two or more PCS's… possibly separate cost and schedule responsibilities
  - Small projects… one PCS does both cost and schedule, on multiple projects
  - Very small projects… may be part of project / construction manager's job

Organizational Relationships - How to Improve …

- Create common goals at all levels
  - Defuse adversarial relationships
  - All people working together
  - Cooperation and open communications
- Team Building sessions
  - To kick off the project right after contract award
  - Key people from all groups
    - Client / PMT / Contractor
  - Periodic sessions to reinforce common goals, resolve hostilities outside of work environment

Open Discussion

What do you consider the key issues that we face when establishing project teams…

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Project Controls

- Scalability
- Decision Usefulness

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Scalability

- The concept of scalability refers to the ability for a business to accept increased or decreased volumes of work without impacting the financial aspect of the business (which includes the mitigation of risk). There are two types of scalability.

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Scalability – Two Types

Functional scalability:

- is the ability for a department to define the functionality for each of the business models within the Project Delivery Model (PDM).
- Project Management and Controls functionality should be designed proportionately for each business model (if more than one);
  - that supports the identification and mitigation of any project risks, as well as provide due diligence to the financial obligations of the organization.

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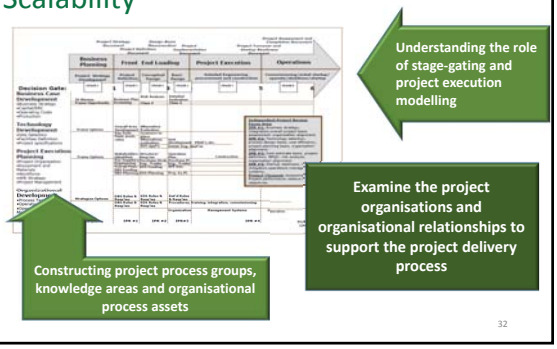
Scalability – Two Types

Stage Gate scalability:

- refers to the ability to eliminate stages within the stage gating process. Only under extreme circumstances, such as emergency or fast track projects, should the elimination of gates be allowed.

Scalability



Understanding the role of stage-gating and project execution modelling

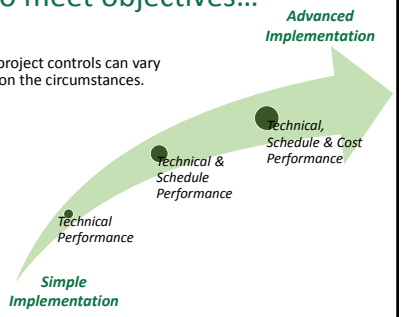
Examine the project organisations and organisational relationships to support the project delivery process

Constructing project process groups, knowledge areas and organisational process assets

Scalability to meet objectives…

The *implementation* of project controls can vary significantly depending on the circumstances.

- project complexity
- maturity of the team



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Scalability – Deliverables / Expectations

Simple	Intermediate	Advanced
• Define Work via WBS • Assign Values (Level of effort) • Define Earning Rules • Execute Project • Monitor technical accomplishment	• Define the Work via WBS • Assign Values (Estimate) • Define Earning Rules • Develop a CPM Schedule • Execute Project • Monitor & assess technical & schedule accomplishments & performance • Define technical & schedule recovery plans	• Define the Work via WBS • Define OBS & RAM to support Execution • Assign Values (Estimate) • Define Earning Rules • Develop a CPM Schedule • Establish Controls Accounts • Execute Project • Monitor & assess technical, schedule and cost accomplishments & performance • Define technical, schedule and cost recovery plans

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Scalability – Surveillance

Simple	Intermediate	Advanced
• none	• Schedule Performance • Schedule Variance	• Schedule Performance • Schedule Variance • Cost Performance • Cost Variance • Estimate At Completion • Variance At Completion

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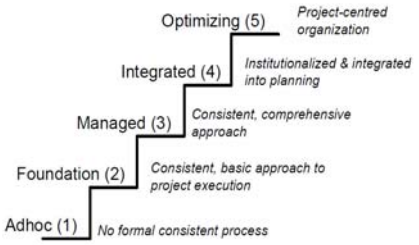
Scalability – Need to understand Organizational Maturity



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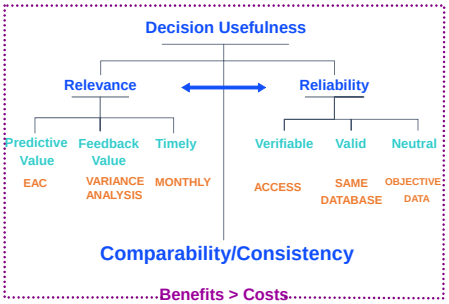
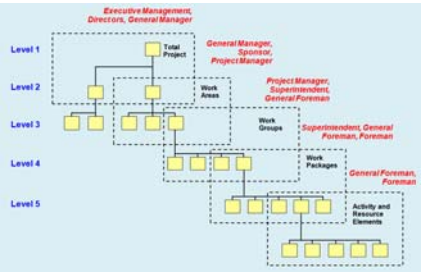
Decision Usefulness - Information



Decision Usefulness – What's needed for control

- In what depth?…philosophically, exercise control at the highest level (least amount of detail) consistent with effective control
- Look to simplify data keeping / systems on smaller projects
- PMT should periodically assess level of detail, fine tune as necessary to achieve effectiveness…each project is different…each contractor different

Decision Usefulness – Level of Detail



Decision Usefulness – Level of Detail

- Level of detail refers to three concepts:
  - the precision in providing the right information to support the appropriate actions (required knowledge for comprehension or experience);
  - the generality of the project information available;
  - and the organizational strategy in which the project team executes the project according to the hierarchy of detail.

A number of fundamental principles must be considered when proposing the appropriate levels of detail for each technical product or deliverable.

Decision Usefulness

Example of level of Estimate versus level of Control

What you decide to do between the AFE and lowest WBS Element will determine the required controls effort in managing the project.

Decision Usefulness

- Control, a primary function of the PMT… where the processes and system must meet minimum requirements
- When?
  - Throughout all project phases
- How?
  - Through the Six Elements of Project Controls

Open Discussion

How is scalability defined in your organization, level of detail?

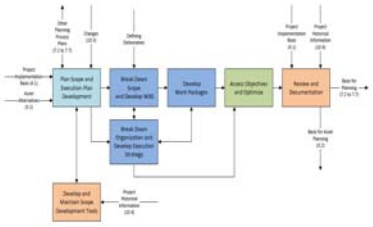
Six Elements of Project Controls

Know What Has To Be Done!

… detailed budget and tracking profiles which provide schedule and cost control bases

Know What Has to Be Done

- Scope Management



TCM Framework 2nd Edition, Process Map 7.1-1

Know What Has To Be Done

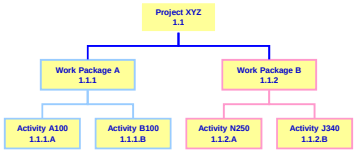
- Establish a control estimate and schedule as the performance baseline
- Control estimate characteristics (For Client - Class 3; for Contractors - Class 2 or 1)
- Control Schedule characteristics (For Client - Level 2; for Contractors, Level 4)
- Establish Planned Burn/Productivity Rates
- Incorporates Risk Management and Validation (Cost & Schedule) Techniques
- Available at or before entering next gate / stage (by Client) or mobilization to site (by contractor)…

Work Breakdown Structure

- Decomposes overall project scope into deliverables and supports the definition of the work effort
  - Supports planning, budgeting and performance management
- Cleary defines scope so project participants can understand
- Supports documenting accountability and responsibility of deliverables through the OBS (Organizational Breakdown Structure) and RAM (Responsibility Assignment Matrix)
  - Assists in determining required resources

Work Breakdown Structure - Appropriate Level of Detail

- Framework for organizing and ordering activities
- Systematic approach reflecting top-down structure with lower levels providing more detail and smaller elements of overall work

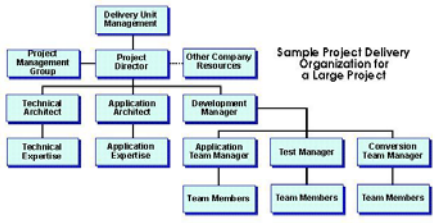


Time, Cost & Resource Coding Structure
Frame of Reference for Communicating & Updating

Establishing the Organization

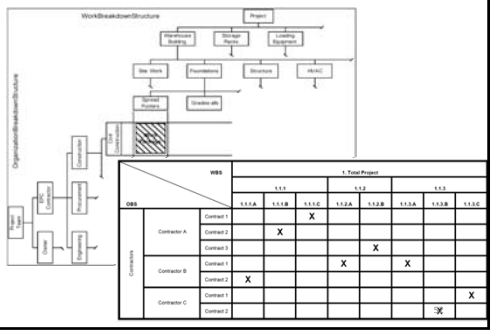
- OBS is used to define the responsibilities for project management, project controls, discipline and craft, etc.
- The OBS provides an organizational rather than a task-based perspective of the project.
- The hierarchical structure of the OBS allows the aggregation (rollup) of project information to higher levels.
- When project responsibilities are defined and work is assigned, the OBS and WBS are connected providing the possibility for powerful analytics to measure project and workforce performance at a very high level or down to the details.

Establishing the Organization



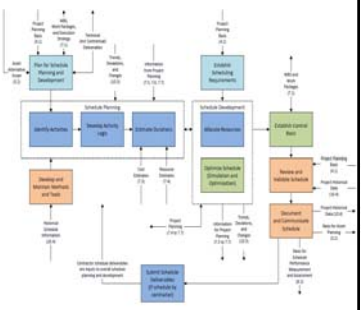
Sample Project Delivery Organization for a Large Project

WBS & OBS Matrix



Know What Has to Be Done

- Schedule Development



TCM Framework 2nd Edition, Process Map 7.2-1

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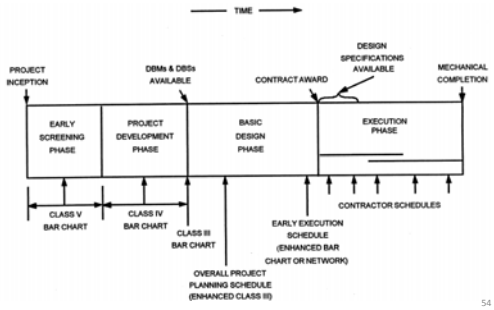
Schedule Classifications



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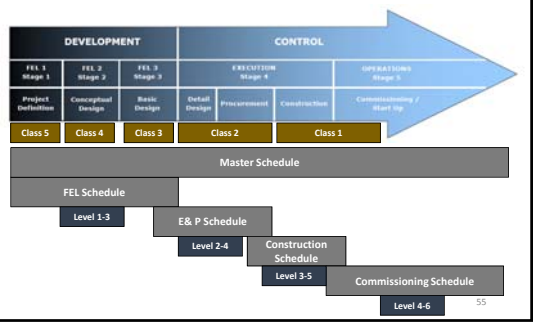
Schedule Levels



Early Bar chart Schedules

- Prepared in conjunction with corresponding class of cost estimate
- Input required to prepare schedule includes
  - Contractor's engineering deliverable and direct labour man-hours, including contingency
  - Unique project features and criticalities
- Illustrated in bar chart format
- Highlights both Owner and contractor activities
- Activities identified at summary level (5-20 activities)

Schedule Control Philosophy

- Embraces several concepts - paramount is "plan the work, then work the plan"
- Should look at the contractor to be responsible for establishing schedule control base and performance within the base
  - Please remember, contractor's assessments of overall schedule usually optimistic; early schedules are achieved only 1 time in 3
- In-house schedules should be based on durations having 50/50 chance of attainment
- For planning and assessing performance, contractor's schedule used as the target

Schedule Control Characteristics

- Detailed project plan is most important tool contractor has in exercising schedule control
- Detailed project plan must be:
  - In sufficient detail to identify all activities on critical path to achieving project completion
  - Detailed, step-by-step prediction of how job will be executed
  - Both roadmap and yardstick for performance
  - Consistent with project cost control estimate in:
    - manpower requirements, and
    - productivity levels

Reporting Schedule Status

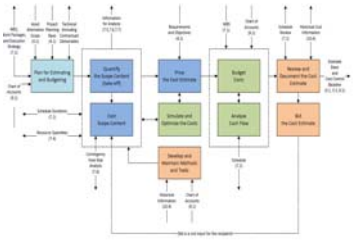
- Contractor's report - covers monthly progress in engineering, procurement and construction by publishing
  - Original and current target dates
  - Progress curves ... planned and actual
  - Manpower data ... planned and actual
  - Text highlighting events influencing critical path
- PCS and contractor agree content early in project

Reporting Schedule Status

- Owner's report – the Team writes the schedule report starting from contractor's report, but includes later date and schedule reserve. Specific items include:
  - Progress highlights
  - Reconciliation to previous schedule forecast if different
  - Status of activities outside contractor's scope
  - Progress curves

Know What Has to Be Done

- Cost Estimating & Budgeting



TCM Framework 2nd Edition, Process Map 7.3-1

What is a Cost Estimate

- To estimate is "to calculate approximately the worth, size or cost…"(Webster's)
- An estimate is based on a plan for a project's design, and execution: design, schedule, contracting approach, etc., are explicitly or implicitly defined
- An estimate should be unbiased…must have an equal probability of overrun or under-run

AACE's Process Industry Estimate Classification Matrix

	Primary Characteristic	Secondary Characteristics			
	LEVEL OF PROJECT DEFINITION	END USAGE	METHODOLOGY	ACCURACY RANGE	PREPARATION EFFORT
ESTIMATE CLASS	Expressed as % of complete definition	Typical purpose of estimate	Typical Estimating Method	Typical variation in low and high ranges (a)	Typical degree of effort relative to least cost index of 1 (b)
5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgement, or Analogy	-20% to -50% +30% to +100%	1
4	1% to 15%	Study or Feasability	Equipment Factored, or Parametric Models	-15% to -30% +20% to +50%	2 to 4
3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs w/ Assembly Level Line Items	-10% to -20% +10% to +30%	3 to 10
2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost w/ Forced Detailed Takeoff	-5% to -15% +5% to +20%	4 to 20
1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost w/ Detailed Takeoff	-3% to -10% +3% to +15%	5 to 100

Owner Emphasis

Notes:
a) The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.
b) If the range indice value of "1" represents .005%, then an indice value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

AACE Estimate Maturity Matrix

	ESTIMATE CLASSIFICATION				
	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
DEGREE OF PROJECT DEFINITION	0% to 2%	1% to 15%	10% to 40%	30% to 75%	70% to 100%
General Project Data:					
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:					
Block Flow Diagrams	S/P	P/C	C	C	C
Plot Plans		S/P	C	C	C
Process Flow Diagrams (PFDs)		P	C	C	C
Utility Flow Diagrams (UFDs)		S/P	C	C	C
Piping & Instrument Diagrams (P&IDs)		S/P	C	C	C
Heat & Material Balances		S/P	C	C	C
Process Equipment List		S/P	C	C	C
Utility Equipment List		S/P	C	C	C
Electrical One-Line Drawings		S/P	C	C	C

S=Started, P=Preliminary, C=Complete
(recommend leaning to the more stringent of S/P or P/C)

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Six Elements of Project Controls

Estimates By…

- An estimate completed by the contractor, owner or representative will reflect its own:
  - Standards
  - Design proficiency
  - Assessment of productivity
  - Approach to project execution
- Late check of a contractor's completed estimate can be difficult
  - May be difficult to identify / resolve differences in estimating methodology
  - If left alone, excessive recycle may be required
  - Timing may indicate acceptance of a poor product
- Proactive / early involvement can significantly upgrade estimating quality / usefulness

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Six Elements of Project Controls

Reviewing Estimates

- General
  - Primary objective – check for completeness, consistency with defined scope of work
  - Compare overall level with early in-house estimates, evaluate differences
  - Early piecemeal checks are vital
- Direct Costs
  - Spot check details using in-house methodology
  - Spot check contractor's application of previously agreed methods, data

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Reviewing Estimates

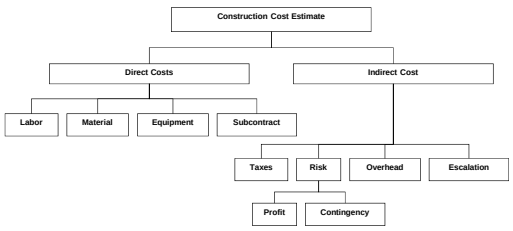
- Indirect Costs
  - Make broad gauge checks against in-house methodology
  - Percentages of direct labour are good basic guides
  - For field supervision, construction equipment
    - Review bar charts for durations and numbers
    - Check unit rates
  - Check field labour overheads against in-house methodology
  - Check contractor's engineering and fee against in-house methodology
- Add non-contractor costs, escalation, contingency and reconcile to early owner estimates

Capital Cost Elements (Typical)

Direct Costs	
Material	67.0
Labour (DFL)	25.0
Subcontracts	18.0
Subtotal – Directs	110.0
Indirect Costs	
Field OH, Burden	22.0
Temp. Const. Equipment	8.5
Subtotal – Indirects	30.5
Other Costs	
Home Office	7.0
Subtotal – Other	7.0
Total Project Costs	147.5
Non Reimbursable	1.5
As Sold Project Costs	149.0

- Direct Costs – The cost of equipment, materials, and direct hire or subcontract labour associated with construction of the permanent facility
- Indirect Costs – The cost of services and materials required in support of the field construction effort which do not contribute directly to the permanent facility. Usually consists of home office and field support costs
- Project Contingency – Historical allowance to cover development changes

Cost Estimate Structure



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Six Elements of Project Controls

Control Budget – Minimum Requirements…

- Must reflect execution plan
  - Non-detailed budgets may be sufficient to check level of lump sum bids for plants or package units
- Where minimum requirements not met…
  - Owner must develop or,
  - Assist (insist) contractor develop control budget quantities, and appropriate prices…and conduct proactive / comprehensive review

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Six Elements of Project Controls

Control Budget – Uses & Limitations

- Defines cost of scope of work in detail, reflecting:
  - Average performance
  - Specific job conditions
  - Execution plan and schedule
- Establishes basis for comparison and control:
  - Hardware quantities and manpower quantities
  - Economic climate / unit costs
  - Contractor proficiency / efficiency
- It must be available before money or man-hour expenditures are made

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Six Elements of Project Controls

The Control Budget – Summary

	Control Estimate	Changes	Current Control Estimate	Forecast	Over / Under (run)
Direct Costs					
- Material					
- Labour					
- Erection S/C					
Subtotal					
Indirect Costs					
- Engineering					
- Fees					
- Field Labour OH					
Subtotal					
Total Prime Contract					
Other Costs					
- Owner Charges					
- Other Charges					
Subtotal					
Project Contingency					
Total Project Cost					

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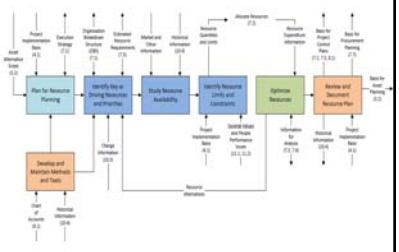
Contingency - Overview

- Purpose of contingency is frequently misunderstood. It covers development changes … as previously defined
- Historical data shows contingency usage primarily a straight line over time from effective engineering start to mechanical completion
- Change status definitions:
  - Anticipated or Potential…changes expected but not yet revealed
  - Pending Changes …in the system …not fully evaluated or not approved
  - Approved Changes …change fully evaluated, papers processed and approved
- Approved, pending and anticipated changes are all shown in both the current control estimate and the forecast

Know What Has to Be Done

- Resource Planning



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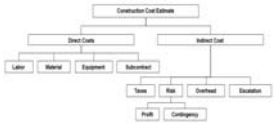
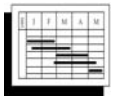
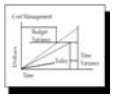
Resource Planning







- Human Resources
  - PMT; Discipline & Craft
- Equipment Planning & Utilization

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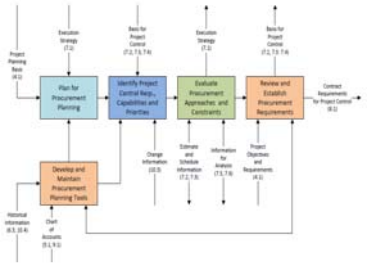
Six Elements of Project Controls

Know What Has to Be Done

- Procurement Planning



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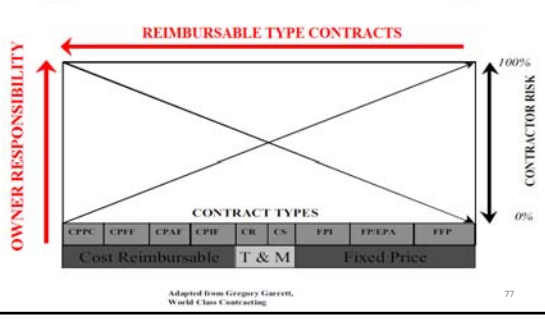
Six Elements of Project Controls

Contracts, Risk & Reporting



Adapted from Gregory Garrett, World Class Contracting

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Six Elements of Project Controls

Contracts, Risk & Reporting

- Lump Sum
  - Detailed CPM Schedule
  - Billing Report
  - Change Log & Change Orders

The decision to execute the project based on cost plus contracts increases the risk to the client.

This risk will then increase governance, auditing and reporting requirements for both the client and the contractor. These requirements will increase the need for supporting personnel…

- Cost Plus
  - Cost Reports
  - Financial Reporting
  - Time & Material Reports
  - Detailed Schedule
  - Resource Histograms
  - Productivity Charts
  - Performance Charts
  - Risk Management& Contingency Reports
  - Change Log & Change Orders

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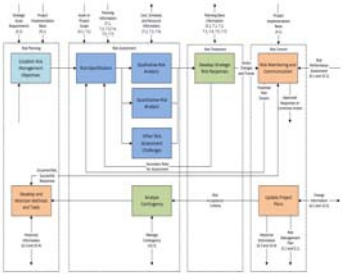
Know What Has to Be Done

- Risk Management



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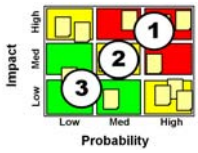
Performing qualitative and quantitative risk analysis

- From a project manager's perspective, risk analysis is part of the larger risk management process (e.g., risk identification, quantification, mitigation and control)
  - From an estimator's viewpoint, risk analysis is a process which can be used to provide management with an understanding of the probability of overrunning (under-running) a specified estimate value
- It provides a realistic view of the probabilities of completing the project for a specified cost value
- Its purpose is to improve the probability of project success (i.e., achieving IRR, being on budget)

Performing qualitative and quantitative risk analysis

- Two types of risk analysis /contingency estimating tools are recommended for use:
  - Systemic risk analysis models which evaluate the level of project definition, project and process technical complexity, etc
  - Detailed, event (project-specific) risk analysis models which evaluate project specific risk drivers and ranges of impacts for defined estimate elements

Event Risk – Define Impact



Quantitative risk analysis

- Recommended steps of performing a detailed risk analysis/contingency estimate are:
  - Identify optimistic, pessimistic, and most likely values for the element / activity
    - You may assign a probability distribution for each risk driver, i.e. triangular distribution, PERT or beta distribution
  - Break the estimate into component pieces or elements
    - Labor Costs, Productivity, Material Allowances
  - Construct a mathematical model of the estimate in order to perform a "Monte Carlo" risk analysis simulation

Contingency management plan – first, understand

- Items covered by contingency include:
  - Errors and omissions in the estimating process
  - Quantity Variability
  - Productivity Variability
  - Wage Rate Variability
  - Pricing Variability (excluding Escalation)

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Six Elements of Project Controls

Contingency management plan – first, understand

- Contingency does NOT include:
  - Significant changes in scope
  - Major (unexpected) work stoppages
  - Disasters (hurricanes, tornadoes, etc.)
  - Escalation (price trends prevailing across entire cost categories)

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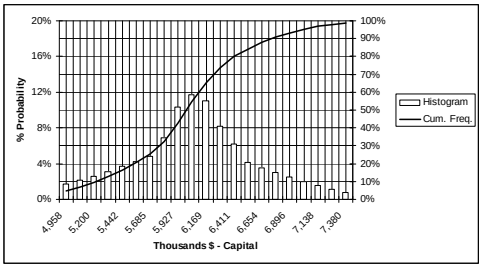
Six Elements of Project Controls

Typical Graphical Output - Cost as well as schedule



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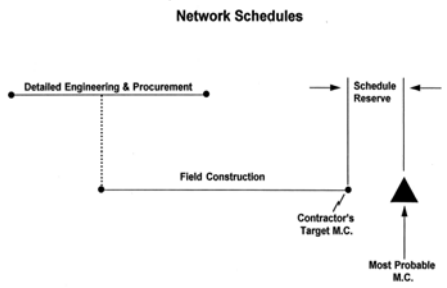
Concept of Schedule Reserve



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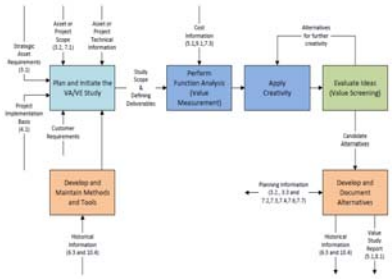
Six Elements of Project Controls

Know What Has to Be Done

- Value Engineering



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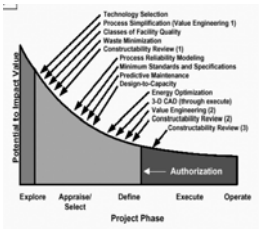
Six Elements of Project Controls

Value Engineering

- Value engineering (VE) is a systematic method to improve the "value" of goods or products and services by using an examination of function.
- Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost.

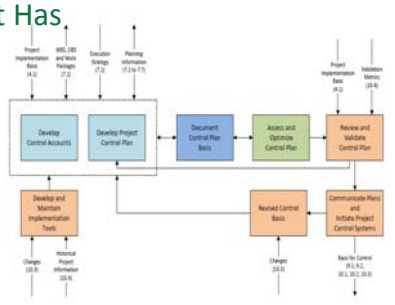


Project Controls EXPO

Six Elements of Project Controls

Know What Has to Be Done

- Project Controls Plan



TCM Framework 2nd Edition, Process Map 8.1-2

Principles of Project Controls Planning Development

- PCP Required for every project…but must be tailored to project needs and project size
- Should be realistic…constructive…objective oriented
- Conceptual document
  - No detailed procedures
  - Establishes framework for evolution of details
- Concise and usable
- Updated as project progresses through the phases
- Input and commitment from all functions

Typical Project Controls Plan

PCP typically includes:

- Introduction / executive summary
- Objectives / priorities / philosophy
- Definition of roles / responsibilities
- Critical Issues
- Performance Baselines & Measurement/Assessment
- Change Management & Forecasting
- Contracting plan (as required)
- Project background information

AACE International
RP No. 60R-10
DEVELOPING THE PROJECT CONTROLS PLAN

Supporting Information

The following is a list of procedures that may be developed to support the use and implementation of the project controls plan.

- Team development procedure
- WBS development procedure
- Project control account development procedure
- Estimate and budget development procedure
- Schedule development and management procedure
- Cost management procedure
- Change management procedure
- Progress measurement procedure
- Performance assessment procedure
- Forecasting procedure
- Purchasing / contract administration procedure
- Glossary of terms, acronyms and formulas
- Risk management procedure
- Value improving practices (VIP) procedure
- Accounting and invoicing procedure
- Financial stewardship procedure
- Contingency management procedure
- Claims and dispute resolution procedure
- Project closeout procedure
- Historical data collection and benchmarking procedure
- Communication procedure
- Systems integration procedure
- Audit / compliance procedure

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Know What Has Been Done!

… identify actual performance data consistent with the detailed budget and schedule… and in timely fashion

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Six Elements of Project Controls

Know What Has Been Done

- Derived from reports…supplemented by project documents and interaction with project personal
- Sources include:
  - Timesheets
  - Purchase orders, work orders
  - Engineering / field man-hour reports
  - Progress curves
  - Sampling reports
- Reports must be timely, accurate, complete

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Six Elements of Project Controls

Know What Has Been Done – Decision Usefulness

- Relevant…predictive feedback (EAC)…feedback value (Variance analysis)…timely (weekly, monthly)
- Reliability… verifiable (access to data)…valid (system integration)…neutral (Objective data)
- Must…have comparability & consistency (for pattern recognition)…be accurate and complete
- Communicate issues and concerns to project team and senior management

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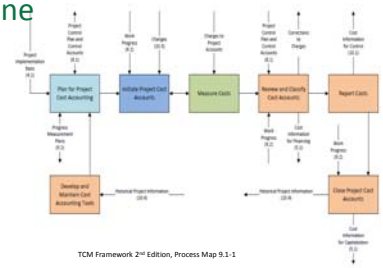
Output Measurement Required For

- Billing / Costs
  - Paid Costs for Physical Progress
- Scheduling
  - Activity Completion & Actual Percent Complete
- Progress
  - Work Accomplished
  - Complete Productivity = Input / Output

Know What Has Been Done

- Project Cost Accounting



TCM Framework 2nd Edition, Process Map 9.1-1

Project Cost Accounting

What is "Project" Cost Accounting?

- The historical reporting of disbursements, costs and expenditures on a project.
- Every business enterprise has an established approach for classifying and summarizing costs that are organized around their business practices
- 3 basic steps: recording, classifying and summarizing cost element data in terms of money expended with time.

Cost Management

1. Cost Development (Project Set up)
   a) Cost Types: Labor, Material, Equipment
   b) Cost Structures: Direct & Indirect Costs, Fixed and Variable Costs
   c) Project Structures: WBS, OBS, Code of Accounts
2. Cost Control
   a) Forecasting, Change Management
   b) Performance, Variances & Analysis
   c) Reporting

Coding Structures

A company's control accounts is configured to support the execution of the project, and may provide the recording of cost data in the general ledger.

Regardless of how cost elements are classified and grouped, it is important that this is done in a manner that is consistent with the way "future work" is established and budgeted.

Cost Development and Project Set Up: Cost Types

Cost is the value of an activity or asset

… Determined by the required resources to complete the activity or asset

- Labor
- Material
- Equipment

- Subcontracts
  - Labor
  - Material
  - Equipment

Category	Cost Element
Materials	drafting paper/pencil, concrete, nails, lumber, deck screws, paint, brushes, drop cloth
Labor	draw plans, get permit, get materials, construct footings, erect deck, paint deck, wife's support for making lunch
Other	building permit fee, use of house to draw plans, shovel, power saw, power drill, electricity, pickup truck, gasoline

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Six Elements of Project Controls

Control Accounts (Example)

100A965 — Project ID

100 — Area Code

91201 — CA

Cost Category

Codes can used as identifiers for client coding or WBS coding requirements

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Six Elements of Project Controls

WBS , OBS & CBS Matrix

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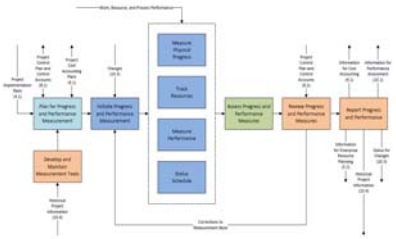
Project Controls EXPO

Six Elements of Project Controls

Know What Has Been Done

- Progress & Performance Measurement



TCM Framework 2nd Edition, Process Map 9.2-1

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Schedule & Resource Management

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Schedule – Status

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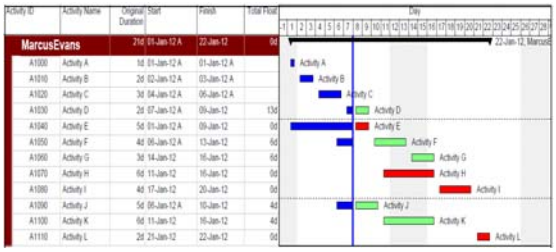
Schedule – Status



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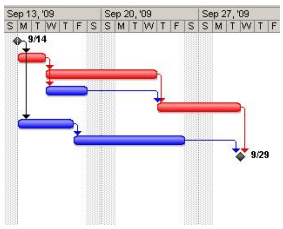
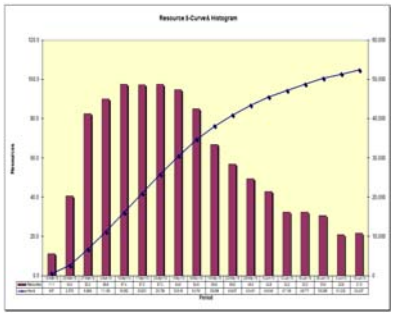
Schedule – Percent Complete



Use the schedule to determine activity percent complete:

- Ensure the schedule is resource loaded so that the proper weighting is assigned to the activity
- A defined process for determining activity percent complete will be required in order to ensure consistency in monitoring progress.

Histogram



Measure Physical Progress

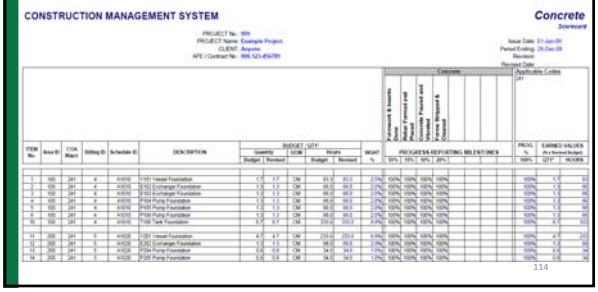
Progress Measurement

- Progress Measurement determines the degree of completion or status of project work packages or deliverables (e.g., the extent that materials have been installed, deliverables completed, or milestones achieved)
- Allows observations of how work is being performed (e.g., work sampling) for the Engineering, Procurement and Construction (Execution) Stages of the project
- Progress against each of the planned work packages or deliverables is measured to support earned value analysis and forecasting and allow for the actual work completed to be compared against planned performance

Six Methods to Measure Physical Work Accomplished

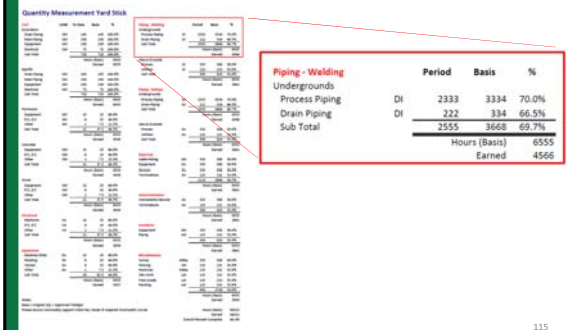
- Units Complete
- Incremental Milestones
- Start / Finish
- Supervisor Opinion
- Cost Ratio
- Equivalent Units

Scorecard – Earning Rules


CONSTRUCTION MANAGEMENT SYSTEM

Concrete
Scorecard

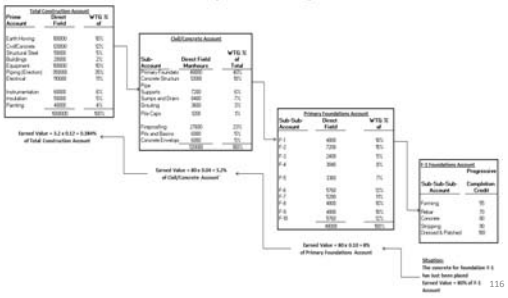
Quantity Based Progress – Pipe Welding



Piping - Welding		Period	Basis	%
Undergrounds				
Process Piping	DI	2333	3334	70.0%
Drain Piping	DI	222	334	66.5%
Sub Total		2555	3668	69.7%
			Hours (Basis)	6555
			Earned	4566

Cascading of project information

Physical Progress



Recap…

- Control basis…prepare Class II Estimate and recast to work breakdown structure and code of accounts…or use contractor prepared estimate after review
- Maintain control budget current via change order system
- Use during engineering and procurement plus initial field activities to monitor actual performance
- Replace with QAB for field control as final design quantities emerge

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Know How Actual Performance Compares with Performance Norms

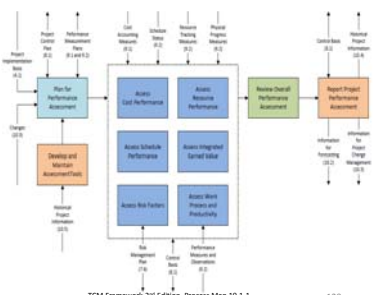
… analysis of the performance to date

Know How Performance Compares with Performance Norms

- Analysis is the starting point for control… simply reporting results is not enough… and reporting alone is not control
- Data sources for analysis include:
  - Current control estimate
  - Performance patterns
  - Full range of reported information (actual performance to date)
- Three analysis steps:
  - Compare actual with expected performance, accounting for normal project performance patterns
  - Where significant deviations exist, find out why
  - Explore corrective action alternatives with PMT
- Analysis ongoing throughout project life

Know How Actual Performance Compares

- Project Performance Assessment



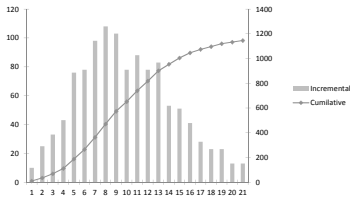
TCM Framework 2nd Edition, Process Map 10.1-1

Budget At Completion – Original Estimate

Area 1 – Contractor A

Cost Element	BAC	EAC	VAC	Planned To Date	Earned To Date	Actual To Date
Civil / Site Prep	$375,000	$375,000	$0	$0	$0	$0
Concrete	$1,925,000	$1,925,000	$0	$0	$0	$0
Structural Steel	$1,837,500	$1,837,500	$0	$0	$0	$0
Buildings	$1,260,000	$1,260,000	$0	$0	$0	$0
Equipment	$1,260,000	$1,260,000	$0	$0	$0	$0
Piping	$582,500	$582,500	$0	$0	$0	$0
Electrical	$337,500	$337,500	$0	$0	$0	$0
Instrumentation	$30,000	$30,000	$0	$0	$0	$0
Coatings	$95,630	$95,630	$0	$0	$0	$0
Sub Total Costs	**$7,703,130**	**$7,703,130**	**$0**	**$0**	**$0**	**$0**
Construction Indirects	$97,365	$97,365	$0	$0	$0	$0
Engineering Costs	$138,500	$138,500	$0	$0	$0	$0
Owner Costs	$10,190	$10,190	$165	$0	$0	$0
Total Funded Costs	**$7,949,185**	**$7,949,185**	**$165**	**$0**	**$0**	**$0**

Budget At Completion – Original Estimate



Measure, Review, Classify, and Account Costs

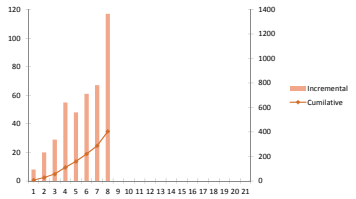
- The project control function regularly checks that the costs recorded by the accounting process are appropriate.
  - Cost data are commonly miscoded, misfiled, improperly invoiced, or otherwise mischarged.
  - Work may have been completed or materials received, but not yet invoiced; project control must review progress measurements to determine if costs have been incurred.

Actuals To Date

Area 1 – Contractor A

Cost Element	BAC	EAC	VAC	Planned To Date	Earned To Date	Actual To Date
Civil / Site Prep	$375,000	$375,000	$0	$37,500	$0	$40,000
Concrete	$1,925,000	$1,925,000	$0	$192,500	$0	$201,500
Structural Steel	$1,837,500	$1,837,500	$0	$183,750	$0	$184,000
Buildings	$1,260,000	$1,260,000	$0	$96,000	$0	$104,000
Equipment	$1,260,000	$1,260,000	$0	$25,000	$0	$19,700
Piping	$582,500	$582,500	$0	$22,500	$0	$27,500
Electrical	$337,500	$337,500	$0	$18,050	$0	$31,500
Instrumentation	$30,000	$30,000	$0	$500	$0	$480
Coatings	$95,630	$95,630	$0	$0	$0	$0
Sub Total Costs	**$7,703,130**	**$7,703,130**	**$0**	**$575,800**	**$0**	**$608,680**
Construction Indirects	$97,365	$97,365	$0	$89,576	$0	$95,000
Engineering Costs	$138,500	$138,500	$0	$138,500	$0	**$154,275**
Owner Costs	$10,190	$10,190	$0	$7,025	$0	$7,025
Total Funded Costs	**$7,949,185**	**$7,949,185**	**$0**	**$810,901**	**$0**	**$864,980**

Actuals To Date



The credibility of capturing costs

- Ensure the proper coding of all actual costs
  - Establish preambles (definitions) around who can charge, what can be charged, and what can't be charged
- Minimize having an exhaustive coding structure; simple is best…
- For personnel, lock the system down - only allow personnel to charge to their assigned codes
- Train individuals (from Supply Chain Mgmt, Engineering / Constructor Firms to internal personnel)
- Ensure the codes for capturing cost are appropriate for your project

Resource Performance

Three Aspects:

- The performance of the resources of worked accomplished
- The type of personnel (direct, vs. indirect vs. overhead)
- The cost and price of the resource

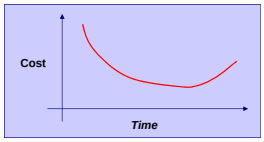
Preventing project cost overruns by establishing cost trending analysis

Use Cost Trending…

In this particular case, cost trending is not considered "Trend Management" in terms of engineering.

Look at pattern recognition!!!

Smiley Curves



Resource Performance – Cost Trending

- Cost trends are established from historical cost accounting information (project):
- May focus on how expenditures are trending relative to physical accomplishments.
- *"How much are we spending for pipefitters and how much piping has been installed during the last six months?"*

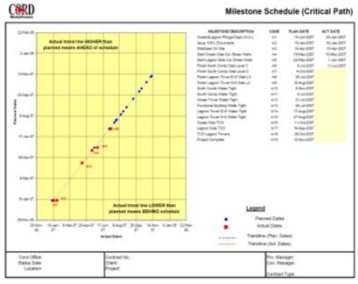
Unit Rates & Overtime

- There are many different overtime wage situations and there are several aspects that need to be evaluated in developing an overtime wage structure.
- Overtime can range from straight time pay for additional hours beyond the standard workweek of 40 hours or 8 hours per day; to 1.5 and 2.0 time regular pay.
- "When developing the overtime formula the estimator needs to take into account the overtime requirements of the project"

Comparing baseline schedules vs. Actual – *the comparison*

Activity ID	Activity Name	Original Duration	BL Start	Current Start	BL Finish	Finish	Total Float	Variance -Start Dates	Variance -Finish Dates
A1000	Activity A	1d	01-Jan-12	01-Jan-12	01-Jan-12	01-Jan-12		0	0
A1010	Activity B	2d	02-Jan-12	02-Jan-12	03-Jan-12	03-Jan-12		0	0
A1020	Activity C	3d	04-Jan-12	04-Jan-12	06-Jan-12	06-Jan-12		0	0
A1030	Activity D	2d	07-Jan-12	07-Jan-12	08-Jan-12	09-Jan-12	13d	0	-1
A1040	Activity E	5d	01-Jan-12	01-Jan-12	05-Jan-12	09-Jan-12	0d	0	-4
A1050	Activity F	4d	06-Jan-12	06-Jan-12	09-Jan-12	13-Jan-12	6d	0	-4
A1060	Activity G	3d	10-Jan-12	14-Jan-12	12-Jan-12	16-Jan-12	6d	-4	-4
A1070	Activity H	6d	07-Jan-12	11-Jan-12	12-Jan-12	16-Jan-12	0d	-4	-4
A1080	Activity I	4d	13-Jan-12	17-Jan-12	16-Jan-12	20-Jan-12	0d	-4	-4
A1090	Activity J	5d	06-Jan-12	06-Jan-12	10-Jan-12	10-Jan-12	4d	0	0
A1100	Activity K	6d	11-Jan-12	11-Jan-12	16-Jan-12	16-Jan-12	4d	0	0
A1110	Activity L	2d	17-Jan-12	21-Jan-12	18-Jan-12	22-Jan-12	0d	-4	-4

Managing project deliverables and milestones effectively



Schedule Metrics and TF

- TF > 0
  - SPI > 1.0—ahead of schedule on critical path; more work being done than planned
  - SPI = 1.0—ahead of schedule on critical path; some shortfall in work on non-critical activities
  - SPI < 1.0—ahead of schedule on critical path; significant shortfall in work on non-critical activities
- TF = 0
  - SPI > 1.0—critical path on schedule; more work being done on non-critical activities
  - SPI = 1.0—critical path on schedule; total work volume is as planned
  - SPI < 1.0—critical path on schedule; shortfall in work on non-critical activities
- TF < 0
  - SPI > 1.0—critical path activities behind schedule; total work more than planned indicating excess attention to non-critical activities
  - SPI = 1.0—critical path activities behind schedule; total work volume as planned meaning too much attention to non-critical activities
  - SPI < 1.0—critical path activities behind schedule; total work less than planned; need more overall effort

Please remember, SPI cannot determine if your project is behind or ahead of schedule. SPI can only provide an indication that your project has not accomplished the cumulative value as per the planned value.

Use CPM to determine schedule completion.

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Productivity Assessment

- Two types of assessment:
  - Performance (Discipline)
  - Productivity (Commodity)
- The performance / productivity values may not be indicative of final outcome.
  - If the estimate is incorrect, the basis for calculation may be off…. Look at pattern recognition, upward and downward trends (performance improvement vs. decay).
- For long duration projects, you may want to use moving averages vs. cumulative values.
- Remember, you don't have much time, get true performance early…

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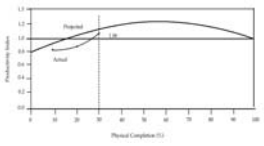
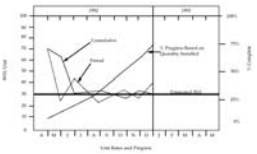
Discipline Performance Trend Chart

Construction Performance	Engineering Performance
• Carpenters • Ironworkers • Boilermakers • Instrument Techs • Welders • Electricians • Insulators	• Civil Engineers • Structural Engineers • Piping Draftsman • Instrument Engineers • Mechanical Engineers • Electrical Engineers
Examples	
Earned Work-hours / Actual Work-hours	Earned Work-hours / Actual Work-hours



Commodity Productivity Trend Chart

Construction Productivity	Engineering Productivity
• Concrete • Structural Steel • Piping • Instrumentation • Equipment • Electrical • Insulation	• Concrete • Structural Steel • Piping • Instrumentation • Equipment • Electrical
Examples	
Work-hours / Qty Installed	Design-hours / IFC Quantity



Performance Data Analysis Review – Earned Value

Earned To Date

Area 1 – Contractor A

Cost Element	BAC	EAC	VAC	Planned To Date	Earned To Date	Actual To Date
Civil / Site Prep	$375,000	$375,000	$0	$37,500	$37,500	$40,000
Concrete	$1,925,000	$1,925,000	$0	$192,500	$192,500	$201,500
Structural Steel	$1,837,500	$1,837,500	$0	$183,750	$183,750	$184,000
Buildings	$1,260,000	$1,260,000	$0	$96,000	$87,950	$104,000
Equipment	$1,260,000	$1,260,000	$0	$25,000	$21,000	$19,700
Piping	$582,500	$582,500	$0	$22,500	$19,575	$27,500
Electrical	$337,500	$337,500	$0	$18,050	$18,000	$31,500
Instrumentation	$30,000	$30,000	$0	$500	$385	$480
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Construction Indirects	$97,365	$97,365	$0	$89,576	$89,576	$95,000
Engineering Costs	$138,500	$138,500	$0	$138,500	$138,500	**$154,275**
Owner Costs	$10,190	$10,190	$0	$7,025	$7,025	$7,025
Total Funded Costs	**$7,949,185**	**$7,949,185**	**$0**	**$810,901**	**$795,761**	**$864,980**

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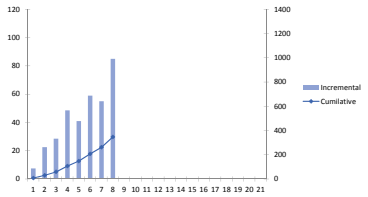
Earned To Date



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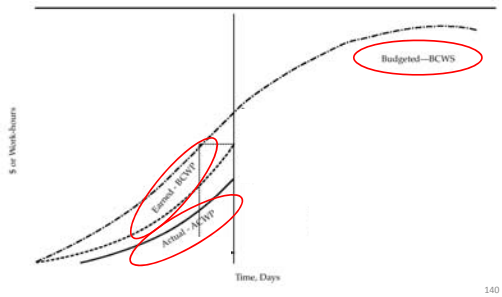
Earned Value Metrics - Variances



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Earned Value Metrics – Variances & Ratios

- Cost Variance / Cost Ratio
- Schedule Variance / Schedule Ratio

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Cost Variance & Variance %

- CV is the Difference between Earned Work hours and Actual Work hours
  - CV = BCWP – ACWP or EV – AC
  - CV > 0 is Good Performance (favorable)
- CV is the percentage between Earned Work hours and Actual Work hours
  - CV % = (BCWP – ACWP) / BCWP
    - or (EV – AC) / EV
  - Positive Value = Good Performance (favorable)

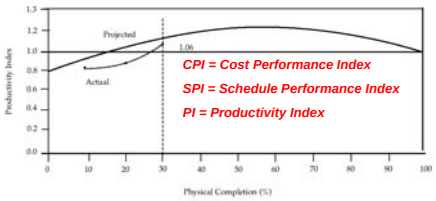
Schedule Variance & Variance %

- SV is the Difference between Earned Work hours and Scheduled Work hours
  - SV = BCWP – BCWS or EV – PV
  - SV > 0 is Good Performance (favorable)
- SV % is the percentage between Earned Work hours and Scheduled Work hours
  - SV % = (BCWP – BCWS) / BCWP
    - or (EV – PV) / EV
  - Positive Value = Good Performance (favorable)

Cost & Schedule Ratios

- Cost Performance Index (CPI)
  - CPI is the Ratio of Earned Work hours to Actual Work hours
    - ✓ CPI = BCWP / ACWP or EV / AC
    - ✓ CPI > 1.00 is Good Performance (favorable)
- Schedule Performance Index (SPI)
  - SPI is the Ratio of Earned Work hours for Scheduled Work hours
    - ✓ SPI = BCWP / BCWS or EV / PV
    - ✓ SPI > 1.00 is Good Performance (favorable)

Performance Metrics - Ratios



CPI = Cost Performance Index

SPI = Schedule Performance Index

PI = Productivity Index

EAC Calculation Method(s)

The Estimate At Completion value can be defined as "the forecasting of total project costs".

- EAC_1 = AC + BAC - EV
- EAC_2 = BAC / CPI
- EAC_3 = BAC / SPI
- EAC_4 = AC + [(BAC – EV) / CPI]
- EAC_5 = AC + [(BAC – EV) / SPI]
- EAC_6 = AC + [(BAC – EV) / (CPI x SPI)]
- EAC_7 = AC + (BAC – EV) / [(w1 x CPI) + (w2 x SPI)]
- EAC_8 = Extrapolation (experience, review of project data)

Estimate At Completion (EAC)

Area 1 – Contractor A

Cost Element	BAC	EAC	VAC	Planned To Date	Earned To Date	Actual To Date
Civil / Site Prep	$375,000	$40,000	**($2,500)**	$37,500	$37,500	$40,000
Concrete	$1,925,000	$201,500	**($9,000)**	$192,500	$192,500	$201,500
Structural Steel	$1,837,500	$184,000	**($250)**	$183,750	$183,750	$184,000
Buildings	$1,260,000	$114,000	$12,000	$96,000	$87,950	$104,000
Equipment	$1,260,000	$127,500	**($1,500)**	$25,000	$21,000	$19,700
Piping	$582,500	$71,000	**($12,750)**	$22,500	$19,575	$27,500
Electrical	$337,500	$31,500	$2,250	$18,050	$18,000	$31,500
Instrumentation	$30,000	$2,500	$500	$500	$385	$480
Coatings	$95,630	$12,000	**($2,438)**	$0	$0	$0
Sub Total Costs	**$7,703,130**	**$784,000**	**($13,688)**	**$575,800**	**$560,660**	**$608,680**
Construction Indirects	$97,365	**$102,515**	**($5,150)**	$89,576	$89,576	$95,000
Engineering Costs	$138,500	**$154,275**	**($15,775)**	$138,500	$138,500	**$154,275**
Owner Costs	$10,190	$10,025	$165	$7,025	$7,025	$7,025
Total Funded Costs	**$1,016,368**	**$1,050,815**	**($34,448)**	**$810,901**	**$795,761**	**$864,980**

Five steps to ensure consistency in measuring and assessing performance

1. Establish clear terms of governance for the application of progress & performance monitoring of the project.
2. Develop clear monitoring methodologies or frameworks
3. Provide project teams with easy-to-use tools and templates that will ensure consistency of project monitoring.
4. Train employees in project monitoring so they know how to apply the project monitoring methodology, tools and templates.
5. Management to oversee the project to make sure the project monitoring framework, templates and tools are being used consistently.

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Know What Remains To Be Done!

… forecast the potential result

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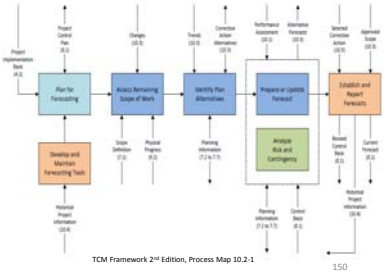
Know What Remains To Be Done

- Forecasting



TCM Framework 2nd Edition, Process Map 10.2-1

Analysis is the Key to Forecasting & Control

- Analysis…comparing actual performance with control budget
- Forecasting…determining what remains to be done
  - → which leads to control…
    - → which leads to identifying and implementing corrective action

Analysis is the Key to Forecasting & Control

- This sequence will be:
  - Engineering
  - Equipment
  - Bulk Materials
  - Field Labour
  - Field Labour Overheads
  - Erection subcontractors
  - Contingency
- Principles are general…can be applied (and are valid) for any size project

Overview of Analysis / Forecasting / Control

- Data sources - Budgets
  - Project control budget (original / adjusted)
  - Historical tracking profiles (performance norms)
- Data Sources – Actuals
  - Project reports & supporting material
  - Schedule Work Accomplished / Progress
- Data to be Analyzed
  - Progress…% complete
  - Human resources…man-hours (engineering / field)
  - Quantities… cm of concrete
  - Costs…equipment, $ / mh

Overview of Analysis / Forecasting / Control

- Analytical techniques
  - Direct comparison…equipment
  - Sampling…bulks
  - Trend charts…field indirects
- Forecasting mechanisms
  - Trend analysis
  - Independent assessments
- Forecasting
  - Original Work vs. Change Management
  - Contingency forecasting

Schedule Forecasting

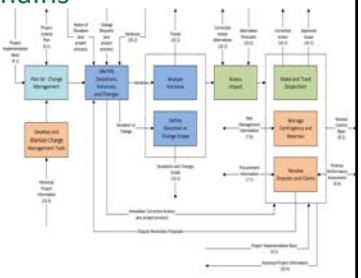
- Perspectives - two levels ... mechanical completion of overall project and milestone(s) completions
  - Mechanical completion ... Client's focus
  - Milestone(s) completion ... PMT's focus ... timely milestone completions lead to timely mechanical completion
- Forecast basis - same ingredients for overall project and milestones ... latest trend analysis for progress, manpower productivity, changes, and status of material deliveries

Schedule Forecasting

- Iterative process
  - Initial schedule based on "trends continue"
  - Later revisions refine initial schedule with
  - Analysis of deviations between planned and actual events
  - Results of recovery plans
- Date for mechanical completion changes less frequently than total cost forecast
  - For milestone schedules, updates more frequent as project nears milestone

Know What Remains To Be Done

- Change Management



TCM Framework 2nd Edition, Process Map 10.3-1

Change Management

- The control estimate and schedule must always represent the current approved scope of work
- As the project progresses in execution, decisions are made which modify the job
- Modifications, additions and deletions are all changes and must be introduced to adjust the control estimate and schedule
- Change orders provide the mechanism for adjusting the control estimate and schedule

Note: Changes are the vehicle to get lump sum job discipline on a reimbursable cost job

Types of Changes

- Three broad categories
  - Scope and basis
  - Transfer of work
  - Development (design, execution, estimating)
- Project scope and basis changes are not covered by the project contingency
- Transfers of work
  - Within overall appropriation…so no growth in overall project costs
  - If not funded as part of the project, it's not a transfer
  - Project Contingency does not cover unappropriated transfers for work

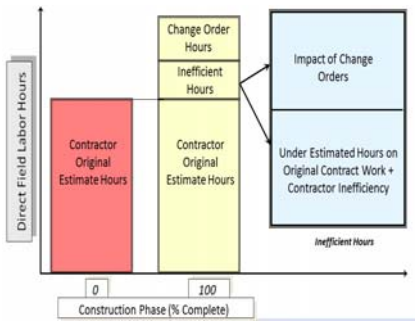
Change Control

- Changes (ex scope / basis and transfers) tracked against contingency rundown…signals deviation from expected project performance
- Control requires discipline and dedication from all parties
- Reporting of all activities that could be a change is vital to forecasting, whether eventually processed as a change or not
- Seek to limit changes to needed items…minimizing nice to have (scope creep)

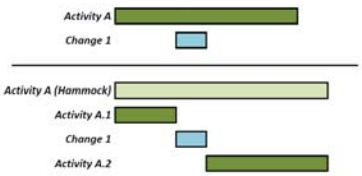
Change Control

- Changes are disruptive whenever they occur, but the consequences of the impact becomes more severe later in the project
  - Moral of the story: if a change must be processed, do it earlier rather than later
- If a high level of changes occurs, the cumulative impact could be very severe… and loss of control is possible

Analyzing the impact of change



Change Control: Schedule

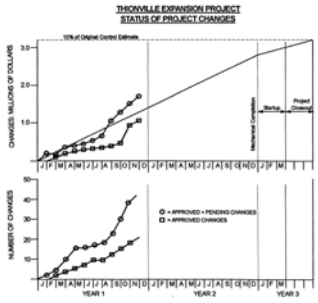


Contingency & Reserve

Contingency - Analysis

- All pending and approved changes categorized, valued, recorded in the change log – contractor maintains and PCS reviews – contractor issues monthly
- Update to replace order of magnitude estimates with preliminary and then reviewed estimate
- PCS maintains separate log on anticipated changes
- PCS tracks changes against contingency "usage"
- Contingency usage curve runs from Class II level to MC (allowing for post MC startup changes)

Change Tracking vs. Contingency



Contingency – Forecasting ($)

- Contingency forecasting …predetermined value depending on time
- Expressed as a % of the project cost …applied to forecast and current control estimate
- Resist temptation / pressure to drawn down contingency more rapidly to compensate for high level of early changes

Contingency – Forecasting (t)

- Timing - re-forecast most probable completion, roughly at:
  - 40-50% engineering (effective field start)
  - 75-85% engineering (15-25% construction)
  - 50% construction (95% engineering)
  - 75% construction (early turnover)
  - 90% construction (50% start-up team's work)
- Assess schedule reserve ... process is subjective, dependent perspective of contractor's performance
  - As a check, until 75% completion in construction, schedule reserve rule-of-thumb is 7% of remaining span

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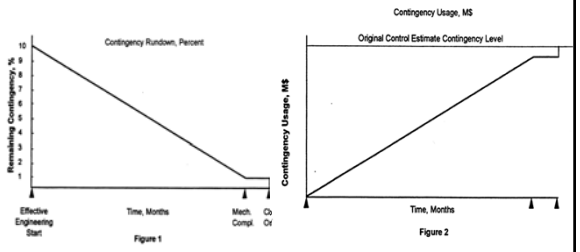
Contingency Rundown vs. Usage



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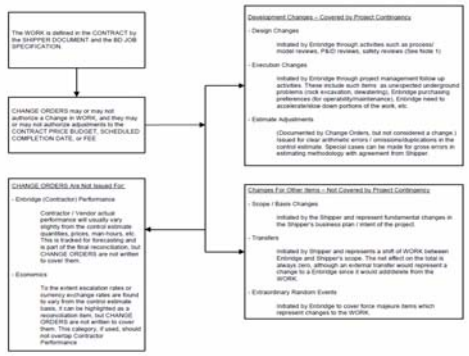

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Identify and implement corrective actions to bring performance in line with expectations

… recovery planning and control

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Variance At Completion – Example Report

Area 1 – Contractor A

Cost Element	BAC	EAC	VAC	Planned To Date	Earned To Date	Actual To Date
Civil / Site Prep	$375,000	$40,000	**($2,500)**	$37,500	$37,500	$40,000
Concrete	$1,925,000	$201,500	**($9,000)**	$192,500	$192,500	$201,500
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Coatings	$95,630	$12,000	**($2,438)**	$0	$0	$0
Sub Total Costs	**$7,703,130**	**$784,000**	**($13,688)**	**$575,800**	**$560,660**	**$608,680**
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Total Funded Costs	**$1,016,368**	**$1,050,815**	**($34,448)**	**$810,901**	**$795,761**	**$864,980**

Identify and implement corrective actions to bring performance in line with expectations

- Ensure the identification of adverse / favorable trends from analysis
- Advise project manager / construction manager… work with team to establish reasons and corrective / enhancement actions…ensure contractor provides recovery planning where necessary
- Provide support to PM / CM in promoting corrective actions
- Feedback helps to improve future budgets / performance norms

Open Discussion

What corrective actions would you put in place for a project that is running over budget and behind schedule?

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Check results of corrective action

... verify

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Project Controls EXPO

Six Elements of Project Controls

Check results of corrective action

- When corrective / enhancement actions instituted, Project Controls follows up to assess results as they become available
- Re-establish the element of control, specifically, know what has been done, know how actual performance compares to the performance norms and corrective actions, and know what remains to be done

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Six Elements of Project Controls

Identify Corrective Actions

- Identify adverse / favorable trends from analysis
- Advise… work with PMT to establish reasons and corrective / enhancement actions
- Provide support to PMT in promoting corrective action
- When corrective / enhancement actions instituted, follow up with PMT / contractor to assess results as they become available
- Feedback helps to improve future budgets / performance norms

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In Closing

The Application of the Six Elements of Project Controls

- Grasp the critical importance of the six elements of project control by:
  - Setting the scene for project delivery by understanding the requirements for development and control
  - Comprehending the different elements and their purpose
  - Gaining awareness of the standards of project controls

Project Controls Activities

- Review contractor's project control capabilities and interview key controls personnel (before contract award)
- Review and upgrade contractor's control procedures/systems (where necessary… determine deficiencies)
- Monitor quality of contractor's project personnel and their work
- Instill a cost/schedule consciousness in contractor / Owner
- Constantly search for ways to maintain/improve project cost/schedule
- Prepare cost schedule reports/forecasts
- Administer change order system

Project Controls Activities

- Interface with in-house financial controls personnel
- Interface with home office for feedback
- Assist other Owner areas with forecasts for non-prime contract work (as needed)

Requirements for Effective Control

- Positive/supportive management attitude
- Cost/schedule conscious PM Team … Complacency is the most serious detriment to effective control
- Adequately staffed contractor control organization reporting to contractor's PM … staffed by skilled practitioners … using proven systems/procedures - upgrade as necessary
- Proper tools … control budget … schedule … performance norms … appropriate manuals and systems
- Follow-up of corrective actions

More Proactive Participation…

- If (when) contractor's shortcomings become evident … PMT may have to take a more proactive role
- Rather than let a job fail … it may be necessary to become directly involved in
  - Technical analysis
  - Project forecasting/controls
  - Subcontracting and administration

Lessons Learned

- Plan the work
  - Get organized
  - PCP / PEP before the AFE
  - Estimates/schedules
- Then work the plan
- Track and control changes early
  - Inputs from operations/project team
  - Monitor and communicate
- Check procedures ... Reduce words and improve clarity

Lessons Learned

- Don't commit funds (spend money) without a budget check
- Develop/track key project parameters
  - Identify deviations and causes
  - How to correct the problem
  - Monitor to verify effectiveness
  - Forecast impact on project cost/schedule
- Include allowances in estimates/forecasts where needed for most probable cost/schedule
  - Based on past performance/historical data
  - Rundown as key milestones occur or according to progress

Lessons Learned

- Tailor data gathering/analysis to project size /contract type
  - Summary level when feasible
  - Expand detail where problem identified
- Get information to monitor from contractor / subcontractors
  - Manhour/progress/productivity data
  - Make sure requirements are clear in contract(s)
- Check contractor forecasts before accepting them
  - Reluctant to forecast
  - Too optimistic

Lessons Learned

- Simplify data collection / analysis
- Keep final cost data … analysis of feedback expands our historical database
- Control (corrective actions) follow naturally
  - Once the problem is identified, and
  - If early enough to be corrected

Thank You!!!!

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