



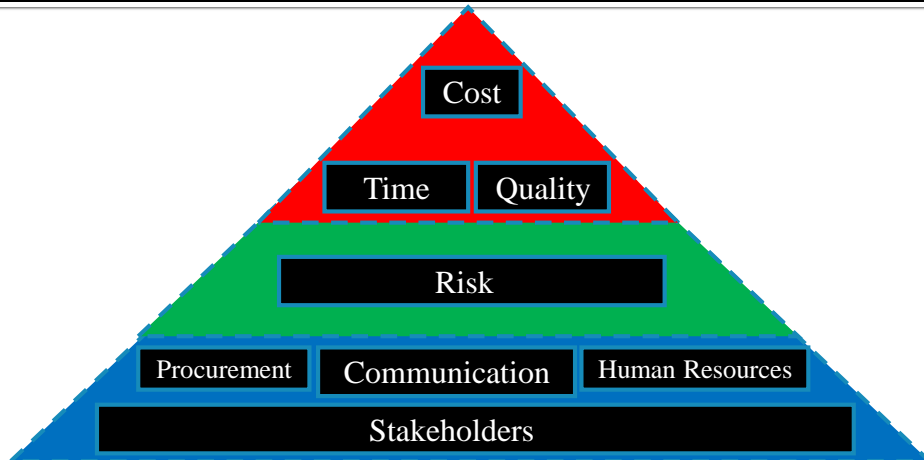
Construction Quality Control & Site Inspection

By
Prof. Karim El-Dash



Project Context

Project Management



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A Project Output



A project is a temporary endeavor undertaken to create a unique



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What Is Project Management?



Project Management is the application of knowledge, skills, tools, and techniques to project activities to meet project **requirements**.

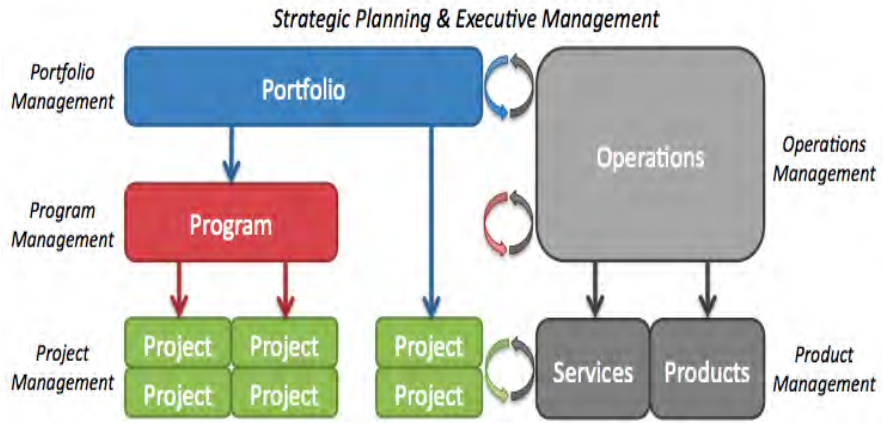
Project Management Process Groups



1. Initiating
2. Planning
3. Executing
4. Monitoring & controlling
5. Closing



Projects & Products

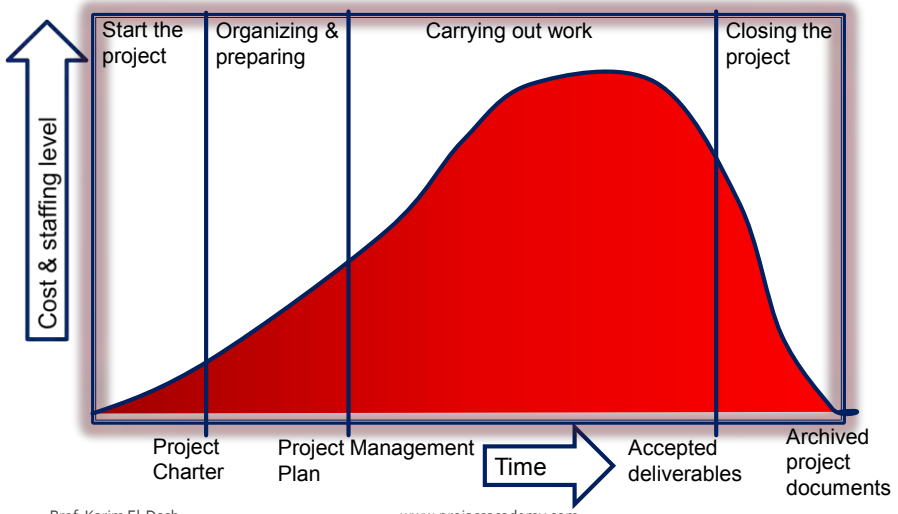


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Cost & staffing levels across PLC

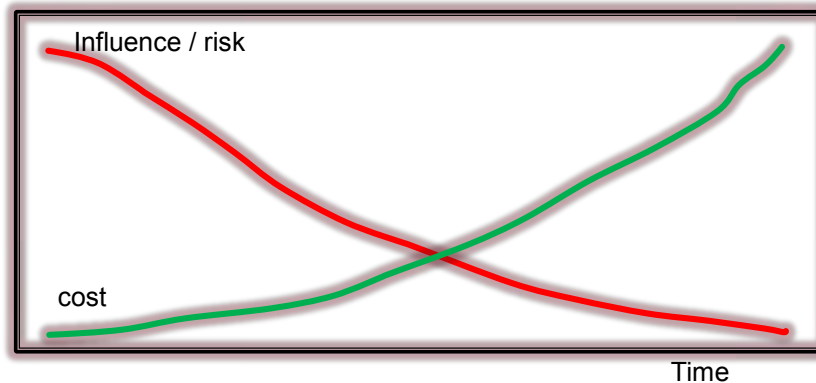


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Impact of variables based on project time



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Project Statement of Work



- Is a narrative description of products or services to be delivered by the project
- For internal projects, the project **sponsor** provides the statement of work
- For external projects, the statement of work **can be received from the customer** as part of a bid document

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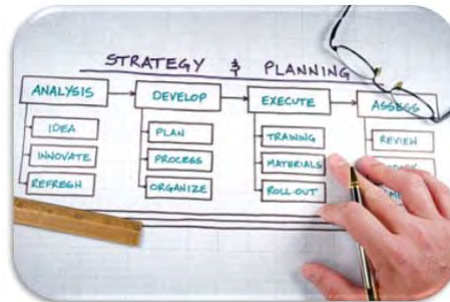
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Develop Project Management Plan



- The project management plan is the process of documenting the actions necessary to **define, prepare, integrate, and coordinate** all subsidiary plans.
- How project will be executed?
- How changes will be monitored and controlled?



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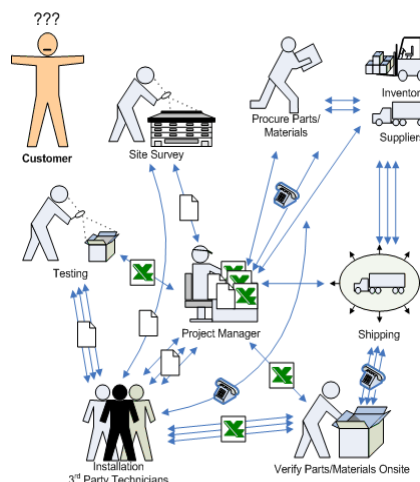
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Direct & Manage Project Work



- Perform activities
- **Create deliverables**
- Staff, train, and manage
- **Manage and use resources**
- Implement the planned methods and standards
- **Establish and manage project communication channels**



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Scope Management Plan



How the scope will be defined, developed, monitored, controlled, and verified.

1. Preparing scope statement
2. Enable creation of WBS
3. Specify how formal acceptance will be obtained
4. Control processing of change requests

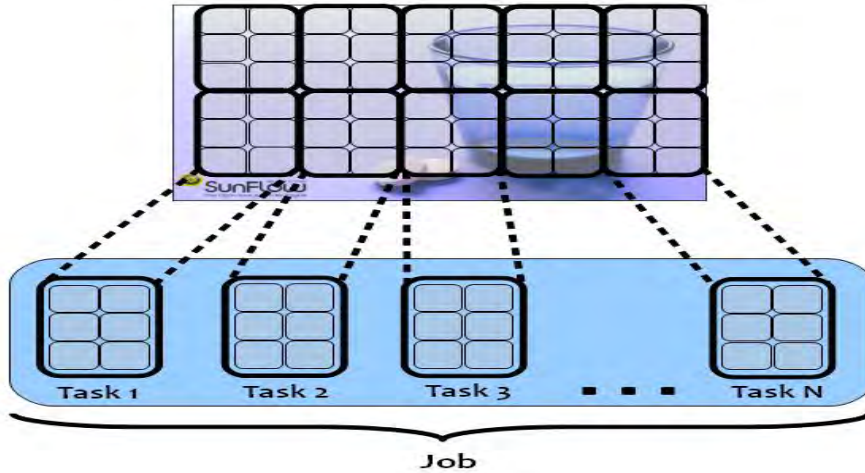
Requirements Management Plan



How requirements will be analyzed, documented, and managed.

1. Requirements activities planned, tracked, reported.
2. Configuration management activities
3. Prioritization
4. Metrics
5. Traceability structure

Decomposition - 100% Rule

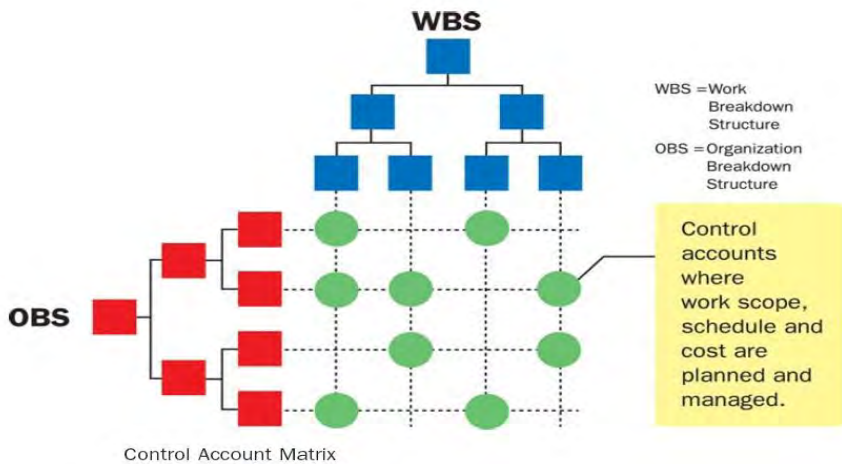


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WBS vs. OBS

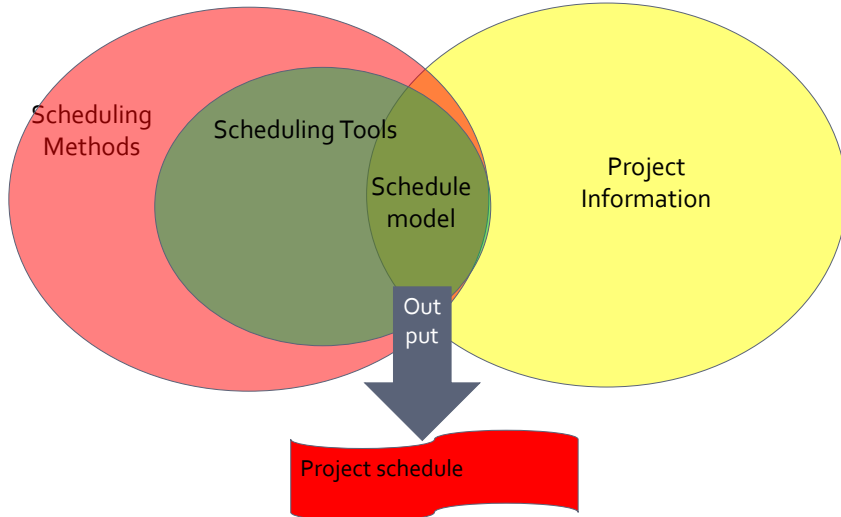


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Scheduling

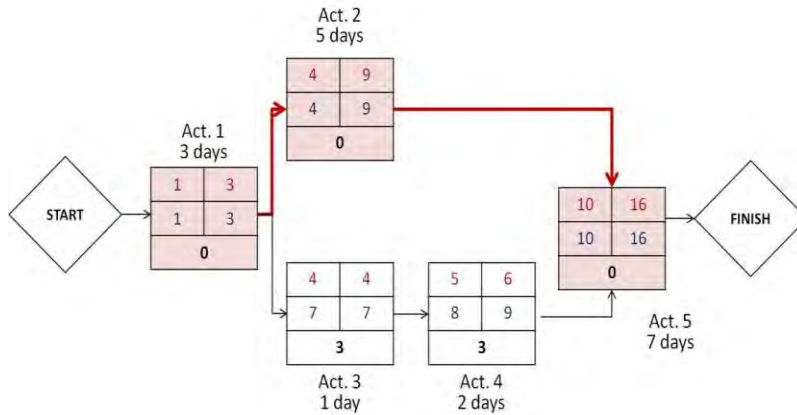


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Critical Path Method (CPM)

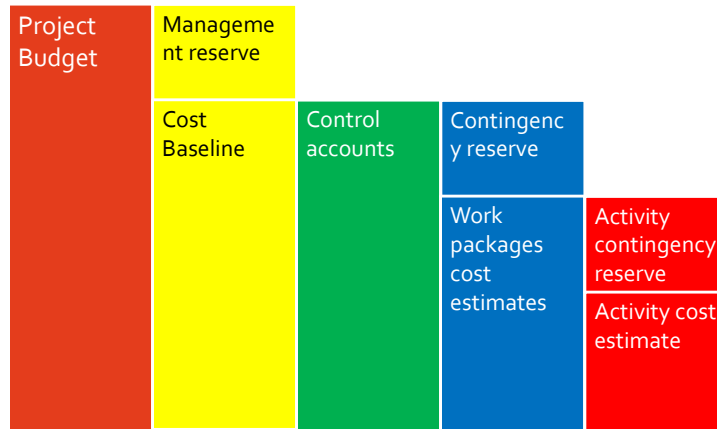


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Project Budget Components



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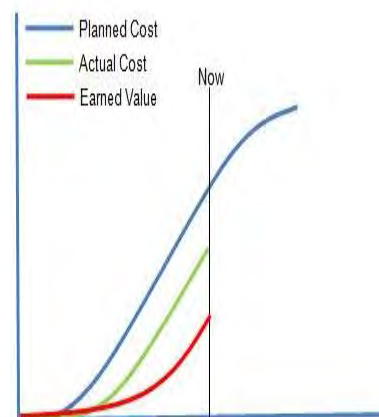
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Cost Baseline



- It is an authorized time-phased budget at completion (BAC) that is used as a basis against which to measure, monitor, and control overall cost performance on the project.

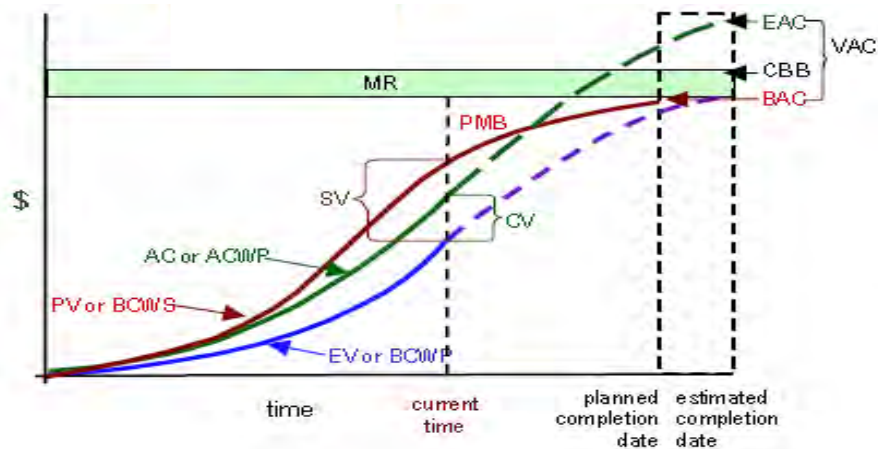


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Earned Value



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Variable & Fixed Costs



- Variable Costs that change with the amount of production.
- Fixed Costs that do not change as production changes.



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Direct and Indirect Cost



Direct Costs for a project include the direct costs for materials, labor, and equipment that can be related specifically to a task or an activity.

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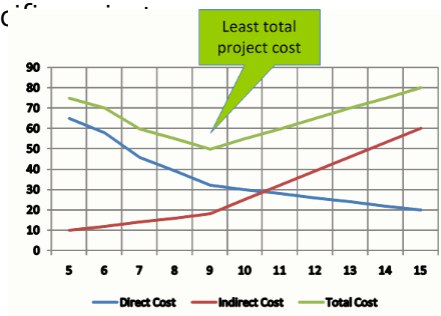
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Direct and Indirect Cost



Indirect costs are the necessary costs of doing business that cannot be related to a particular activity and in some cases cannot be related to a specific activity.

- general overhead
- project overhead.



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Project Quality Management



Includes all the processes & activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken.

Project Quality Management



Quality is

“the degree to which a set of inherent characteristics fulfill requirements”

Grade is

“a category assigned to products or services having the same functional use but different technical characteristics”

Modern Quality Management



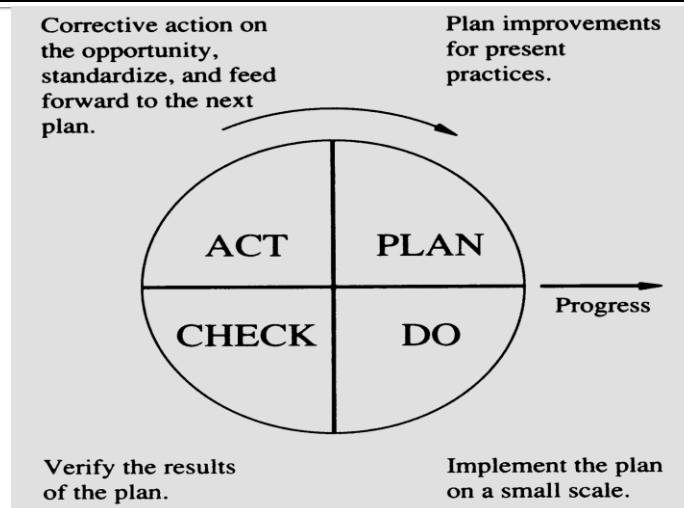
- Customer satisfaction
- Prevention over inspection
- Continuous improvement
 - PDCA
 - SIX SIGMA
 - LEAN SIX SIGMA
 - OPM₃
 - CMMI
- Management responsibility
- Cost of quality

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PDCA Cycle

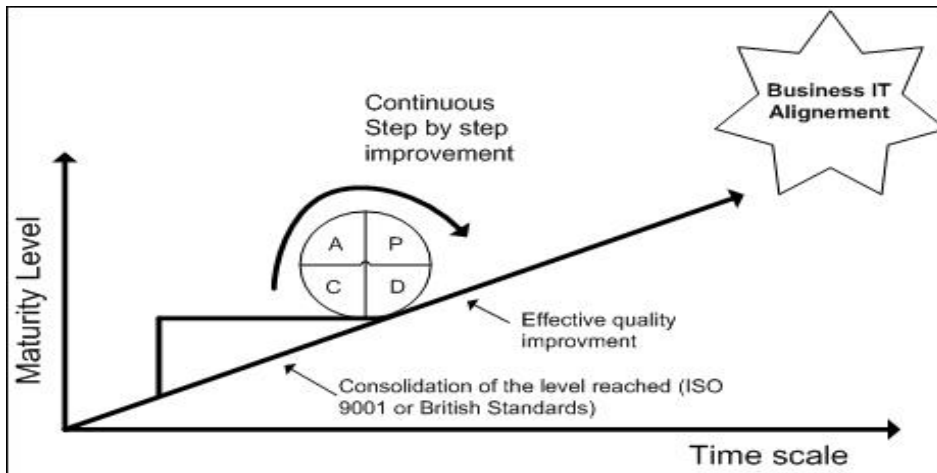


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PDCA



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Project Quality Management



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Cost-Benefit Analysis



- Less rework
- Higher productivity
- Lower costs
- Increased satisfaction



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Cost of Quality (COQ)



Quality costs are:

- Investment in preventing **nonconformance** to requirements
- **Appraising** the product or service for conformance to requirements
- **Failing** to meet requirements (rework)

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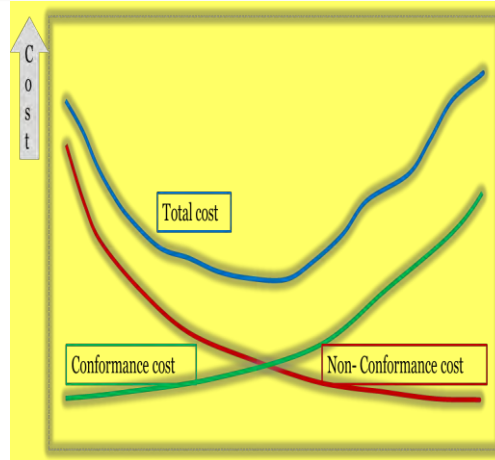
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Cost of Quality (COQ)



- **Conformance** =
prevention +
appraisal
- **Non-conformance**
= internal + external



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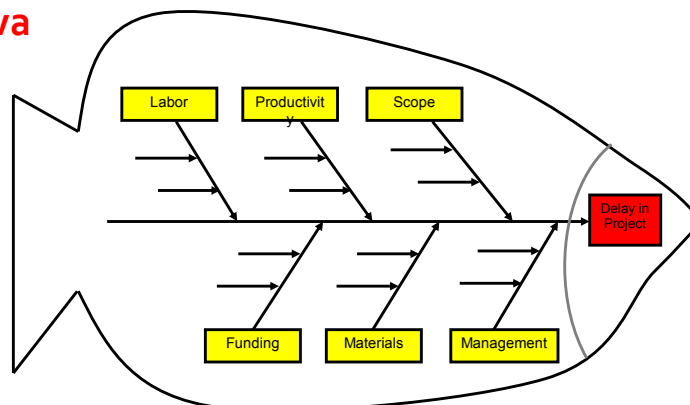
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Seven Basic Quality Tools



1- Cause-and-effect diagram / **Fishbone** / **Ishikawa**



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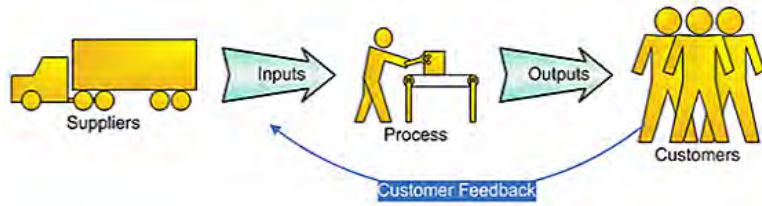
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Seven Basic Quality Tools



2- Flowcharts

SIPOC Diagram



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Seven Basic Quality Tools



3- Checksheets

Site Meeting	
Project background review	
Design details – & unusual requirements	
Schedule	
Budget	
Conflicts with University operations	
Building inspection requirements	
Site	
Site office requirements	
Storage areas	
Access routes	
Parking – workers	
Parking – deliveries & service vehicles	
Sanitary facilities	
Eating areas	
Site Security	
Construction signs	
University contacts	
Emergency number	
Paperwork	
Forms and reporting requirements	
Site meetings	
Minutes of meetings	
Daily Log	
Shop Drawings	
As-built drawings	
Inspections	
Progress billings – Stat. Dec., WCB clearances	

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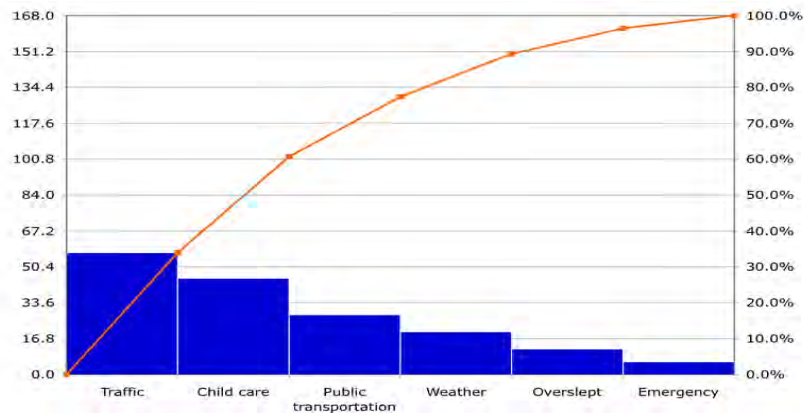
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Seven Basic Quality Tools



4- Pareto diagram



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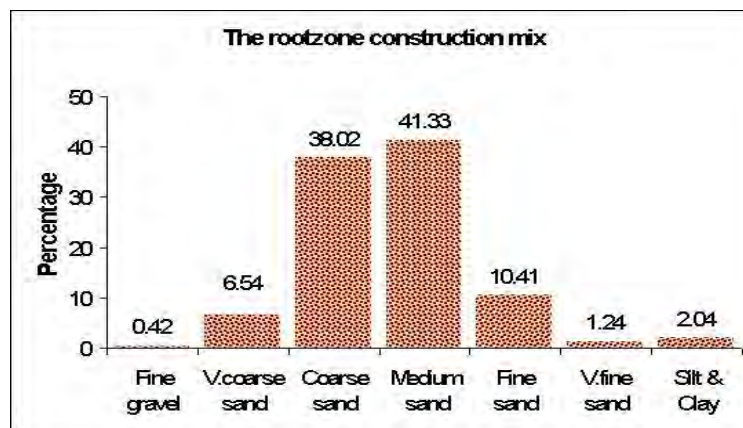
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Seven Basic Quality Tools



5- Histograms



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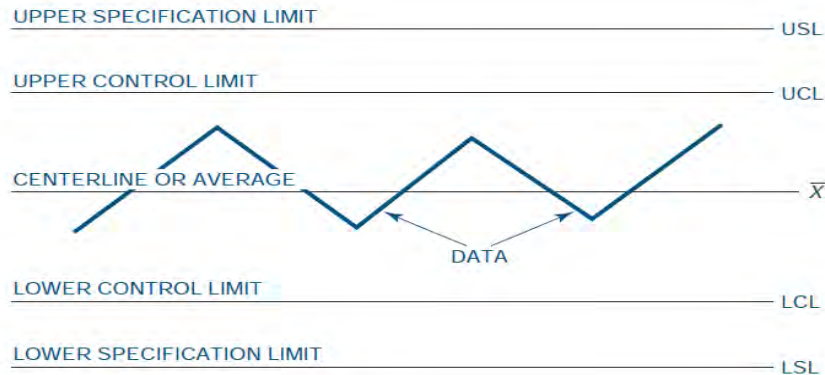
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Seven Basic Quality Tools



6- Control charts



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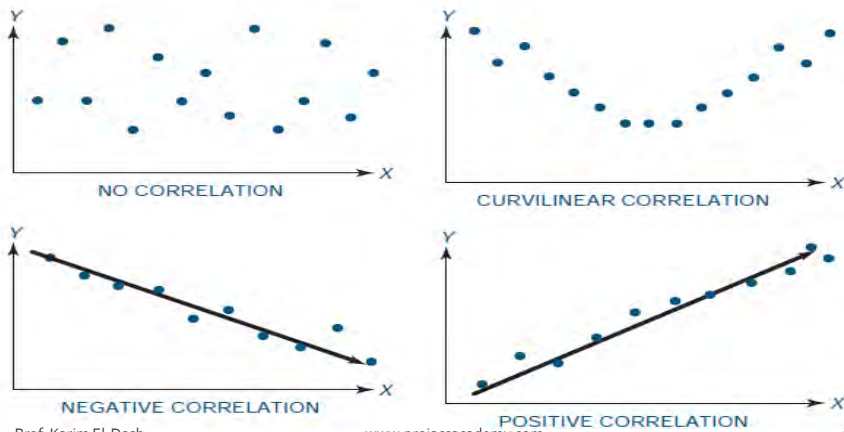
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Seven Basic Quality Tools



7- Scatter diagram



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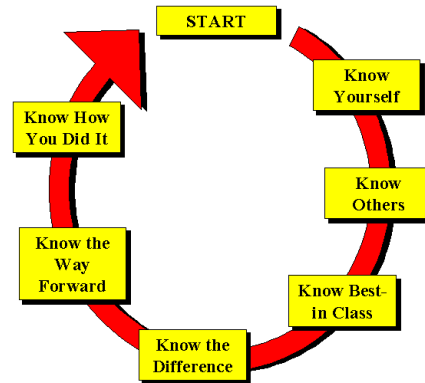
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Benchmarking



- Identify best practice
- generate ideas for improvement
- provide a basis to measure performance



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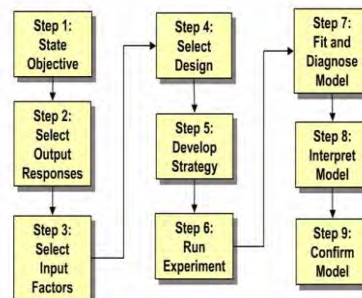
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Design of Experiments



DOE is a statistical method for identifying which factors may influence specific variables of a product or process under development

DOE Flowchart



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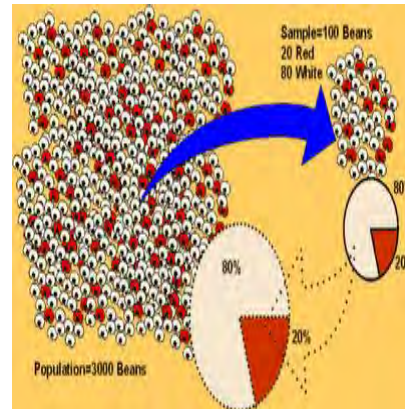
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Statistical Sampling



- Mean
- Standard deviation
- Mode
- Median
- Probability distribution



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Additional quality planning tools



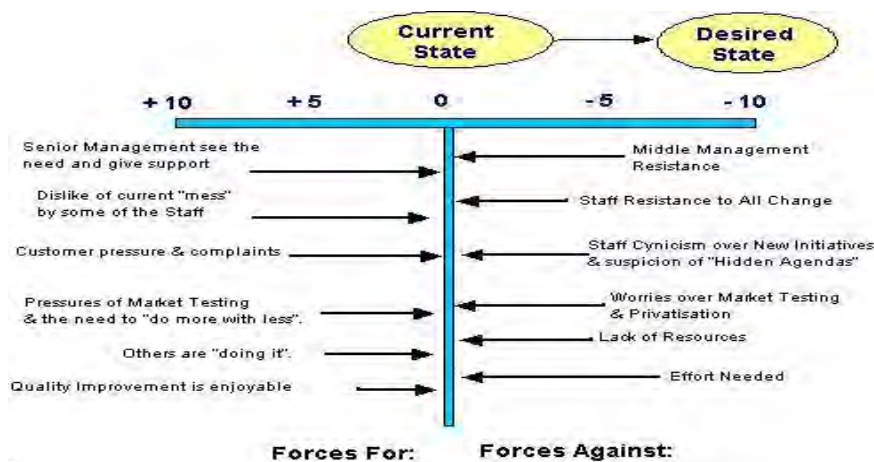
- Brainstorming
- Force field analysis
- Nominal group technique
- Quality management & control tools

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Force Field Analysis



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Plan Quality



- Quality Management Plan
- Quality Metrics
- Quality Checklists
- **Process Improvement Plan**
 - Process boundaries
 - Process configurations
 - Process metrics
 - Targets for improved performance
- Project document updates



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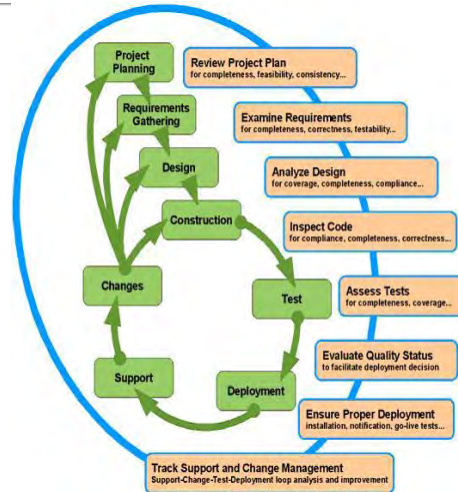
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Perform Quality Assurance



Is the process of **auditing** the quality requirements and the results from quality control measurements to ensure appropriate quality standards and operational definitions are used

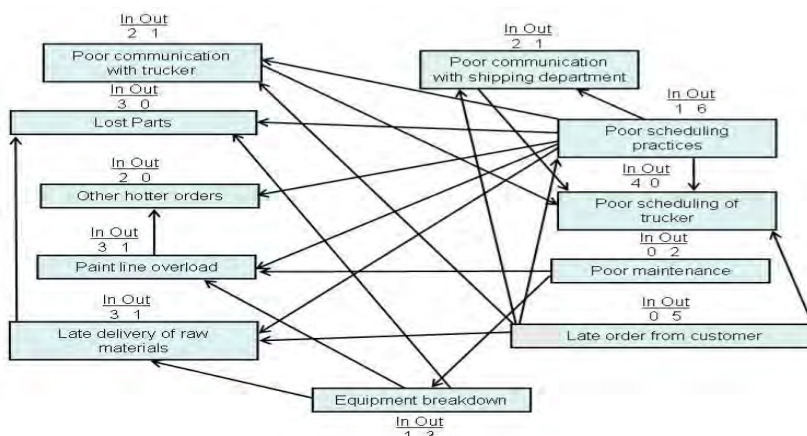


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Interrelationship digraphs



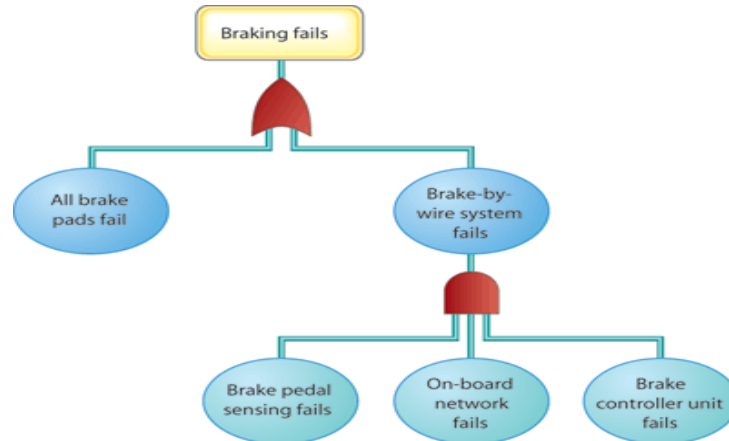
http://www4.asq.org/blogs/statistics/statistical_thinking_tools/interrelationship_digraphs/

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Tree diagrams



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Prioritization Matrices



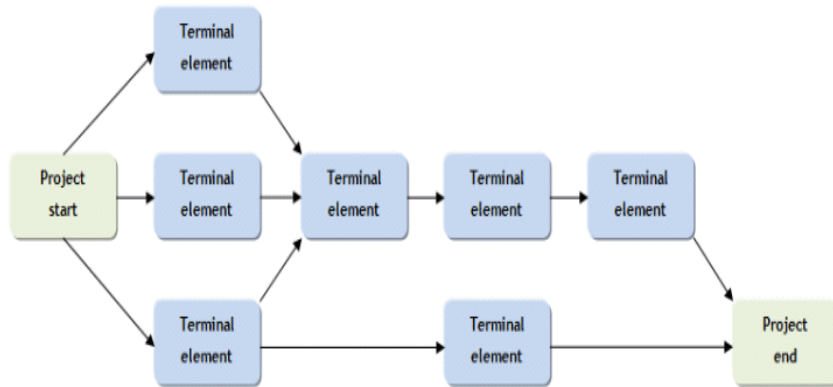
Prioritization Matrix				
<i>Issue</i>	<i>Frequency</i>	<i>Importance</i>	<i>Feasibility</i>	<i>Total</i>
No appointments for the afternoon	5	0	0	5
Delays in registration	6	1	5	12
Incomplete laboratory	9	11	6	26
Not enough materials for the lab	3	0	0	3
Broken down ambulance	0	3	0	3
Long waiting time	7	14	15	36
Disrespect of patients	4	6	10	20

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Activity Network Diagram



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Matrix Diagram



Step	Task	Client	Executive Producer	Production Manager	Creative Director
1	1	C	A	I	R
	2	I	A	R	C
2	1	A	R	I	C
3	1	C	A	R	I
4	1	C	A	R	I

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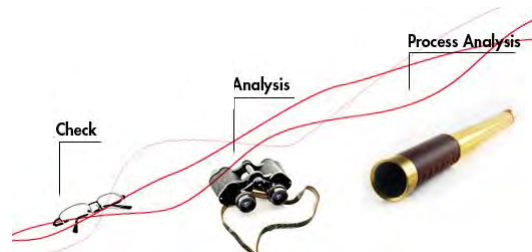
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Perform Quality Assurance



Quality audit

- Is a structured, independent review to determine if project activities comply with organizational and project policies, processes, and procedures



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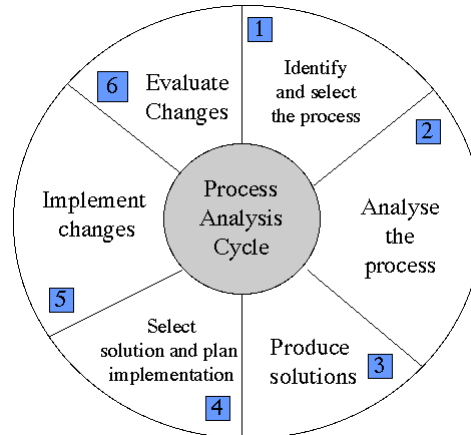
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Process Analysis



- It examines problems, constraints, and non-value-added activities
- It includes root cause analysis - to identify a problem, discover underlying causes, and develop preventing actions



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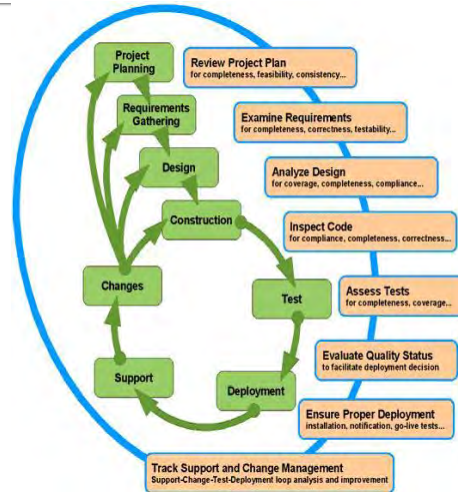
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Perform Quality Control



The process of monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes.

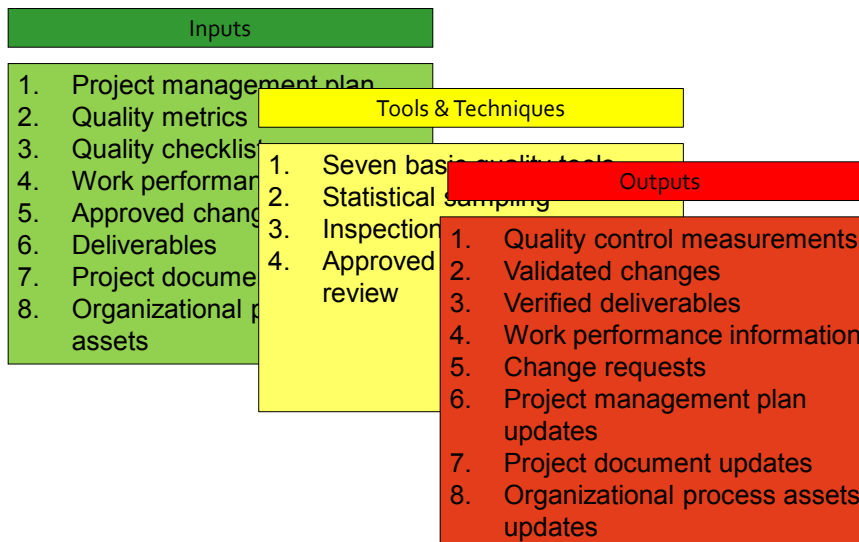


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Perform Quality Control

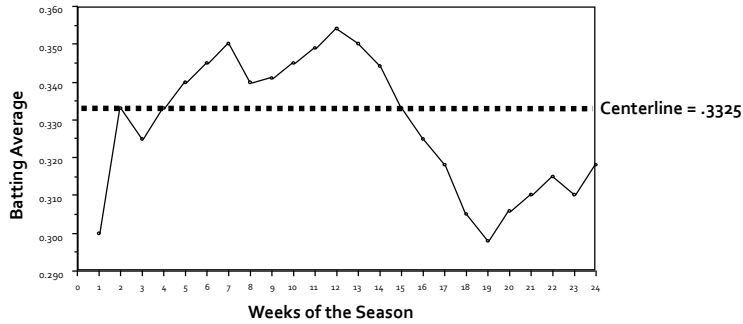


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Parts of a Run Chart



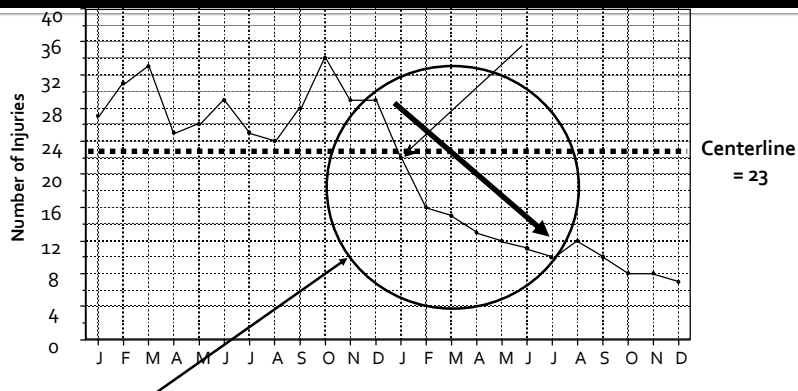
WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
AVG	300	333	325	332	340	345	350	340	341	345	349	354	359	344	333	325	318	305	298	306	310	315	310	318

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Trend Example



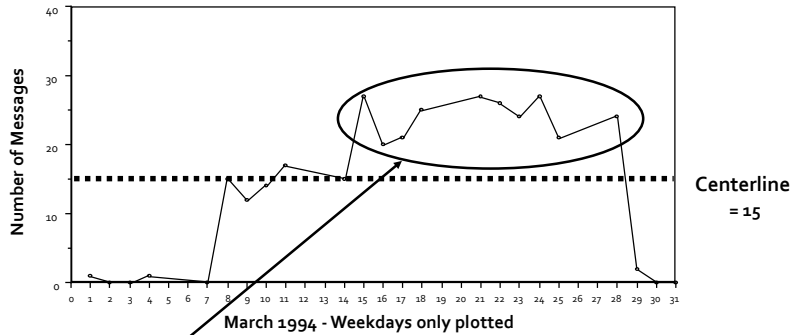
Signal of special cause variation:
7 or more consecutive ascending or descending points

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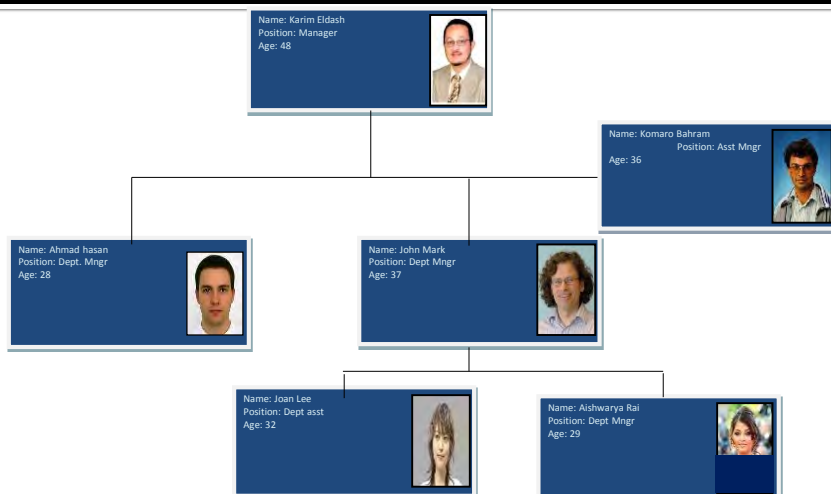
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Run Example



**Signal of special cause variation:
7 or more consecutive data points on the same side of the centerline**

Organization Breakdown Structure (OBS)



Responsibility Assignment Matrix



	Ahmed	Hasan	Aly	Manal	Haitham	Aya
Feasibility	R	A			I	
Design	I		R	A		
Execute			A		R	
Outsourcing					A	R
Handing out	A	R		I		
Public relations	C	C		R		A

R=responsible, A=accountable, C=consult, I=inform

Develop Project Team



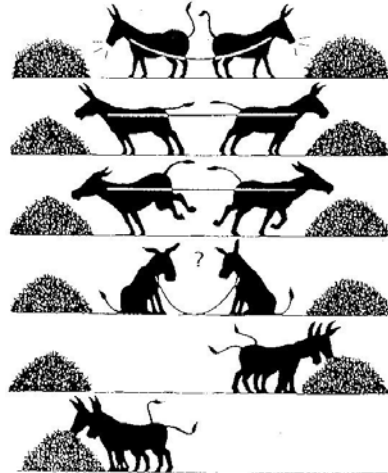
- Team performance assessments
 - Skills
 - Competencies
 - Reduced turnover rate
 - Team cohesiveness



Manage Project Team



- Observation and Conversation
- Project Performance Appraisals
 - Formal or informal
 - 360 degree
- Conflict Management
 - Withdrawing / smoothing / compromising / forcing / collaborating / confronting
- Interpersonal skills



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Manage Project Team



- Observation and Conversation
- Project Performance Appraisals
- Conflict Management
- Issue Log
- Interpersonal skills
 - Leadership
 - Influencing
 - Effective decision making



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Decision Making



- Goals
- Decision making process
- Environmental factors
- Available info
- Personal qualities
- Stimulate creativity
- Manage risk

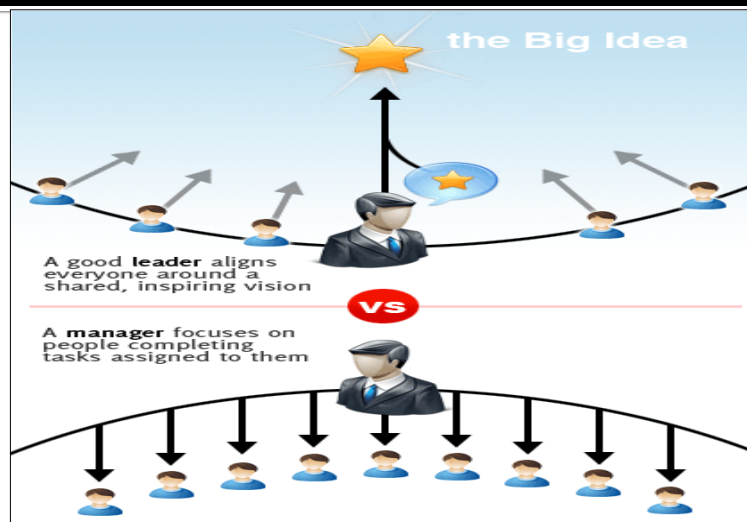


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Leader vs. Manager



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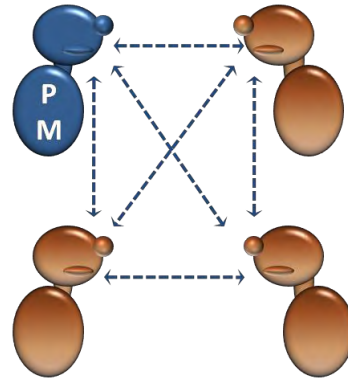
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Project Communication Management



Includes the processes required to ensure timely and appropriate **planning, creation, collection, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition** of project information



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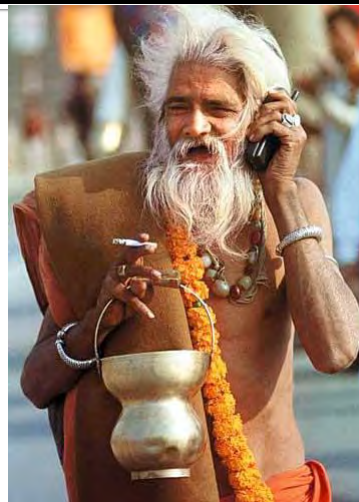
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Communication Technology



- Urgency of the need for information
- Availability of technology
- Ease of use
- Project environment
- Sensitivity & confidentiality

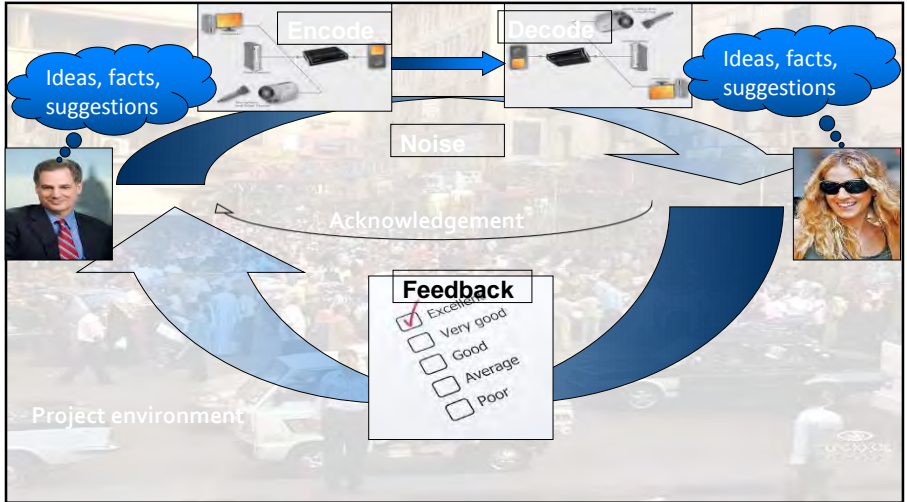


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Communication Model

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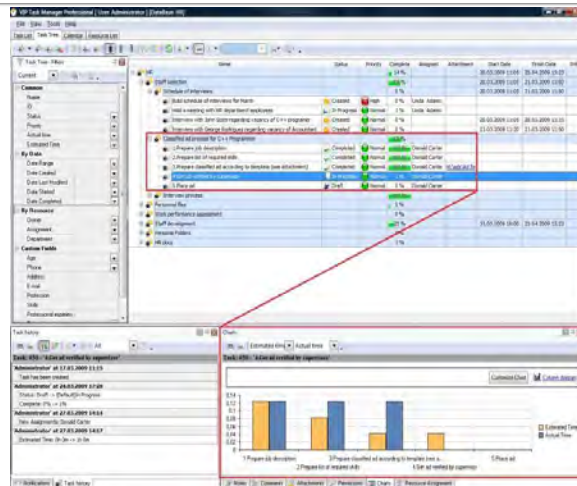
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Report Performance



- Variance analysis
- Forecasting methods
- Communication methods
- Reporting systems



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Project Risk Management



- Objectives are to:
 - increase the probability and impact of positive events, and
 - decrease the probability and impact of events adverse to the project

Project Risk

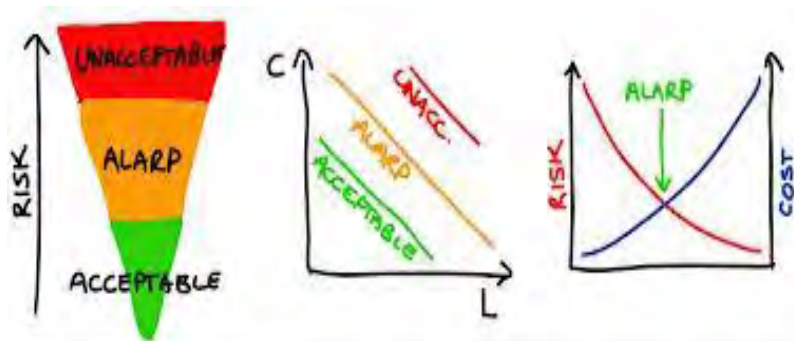


- Project risk is an uncertain event or condition that, if it occurs, has an effect on a project objective.
- Objective : Scope / time / cost / quality
- A risk has a cause or more and, if it occurs, an impact or more.

Analytical Techniques



- Stakeholder risk profile analysis



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Analytical Techniques



- Strategic risk scoring sheet

PROBABILITY (P)		IMPACTS (can be amended to suit contract circumstances) Either TIME dependent or COST dependent (€)		IMPACT (I)		Calculated RISK R=PxI	Degree of Risk	Suggested Action
Very Likely >75%	5	>10 weeks added to planned completion date	>€1M	Very high	5	17 to 25	Unacceptable	If risk cannot be reduced project should not proceed
Likely 50-75%	4	>4 weeks added to planned completion date	€100k to €1M	High	4	13 to 16	Unacceptable	Work must not start until risk has been reduced
Probable 25-50%	3	>4 weeks < 1wk added to planned completion date	€10k to €100k	Medium	3	9 to 12	Significant	Reduce risk. (Mitigate or transfer.)
Unlikely 10-25%	2	1 to 4 weeks on activity; no change to planned completion date	€1k to €10k	Low	2	5 to 8	Tolerable	Consider risk reduction measures
Negligible <10%	1	<1 week to activity; no change to planned completion date	<€1000	Very low	1	1 to 4	Trivial	Monitor work

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Risk Management Plan



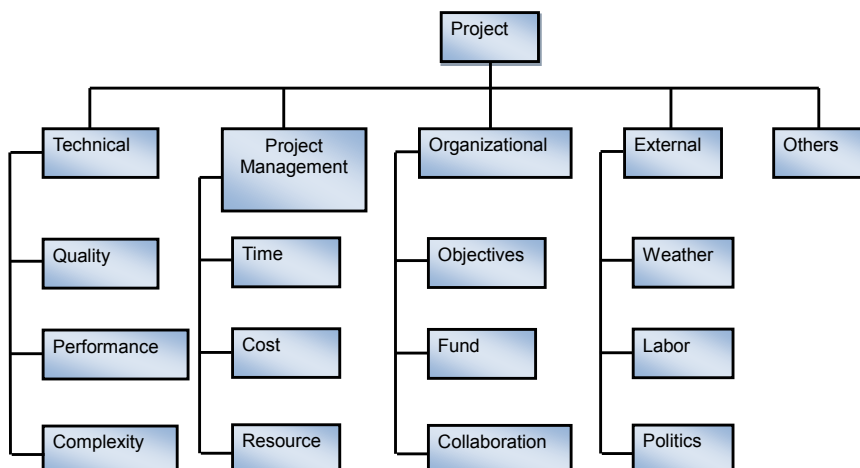
- Methodology
- Roles and responsibilities
- Budgeting
- Timing
- Categories
- Probability & Impact
 - A relative scale “very unlikely” to “almost certainty” could be used.
 - Numerical probabilities on a general scale (e.g., 0.1, 0.3, 0.5, 0.7, 0.9)

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Risk Breakdown Structure (RBS)



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Likelihood Expectations



Level	Likelihood	Expected or actual frequency experienced
1	Rare	May only occur in exceptional circumstances; simple process; no previous incidence of non-compliance
2	Unlikely	Could occur at some time; less than 25% chance of occurring; noncomplex process &/or existence of checks and balances
3	Possible	Might occur at some time; 25 –50% chance of occurring; previous audits/reports indicate non-compliance; complex process with extensive checks & balances; impacting factors outside control of organization
4	Likely	Will probably occur in most circumstances; 50-75% chance of occurring; complex process with some checks & balances; impacting factors outside control of organization
5	Almost certain	Can be expected to occur in most circumstances; more than 75% chance of occurring; complex process with minimal checks & balances; impacting factors outside control of organization

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Impact Scale



Relative or numerical scales					
Objective	Very low / 0.05	Low / 0.10	Moderate / 0.20	High / 0.40	Very High / 0.80
Cost	Insignificant increase	<10% increase	10-20% increase	20-40% increase	>40% increase
Time	Insignificant increase	<5% increase	5-10% increase	10-20% increase	>20% increase
Scope	Barely noticed change	Minor change	Major change	Unacceptable by sponsor	Product is useless
Quality	Barely noticed	Applications affected	Sponsor approval required	Unacceptable by sponsor	Product is useless

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Risk Matrix



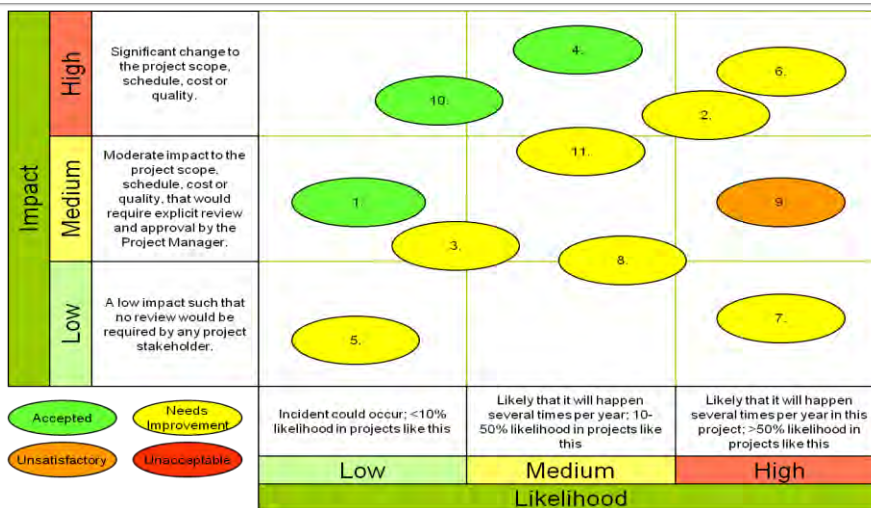
Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Extreme
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	Medium	Medium
Likely	Low	Medium	Medium	High	High
Almost certain	Low	Medium	Medium	High	Extreme

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Risk Severity



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Risk Avoidance



- Involves changing the project management plan to eliminate the threat entirely
- Some risks that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise
- One form of avoidance is to shut down the project



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Risk Transfer



- Requires shifting the negative impact of a threat, along with ownership of the response, to a third party.
- Cost-type contract transfer the cost risk to the buyer
- Fixed-price contract transfer risk to the seller



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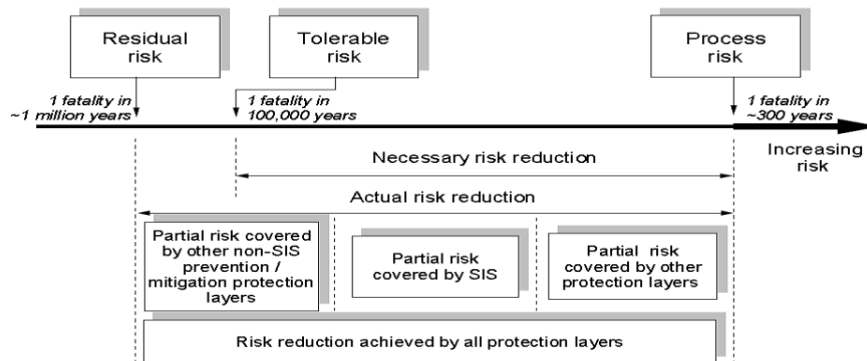
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Risk Mitigation



Implies a reduction in the probability and/or impact of an adverse risk event to an



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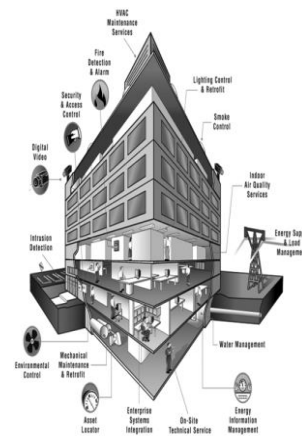
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Risk Acceptance



Indicates that the project team has decided not to change the project plan to deal with a risk, or is unable to identify any other suitable response

- **Passive** acceptance requires no action
- **Active** acceptance strategy is to establish a contingency reserve for known (sometimes unknown) risks



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Risk Exploiting



Eliminate the uncertainty associated with a particular upside risk by making the opportunity definitely happen.



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Risk Sharing



Involves allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project



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Risk Enhancement



Modifies the “size” of an opportunity by:

1. Increasing probability and/or positive impacts
2. Identifying and maximizing key drivers of these positive-impact risks



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Chapter 1

Construction Industry



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Triple Constraint

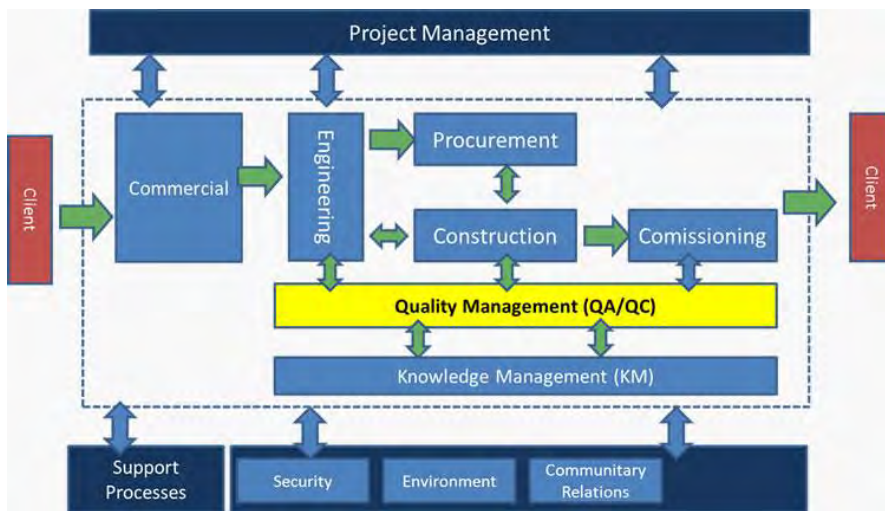


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Construction Management



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Common Risks



Under-performance of in-house staff

Under-performance of worker teams and sub-contractors

Under-performance of suppliers

Damage to and/or loss of materials and equipment

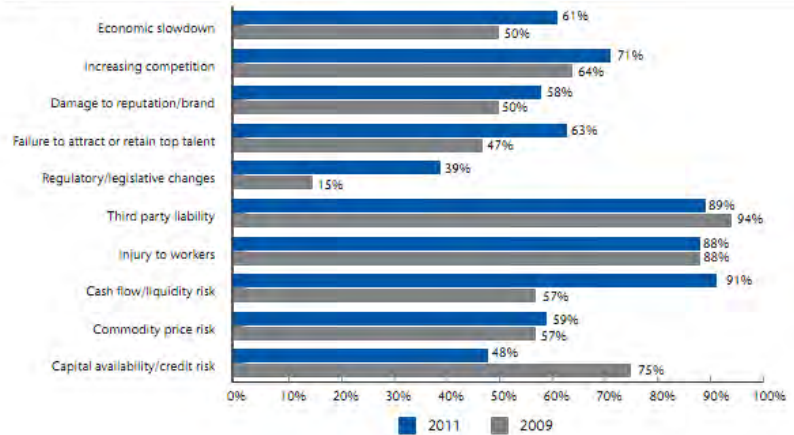
Unavailability of working capital

Industrial action and other disputes

Construction Risks



Top 10 Risks Reported Readiness - Construction



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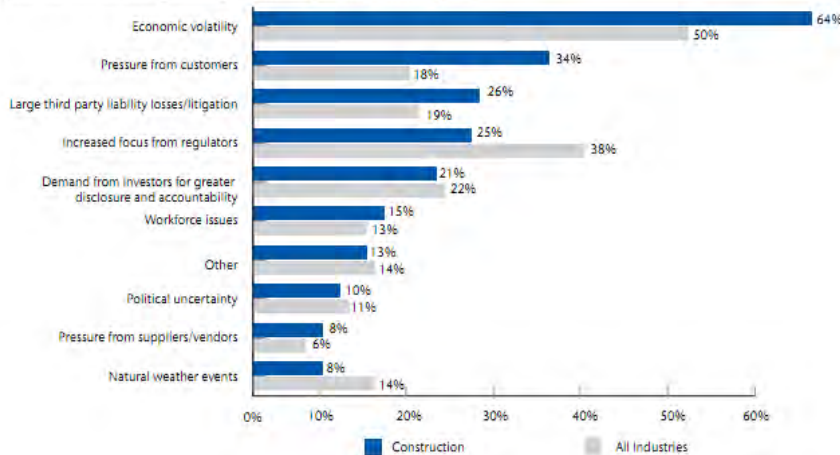
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External Risks



External Drivers Strengthening Risk Management (past two years)



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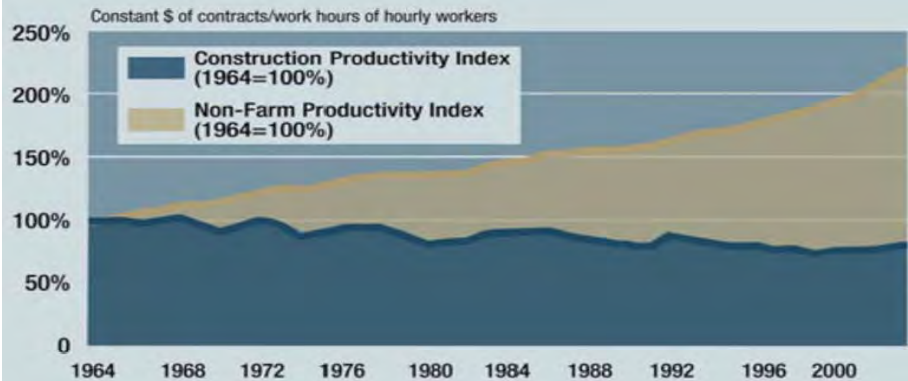
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Construction Labor Learning Curve



CONSTRUCTION AND NON-FARM LABOR PRODUCTIVITY INDEX

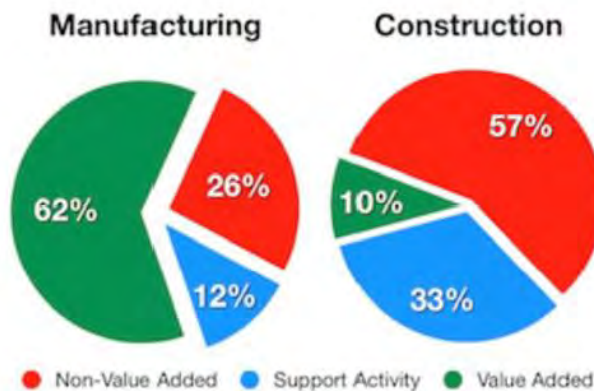


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Construction Labor



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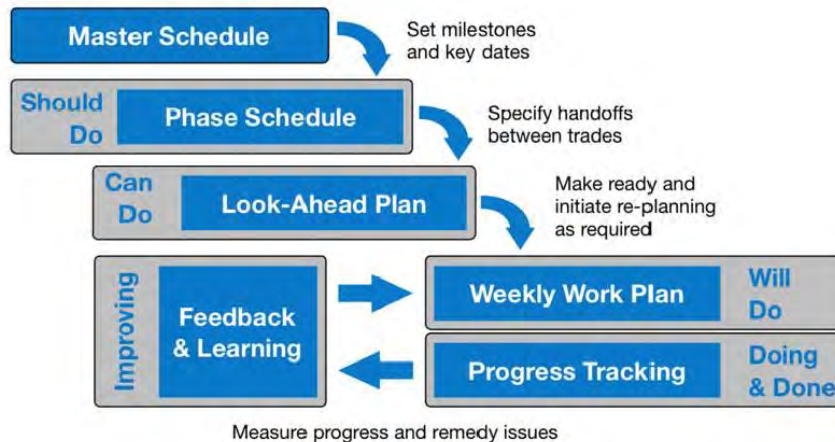
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Last Planner



Last Planner System



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Last Planner



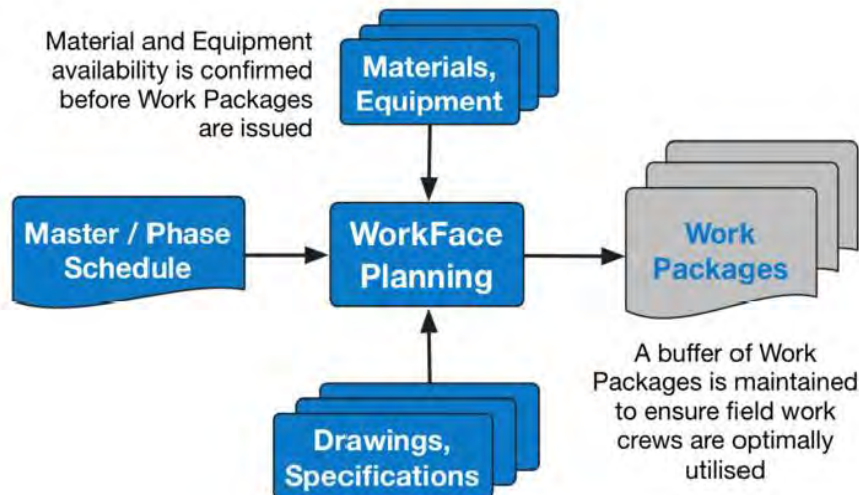
- Collaborative Planning, Lean Planning, Pull Planning, Right to left planning or Short-term planning
- Minimizing work variability between tasks
- Creating *look-ahead* plans that are based upon work without interruption, rework, or remobilization
- Planning work on weekly basis through coordination meetings
- Measuring progress using weekly learning to improve work practices

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Workface Planning



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Workface Planning



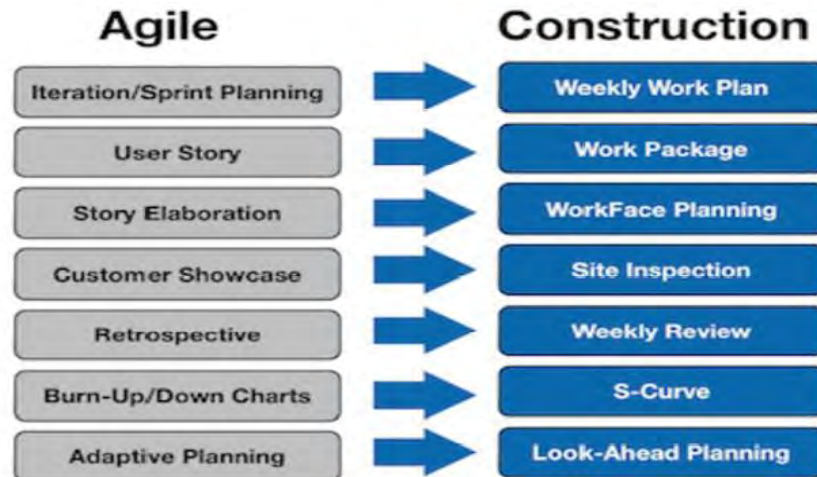
- Involves the creation of small, well defined, Work Packages that support the construction workforce.
- Work Package supports one rotation (5 to 10 days) of a work crew
- WP is based on activities that are extracted directly from the construction plan

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Agile for Construction



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Risk Impact



- **70% and 90%** of projects overrun
- Overrun varies between **50% and 100%** of budget
- **Sydney Opera House** - Final cost was 15 times more than originally planned
- **Channel Tunnel** - Final cost was 80% more than originally planned
- **Boston Arterial Tunnel** - Final cost was 196% more than originally planned

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Sydney Opera



- 1957 – 1963 – 1973
- \$12.5 ->>>> \$102



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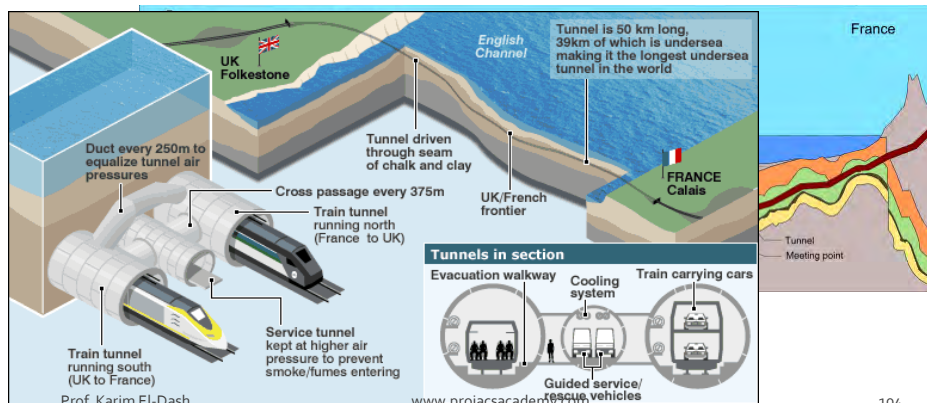
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Channel Tunnel



- 1986 - 1994
- £ 2.7 ->>>> £ 4.9



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The Big Dig

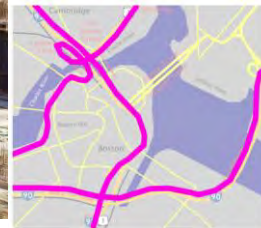


- 1982 – 1997 – 2007
- \$ 2.7 - >>>>>> \$ 15



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Lean Construction



1. Creating material and information flows
2. Maximizing value generation
3. Using plan, execute and control paradigms
4. Optimization of entire system through collaboration
5. Continual improvement and pursuit of perfection
6. Focus on delivering the value desired by client
7. Systematically eliminating obstacles to value creation
8. Elimination of processes that create no value
9. Creating pull production

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Risk Mitigation Tool

Risk Factors	Contract	Management Plan	Payment Bond	Performance Bond	Schedule Controls	Budget Controls	Resource
Contractor Risk Factors							
Contractor Default	●			●			PM
Sub-Contractor Default	●			●			PM
Liens	2 ●	●	●				PM
Owner / Contractor Dispute	1 ●	●					PM
Contractor / Subcontractor Dispute	●	●					PM
Financial Risk Factors							
Client Changes		●				●	Owner
Contractor Claims / Changes	●	●				●	PM
Unforeseen Conditions						●	
Overpayment for Work in Place	●	●					PM
Schedule Risk Factors							
Completion Delay - Base Building	●				●		PM
Completion Delay - Special Technical Elements	●				●		PM
Weather Delay	●				●		
Entitlements / Permit Delays - Base Building					●		PM
Entitlements / Permit Delays - Technical					●		PM
Long Lead Items					●		PM
Designer Risk Factors							
Architect / Engineer Default	●						PM
Errors	●	●					PM
Omissions	●					●	PM
Contract Compliance							
		●					PM
Quality of Documents							
							Design Team/PM
Footnotes (1) Contract modifications required in order to have litigation as the final means of dispute resolution (2) Contract modifications required to insert Affirmative No Lien language							
Legend: ● → Primary Responsibility ● → Secondary Responsibility							

This Risk Mitigation Tool matrix isn't meant to be an exhaustive list of project risks and mitigation techniques; it's a tool to get the project team thinking about where the risks are on a particular project and how to mitigate them.
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Chapter 2 Site Set-Up

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Construction Engineer



- Administration of the construction contract
- Monitoring the work of the Contractor
- Receive and resolve requests for information
- Process all requests for changes
- Responding to concerns from the public.
- Minimize the impact on residents and businesses.
- Checking all payments interim and final
- Monitoring the quality of the work installed
- Record all nonconforming & corrective action.



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Construction Engineer



- Not responsible for safety of the work
- Monitoring the work of others assigned
- Promote a team environment
- Perform periodic reviews
- Reporting to the PM on the progress
- Report major deviations of schedule, price, or quantity.
- Report serious accidents to city administration.
- Set up and maintain the project files.
- Monitor all testing and maintain records
- Notify the PM of quantity/testing issues

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Construction Inspector



Works under the direction of the Construction Engineer.

Perform inspection of a construction contractor's work

Observes the contractor's work and recommends approval

Maintains inspection records

Prepares daily inspection reports

Verify and maintain quantity data for payments.

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Construction Start-Up



Labor and equipment mobilized

Material purchase orders

Permits obtained

Statutory requirements fulfilled

Schedules produced

Knowledge of plans, specifications and contract

Status of right of way and utility relocations

Site and the surrounding areas

Forms and contract administration procedures



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Organization & Management



Check construction database, design, and accounting information

Formal communications made with the Prime Contractor

Representatives should be identified before pre-construction conference.

Know who the person representing the contractor.

Promote relationships with the contractors, utility companies and governmental authorities



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Field Office & Facilities



Potential areas for site offices,

Impact on local residences and businesses

Effect on permanent work

Cost of Contractor

Temporary services

Area provided for Contractor's use

Plan of office layout by contractor

Access to the site.

The site security requirements

Prohibition of access to areas of hazards



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Drawings & Specs



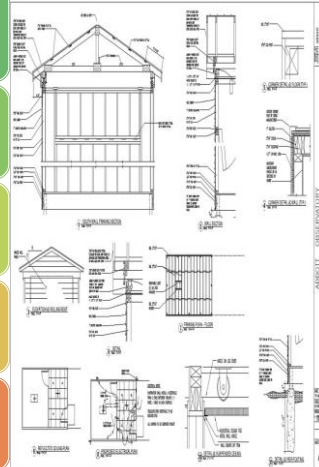
Specifications, drawings, and standards referenced in the contract

Inspectors are familiar with the requirements

CI plays lead role in meetings with the Contractor

Revised documents.

Keeping as-built information.



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Testing Services



Notify testing agent of scheduled start

Coordinate testing requirements

Reliable schedule information

Appropriate testing equipment

Staff available for earthwork, concrete placement, asphalt

Notice of Nonconformance



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Permits



- Checklist of all permits required
- Who is responsible to get them.
- Building Permit, Demolition,
- Erosion and Sediment Control,
- Cut and Fill, Tree Removal,
- Haul Routes, Traffic Control,
- Off-site Grading Plans, Noise,
- Plumbing/Mechanical/Electrical,
- Sewer Connection, Elevator/Escalator,
- Automatic Sprinkler



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Subcontractors



- Qualifications, pre-approval,
- % performed by subcontractors,
- Payments to subcontractors.



Prime Contractor involved in planning, problem resolution

Official communications with subcontractors through the Prime Contractor.

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Communication



CORRESPONDENCES

DAILY/MONTHLY REPORTS

MEETINGS

PROJECT RECORD DOCUMENTS

PHOTOGRAPHIC RECORDS

CONTRACT DRAWING DISTRIBUTION AND REVISIONS

SHOP DRAWINGS, SAMPLE SUBMITTALS

REQUESTS FOR INFORMATION/CLARIFICATION


AGENCY/UTILITY COORDINATION MEETINGS



Chapter 3

Construction Schedule

Construction Contract Schedule




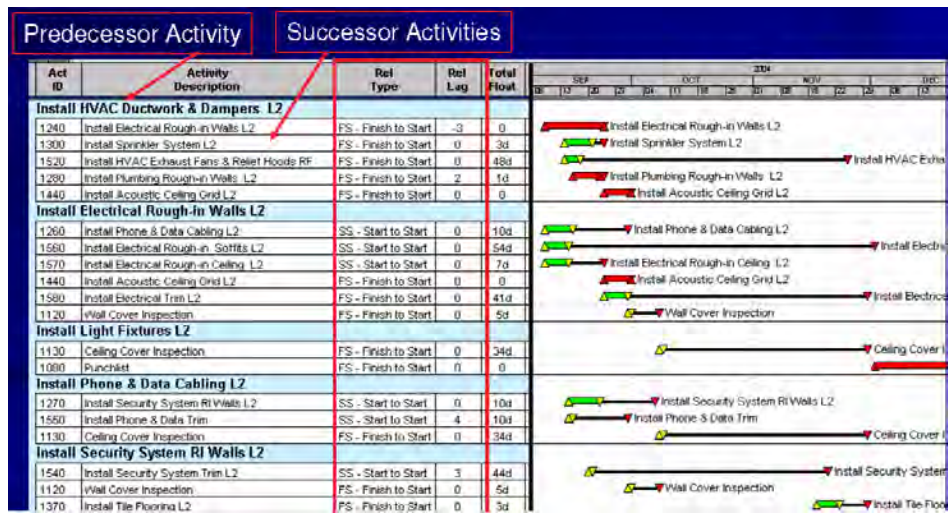
- Final schedule within two (depends on the project) weeks after the notice to proceed.
- Procurement activities
- Submittals and approval of shop and working drawings
- Major equipment or material purchases
- Maximum of 15 working days duration
- Review logical sequence
- Review durations are sensible and achievable

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Dependency

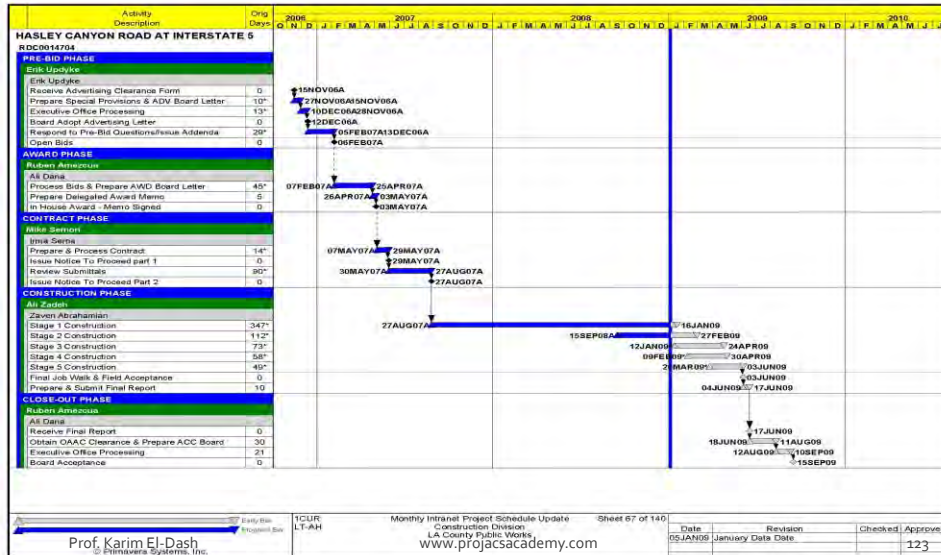



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Construction Master Schedule

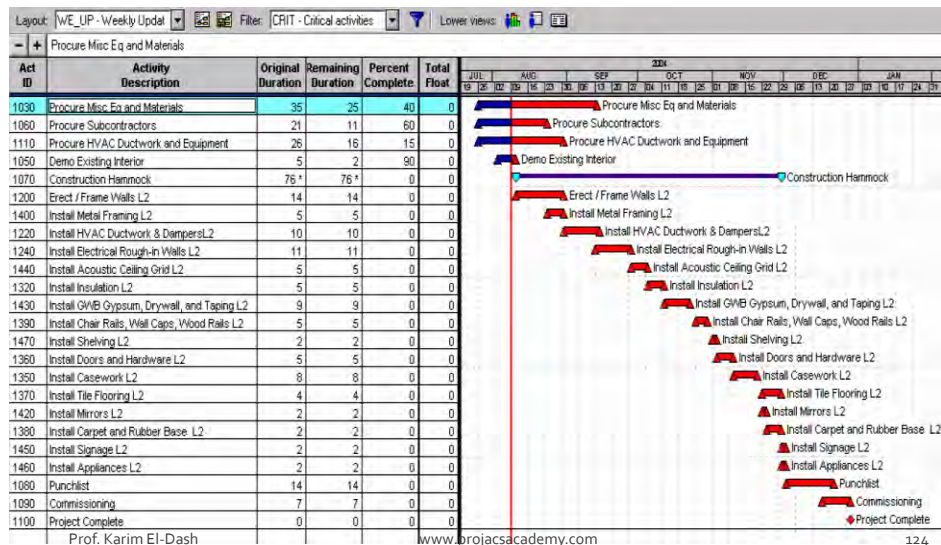


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Monthly Intranet Project Schedule Update
 Construction Division
 LA County Public Works
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Sheet 67 of 140
 Date: 05JAN09
 Revision: January Data Date
 Checked: []
 Approved: []
 123

Critical Path

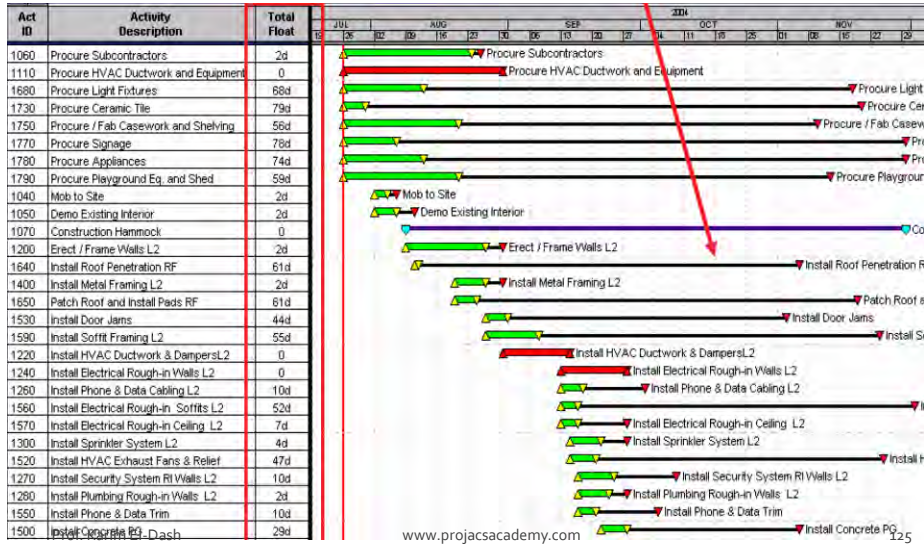


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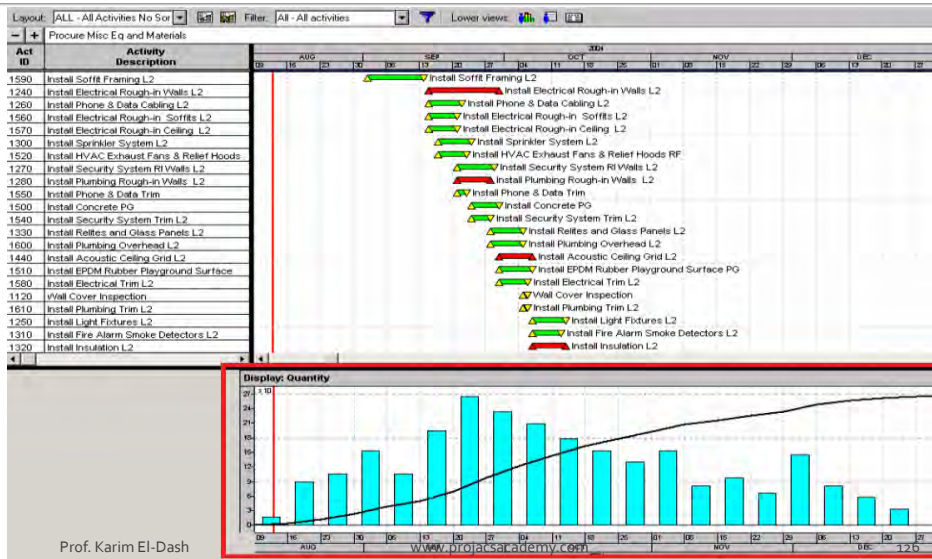
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12.4

Float



Resource Allocation



3-Week Schedule



Act ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float	2015											
						JAN 10	JAN 17	JAN 24	JAN 31	FEB 07	FEB 14	FEB 21	FEB 28	MAR 06	MAR 13	MAR 20	MAR 27
Arrow Construction Company																	
Plumbing Subcontractor																	
BE1200	Install / Re-route Plumbing BEND	5	01/21/05	01/27/05	5d												
CA1200	Install / Re-route Plumbing CAR	5	01/21/05	01/27/05	5d												
CU200	Install Plumbing CUM	5	02/01/05	02/07/05	29d												
Electrical Subcontractor																	
BE1250	Install electrical circuit breaker and line BEND	3	01/21/05	01/25/05	8d												
CA1250	Install electrical circuit breaker and line CAR	3	01/21/05	01/25/05	9d												
RI1210	Install Rough-in Heat Lamps RIV	2	01/28/05	01/31/05	5d												
CJ290	Install Electrical Island and new wall CUM	3	02/01/05	02/03/05	25d												
CJ210	Install Lighting CUM	2	02/14/05	02/16/05	25d												
Cabinet Subcontractor																	
ST1300	Install Cabinets STEV	5	01/18/05	01/24/05	4d												
HD1300	Install Cabinets HOOD	5	01/18/05	01/24/05	9d												
ST1320	Install Counter top STEV	2	01/26/05	01/27/05	3d												
HD1320	Install Counter top HOOD	2	01/26/05	01/27/05	8d												
RI1300	Install Cabinets RIV	5	02/01/05	02/07/05	4d												
HL300	Install Cabinets HILL	6	02/03/05	02/09/05	3d												
RI1320	Install Counter top RIV	2	02/09/05	02/10/05	3d												
HL320	Install Counter top HILL	2	02/10/05	02/11/05	3d												
HVAC, Fans, Venting Subcontractor																	
RI1180	Install Exhaust fans Rough In RIV	2	01/28/05	01/31/05	5d												
CU180	Install Exhaust vents/fans CUM	2	02/01/05	02/02/05	30d												
Insulation Subcontractor																	
HL030	Install Insulation HILL	1	01/27/05	01/27/05	3d												
CU030	Install Insulation CUM	1	02/01/05	02/01/05	33d												
RI1030	Install Insulation RIV	1	02/02/05	02/02/05	3d												
Appliance Vendor																	
BW1120	Install Stove WEST	1	01/25/05	01/25/05	8d												
BW1110	Install Refrigerator WEST	1	01/25/05	01/25/05	11d												
AT1120	Install Stove ATTL	1	01/28/05	01/28/05	17d												
AT1110	Install Refrigerator ATTL	1	01/28/05	01/28/05	19d												
Tile Subcontractor El-Dash																	
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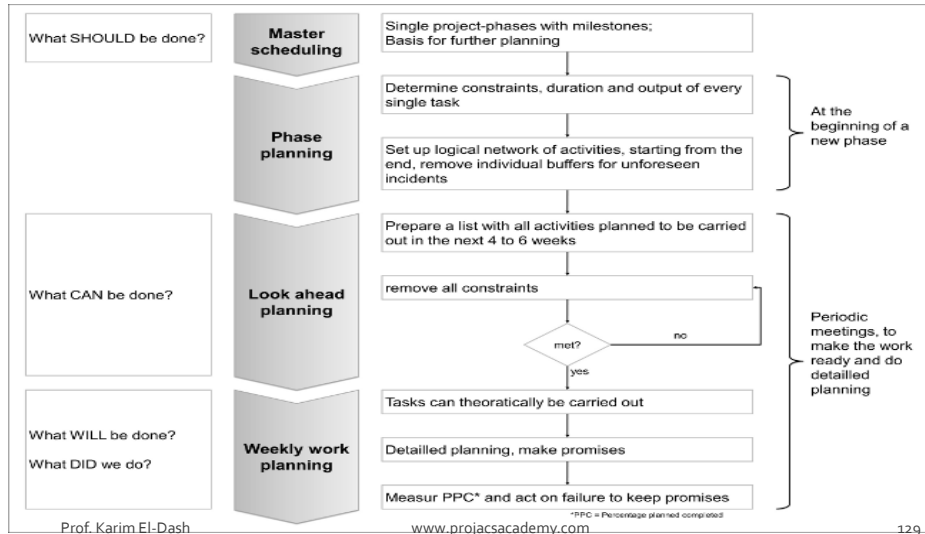
Look Ahead Schedule



1-WEEK LOOK-AHEAD

Foreman:	Date:	Areas/sections										
Paul	1/16/10	LEVEL 3 EAST WING SMLT room										
AD2101 PROJECT												
Activity	Make ready	P-%	A-%	Mon	Tues	Wed	Thur	Fri	Sat	Sun	T-C	Reasons for
prep work for SMLT A	DBs	70%	100%	xxx	xxx						1+2	Builder
LT installation	Label machine		100%			xxx					" "	
Main LT cables term			100%				xxx				" "	
DB Wiring			80%					xxxxxxxxxx			" "	
LT room earth			50%	100%						xxx		
Testing			0%									
Finishing - labling												

Construction Contract Schedule



Chapter 4

Cost Control



Payments

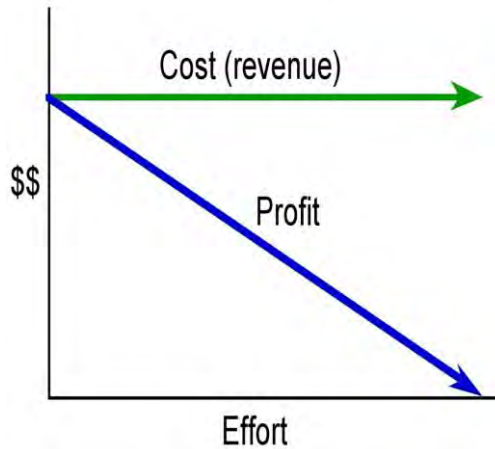


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Payments



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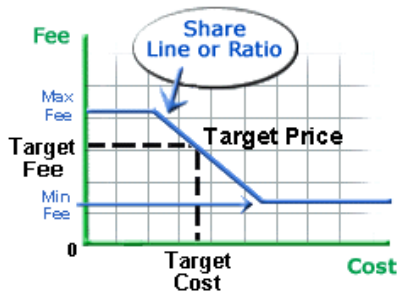
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132

Payments



CPIF Contract



CPIF Contract

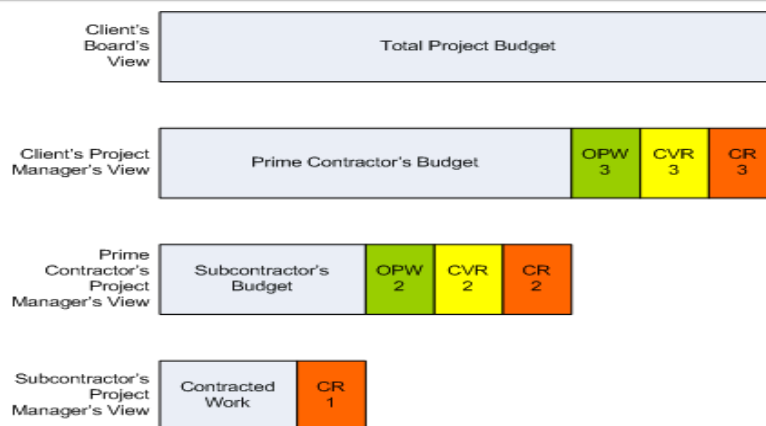


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Contingency



Legend:

CR – Contingency Reserve

OPW – Other Project Work

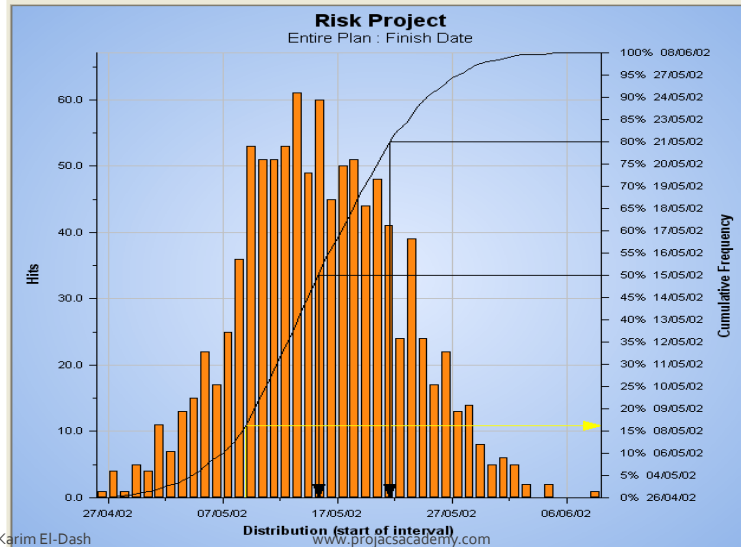
CVR – Change/Variation Reserve

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Contingency



135

Change Orders



Review all notifications of change from the Contractor

Monitor labor, equipment and materials involved

It may be necessary to proceed prior to settlement

Contractor notifies the CE of changed site conditions

Alert to field conditions to anticipate potential change.

CE requests detailed breakout of labor and material costs

If the CE agrees, the proposal is forwarded for approval.

CE will attempt to negotiate with the Contractor.

A change order may require an extension of contract time.

If there is no time extension, assess liquidated damages.

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Claims



The contractor is required to proceed with the work

CE acknowledge receipt of notice of intent of claim, in writing

The contract stipulates the dispute resolution procedures to be adopted.

CE shall assemble all documentary and other evidence relating to the claim

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Claims



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BASELINES



Budget baseline

Schedule baseline

Control account baseline

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MEASURING WORK PROGRESS



Method 1—Units Completed

- This method is applicable to tasks that involve repeated production of easily measured pieces of work, when each piece requires approximately the same level of effort.

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MEASURING WORK PROGRESS



Method 2—Incremental Milestone

- This method is applicable to any control account that includes subtasks that must be handled in sequence.
- Segmenting a task into subtasks is called developing “rules of credit”
- The percentage is normally based on the number of work-hours estimated.

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Rules of Credit (Drums & Tanks)



TASK	INCREMENTAL PROGRESS	CUMULATIVE PROGRESS
Received/ inspected	15%	15%
Setting complete	20%	35%
Alignment complete	15%	50%
Internals installed	25%	75%
Testing complete	15%	90%
Accepted by owner	10%	100%

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142

MEASURING WORK PROGRESS



Method 3—Start/Finish

- This method is applicable to tasks that lack definable intermediate milestones.
- A starting percentage of 50 % is reasonable for short duration, lower-value tasks.
- For tasks with a longer duration, a lesser percentage (20-30 %) would be used at start.
- For very short tasks, the start/finish percentages are usually 0 :100 %.

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MEASURING WORK PROGRESS



Method 4—Supervisor Opinion

- Where developing a more discrete status is not feasible.
- Dewatering, temporary construction, and landscaping.

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MEASURING WORK PROGRESS



Method 5—Cost Ratio

- This method is applicable to tasks that involve a long period of time or that are continuous during the life of a project, and which are estimated and budgeted on bulk allocations of dollars and work-hours.

$$\% \text{ complete} = \frac{\text{actual cost or workhours to date}}{\text{forecast at completion}}$$

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MEASURING WORK PROGRESS



Method 6—Weighted or Equivalent Units

- When the task being controlled involves a long period of time and is composed of two or more overlapping subtasks, each with a different unit of work measurement. (rules of credit)

Allowed Credit	Subtask	Total U/M	Total Quantity	To-Date Quantity	Earned Tons
0.02	run foundation bolts	each	200	200	10.4
0.02	shim	%	100	100	10.4
0.05	shakeout	%	100	100	26.0
0.06	columns	each	87	74	27.5
0.11	beams	each	859	45	3.0
0.10	cross braces	each	837	0	0.0
0.20	girts and sag rods	bay	38	0	0.0
0.09	plumb and align	%	100	5	2.3
0.30	connection	each	2,977	74	3.9
0.05	punch list	%	100	0	0.0
1.00	Steel Totals	ton	520		83.5

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Project Labor Cost Control



- **Construction labor** costs are the most variable element of the project construction budget.
- Project management must continually **compare** the actual dollars to the budget dollars to identify deviations.

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Construction Craft Productivity



- crew sizes and craft composition;
- craft density (area per worker);
- interference with other crews;
- scheduling;
- material availability;
- equipment and tool availability;
- information availability,
- rework
- site layout;
- weather;
- constructability.

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WAREHOUSE PROJECT						
BUILDING CONCRETE LABOR ESTIMATE						
& ACTUAL QUANTITY @ DAY 30						
COST CODE	DESCRIPTION	QTY.	UNIT	LABOR COST	DAY 30	
					ACTUAL QTY.	
	COLUMN PADS 5'-6" x 5'-6" x 1'-0"	64	EACH			
03120	FORMS 4 USES	1,408	SF	\$1.50	\$2,112	PROD RPT
03110	ANCHOR BOLTS	160	EA	\$2.00	\$320	132
03210	REBAR 8- #5 BARS EACH WAY	5,340	LB	\$0.15	\$801	4,380
03310	CONCRETE 4,000 PSI	72	CY	\$5.00	\$360	56
03340	FINISH	1,936	SF	\$0.15	\$290	1,510
	FROST WALL 1305' x 2'-0" x 2'-6"	1,305	LF			
03120	FORMS TOP 4"	870	SF	\$1.50	\$1,305	PROD RPT
03310	CONCRETE 3,000 PSI	242	CY	\$5.00	\$1,210	242
03340	FINISH	2,610	SF	\$0.15	\$392	2,610
	SLAB ON GRADE 360' x 360' x 6"	129,600	SF			
03140	FORMS	2,880	LF	\$0.50	\$1,440	PROD RPT
03220	6 x 6 #6/6 WELDED WIRE FABRIC	129,600	SF	\$0.13	\$16,848	18,150
03330	CONCRETE 4,000 PSI	2,400	CY	\$5.00	\$12,000	240
03360	FINISH	129,600	SF	\$0.25	\$32,400	12,960
03150	CONTROL JOINTS	8,640	LF	\$0.50	\$4,320	520
03160	EXPANSION JOINTS & COLUMN DIAMONDS	1,800	LF	\$1.00	\$1,800	180
	DOCK WALL FOOTINGS 135' x 4'-0" x 1'-0"	135	LF			
03120	FORMS	270	SF	\$1.50	\$405	PROD RPT
03210	REBAR 3-#5 BARS CONT & #4 BENT @ 18" OC	600	LBS	\$0.15	\$90	540
03310	CONCRETE 4,000 PSI	20	CY	\$5.00	\$100	15
03340	FINISH	540	SF	\$0.15	\$81	405
	DOCK WALLS 135' x 1'-6" x 5'-6"	135	LF			
03130	FORMS	1,485	SF	\$2.50	\$3,713	PROD RPT
03210	REBAR 4-#4 BARS CONT & #4 @ 18" OC	659	LB	\$0.15	\$99	264
03320	CONCRETE 4,000 PSI	42	CY	\$7.00	\$294	0
03350	FINISH TOP	203	SF	\$0.25	\$51	0
03370	PATCH & RUB WALLS	1,485	SF	\$0.15	\$223	0
TOTAL ESTIMATED LABOR COST					\$80,653	

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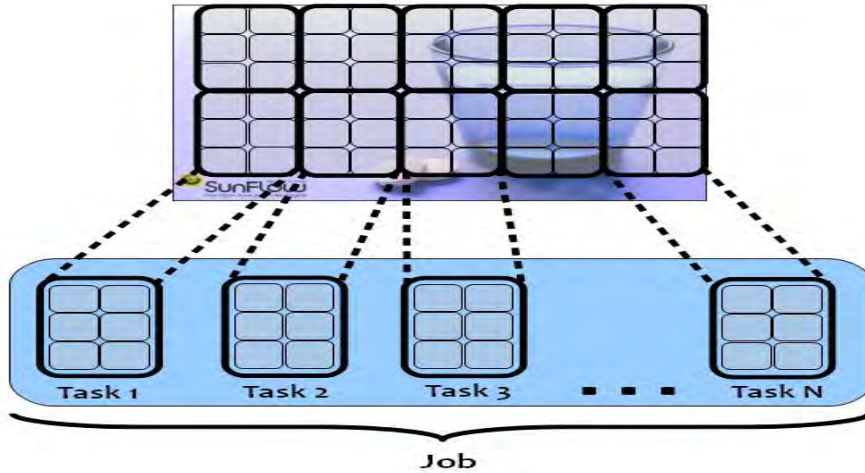
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WAREHOUSE PROJECT																				
BUILDING CONCRETE FORMWORK DAILY PRODUCTION REPORT																				
COST CODE	DESCRIPTION	UNIT	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	DAY	TOTAL @day 30	RULES OF CREDIT	SUBTOTAL	TOTAL QUANTITY	
			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
03120	COLUMN PADS FORMS																			
	ERECT SF	154		154		176		154		154		176		154		22	1,144	0.6	686	862
	WRECK SF				154		154		176								484	0.3	145	
	CLEAN & OIL SF				154		154										308	0.1	31	
03120	FROST WALL FORMS																			
	ERECT SF	200			200		270		200		200		270		200		870	0.6	522	870
	WRECK SF					200		200		270					200		870	0.3	261	
	CLEAN & OIL SF					200		200		270					200		870	0.1	87	
03120	DOCK WALL FOOTING FORMS																			
	ERECT SF							108					108		28		244	0.6	146	190
	WRECK SF											108					108	0.3	32	
	CLEAN & OIL SF											108					108	0.1	11	
03130	DOCK WALLS FORMS																			
	ERECT SF												297				594	0.6	356	356
	WRECK SF																0	0.3	0	
	CLEAN & OIL SF																0	0.1	0	
03140	SLAB ON GRADE EDGE FORMS																			
	ERECT LF											370					397	0.6	460	608
	WRECK LF															370		370	0.3	111
	CLEAN & OIL LF															370		370	0.1	37

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Decomposition - 100% Rule

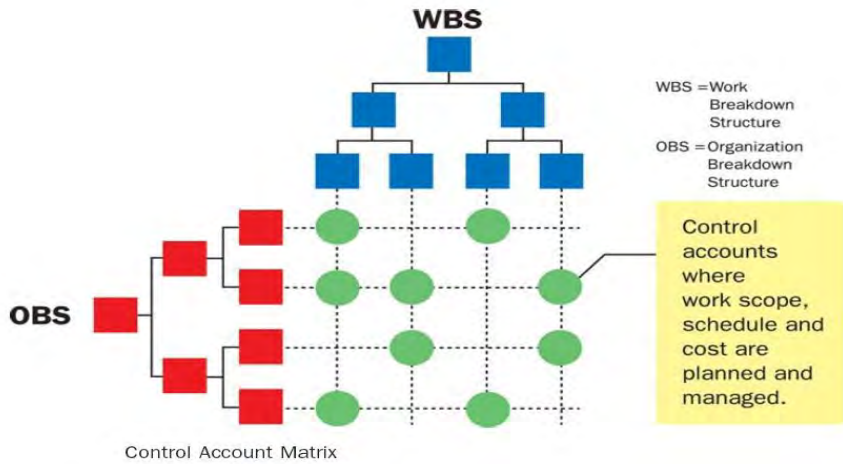


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WBS vs. OBS



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Schedule Management Plan



- Approach
- Milestone
- Critical activities
- Responsibilities
- Prioritization
- Analyzing
- Documentation
- Change process



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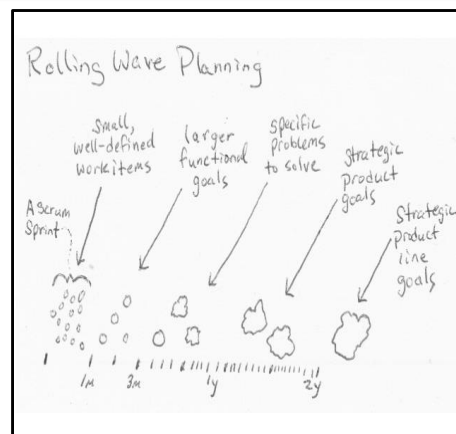
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Rolling Wave Planning



- Is a form of progressive elaboration planning.
- Work to be accomplished in the near term is planned in detail at a low level of the WBS
- Work far in the future is planned for WBS components that are at a relatively high level of the WBS.



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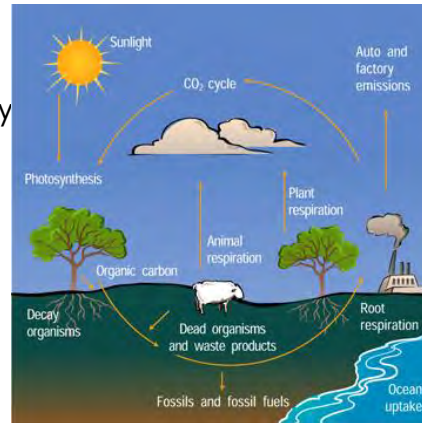
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Dependencies



- **Mandatory** dependency inherent in the nature of the work being done / contractually required (hard logic)
- **Discretionary** dependency determined by project team (soft logic)
- **External**



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155

Estimate Activity



- **Expert judgment:**
- Analogous estimating
- Parametric estimating
- 3-point estimate
- Reserve analysis



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Estimate Activity



- Expert judgment
- **Analogous estimating:** also called *top-down estimating*, means using the actual duration of a previous, similar activity as the basis for estimating the duration of a future activity based on specific parameters like duration, budget, size, weight
- Parametric estimating
- 3-point estimate
- Reserve analysis



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Estimate Activity



- Expert judgment
- Analogous estimating
- **Parametric estimating** uses statistical relationship between historical data and other variables to estimate for activities, such as multiplying quantity of work by productivity rate
- 3-point estimate
- Reserve analysis

$$\Psi_i \cos(\alpha_i + 2\omega t) = \Phi \cos(\dots)$$

$$\Phi = \sum \Psi_i^2 + 2 \sum_{i,j} \Psi_i \Psi_j$$

$$\int x(t) dt = \frac{x(t)}{dt^n} = (\omega)^n$$

$$u = \frac{1}{\sqrt{2}} \left(\frac{\partial u}{\partial t^2} + \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right)$$

$$v = \sqrt{\left(\frac{g\lambda}{2\pi} + \frac{2\pi\gamma}{\rho\lambda} \right) \tan \theta}$$

$$= \int_{-\infty}^{\infty} (\alpha(k)) e^{i(kx - \omega t)} dk$$

$$E = mc^2$$

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Estimate Activity Duration



- Expert judgment
- Analogous estimating
- Parametric estimating
- **3-point estimate**



Optimistic, most likely, pessimistic

$$t_E = \frac{t_o + 4t_M + t_p}{6}$$

and

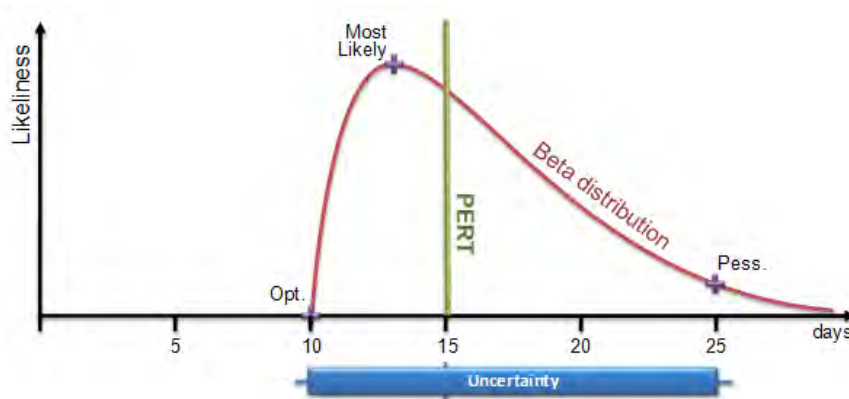
$$t_\sigma = \frac{t_p - t_o}{6}$$

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PERT



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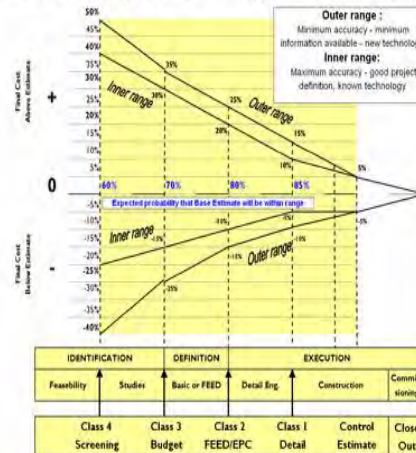
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Estimate Cost



- Activity Cost Estimates
- **Bases of estimates**
 - how it was developed
 - assumptions
 - constraints
 - range of possible estimates ($\pm 15\%$, 8-10)
 - Confidence level
- Project document update

Relation between project phases, estimating type and expected accuracy



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Schedule Compression



- 1- Crashing
- 2- Fast tracking



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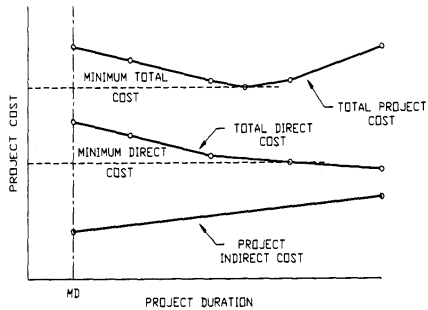
162

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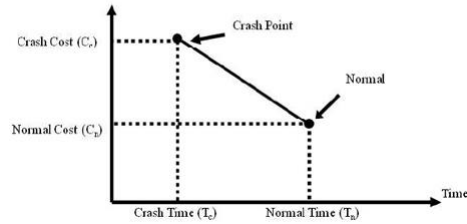
Crashing



Total project duration-cost relationship.



$$\text{Crash Ratio} = \frac{C_c - C_n}{T_n - T_c}$$

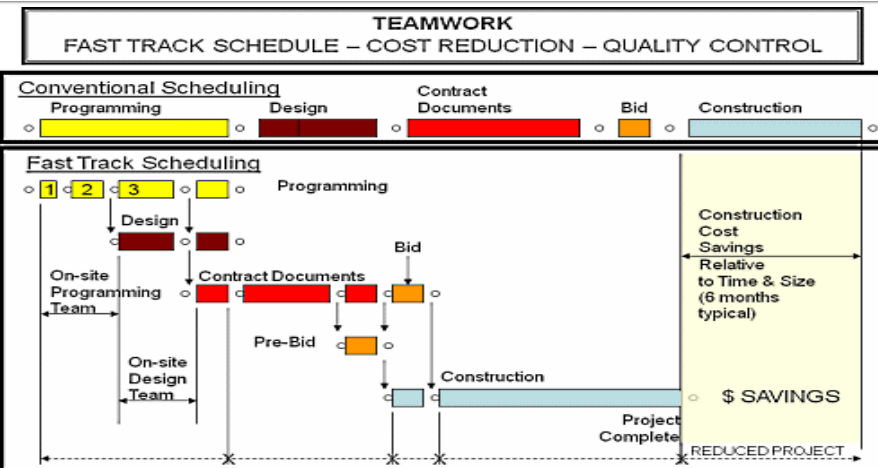


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Fast Tracking



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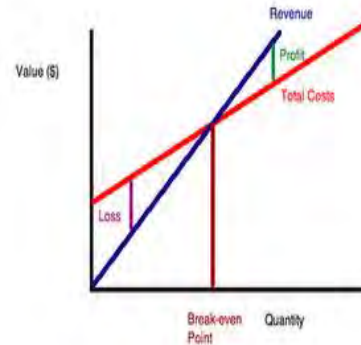
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Variable & Fixed Costs



- Variable Costs that change with the amount of production.
- Fixed Costs that do not change as production changes.



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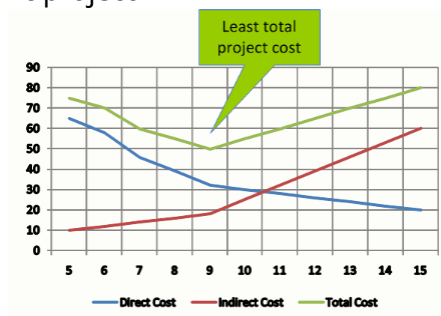
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Direct and Indirect Cost



Indirect costs are the necessary costs of doing business that cannot be related to a particular activity and in some cases cannot be related to a specific project.

- general overhead
- project overhead.

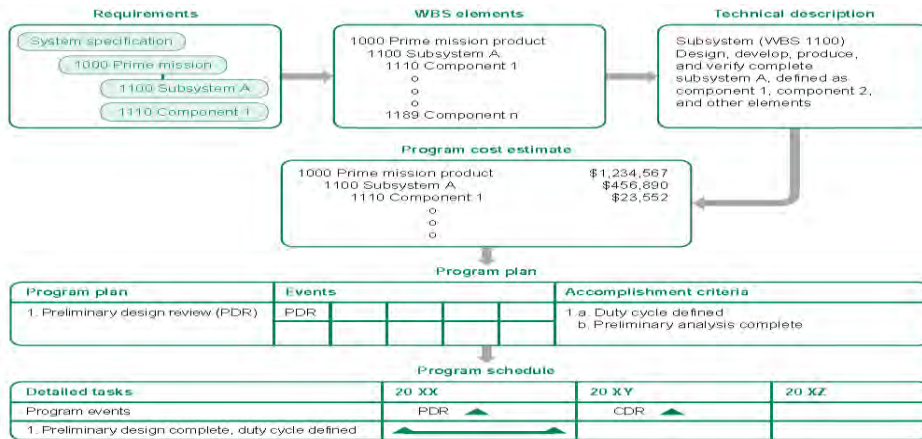


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Cost, Schedule & Technical Integration



Source: NDIA.

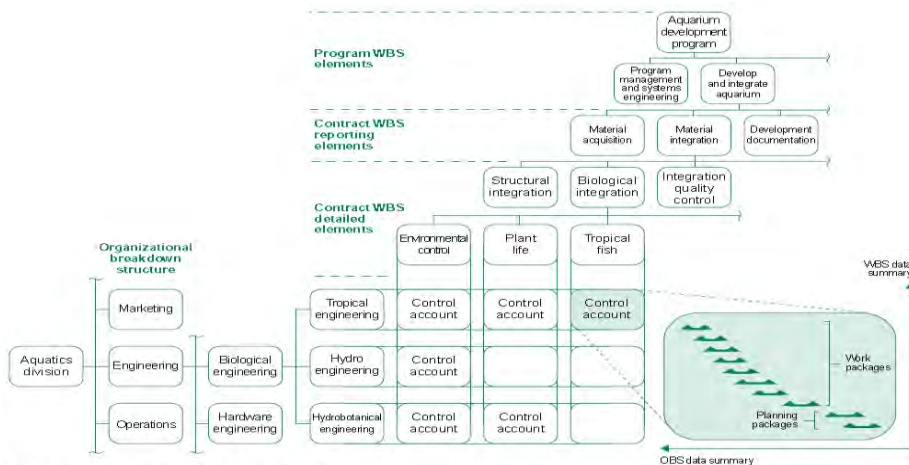
Note: CDR = critical design review.

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167

Responsibility at Control Account



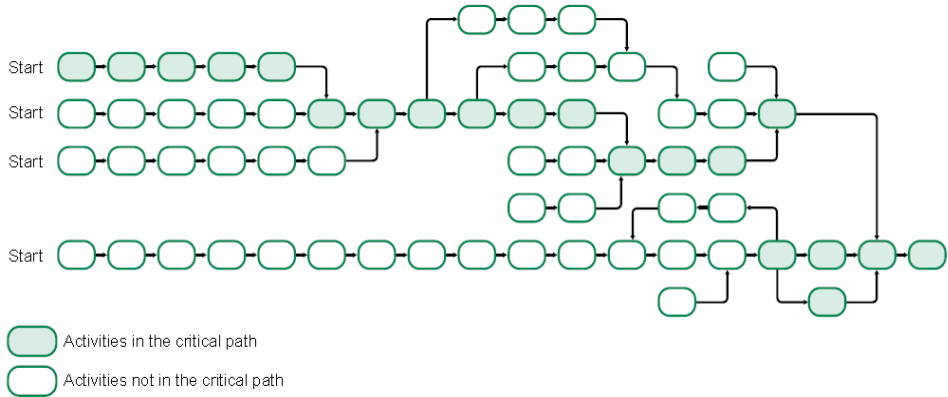
Source: ©2003 SCEA, "Earned Value Management Systems."

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Activity Network


Source: ©2005 MCR LLC, "Schedule Risk Analysis"

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Gantt Chart



ID	Name	Start	2002, Qtr 2			2002, Qtr 3			2002, Qtr 4			2003, Qtr 1		
			Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	Event 1	4/28/02	██████████											
2	Accomplishment 1.1	4/28/02	██████████											
3	Criterion 1.1.1	4/28/02	██████████											
4	Task 1.1.1.1	4/28/02	██████████											
5	Criterion 1.1.2	5/12/02		██████████										
6	Task 1.1.2.1	5/12/02		██████████										
7	Accomplishment 1.2	5/5/02	██████████											
8	Criterion 1.2.1	5/5/02	██████████											
9	Task 1.2.1.1	5/5/02	██████████											
10	Event 2	5/3/02	██████████			██████████								
11	Accomplishment 2.1	5/3/02	██████████			██████████								
12	Criterion 2.1.1	7/26/02				██████████								
13	Task 2.1.1.1	7/26/02				██████████								
14	Criterion 2.1.2	5/3/02	██████████											

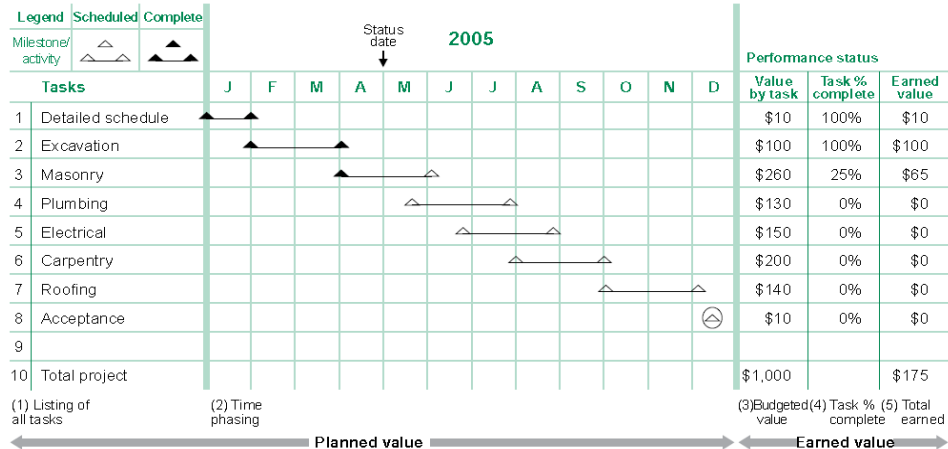
Source: DOD.

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170

Percent Complete Method


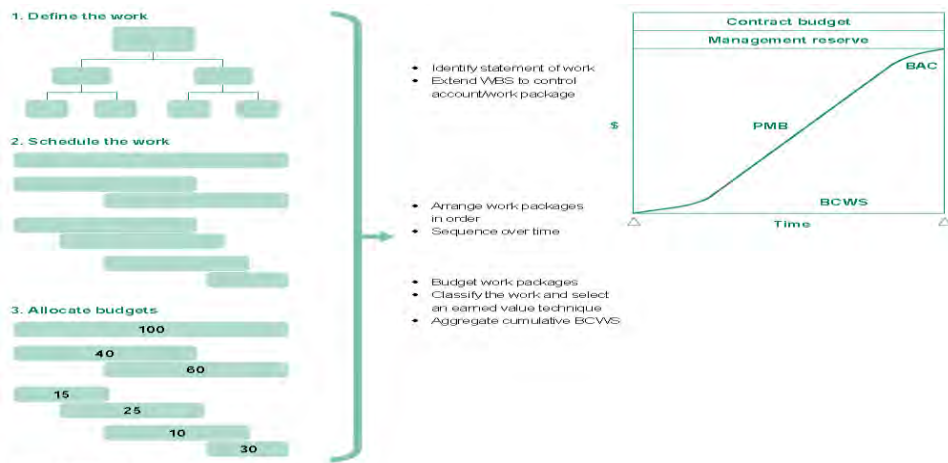
Source: GAO and Quentin W. Fleming at <http://www.quentinf.com>.

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Genesis of the Performance Measurement Baseline

Source: ©2005 MCR, LLC, "Using Earned Value Data"

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172

Cash Flow



Activity	PV	1	2	3	4
A	60,000				
B	40,000				
C	60,000				
D	40,000				
Monthly Indirect Cost		5,000	5,000	5,000	5,000

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173

Cash Flow



A	66,000				
B	44,000				
C	66,000				
D	44,000				
Monthly Direct Cost		33,000	77,000	88,000	22,000
Cumulative Monthly Cost		33,000	110,000	198,000	220,000

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Cash Flow



	A	66,000				
	B	44,000				
	C	66,000				
	D	44,000				
Monthly Direct Cost			33,000	77,000	88,000	22,000
Cumulative Monthly Cost			33,000	110,000	198,000	220,000

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2-month progress



Activity	PV	1	2	3	4	% Complete	AC
A	66,000					100	69,000
B	44,000					60	28,000
C	66,000					40	22,000
D	44,000					10	4,000
							123,000

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Cash Flow



Activity	PV	1	2	3	4	% Complete	EV
A	66,000	■	■	■	■	100	66,000
B	44,000	■	■	■	■	60	26,400
C	66,000	■	■	■	■	40	26,400
D	44,000	■	■	■	■	10	4,400
Total EV							123,200

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177

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Cost & Schedule Performance



- BCWP = budgeted cost for work performed
- BCWS = budgeted cost for work scheduled
- ACWP = actual cost for work performed
- Schedule variance = $SV = BCWP - BCWS$
- Schedule performance index = $SPI = BCWP / BCWS$
- Cost variance = $CV = BCWP - ACWP$
- Cost performance index = $CPI = BCWP / ACWP$

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Performance Report

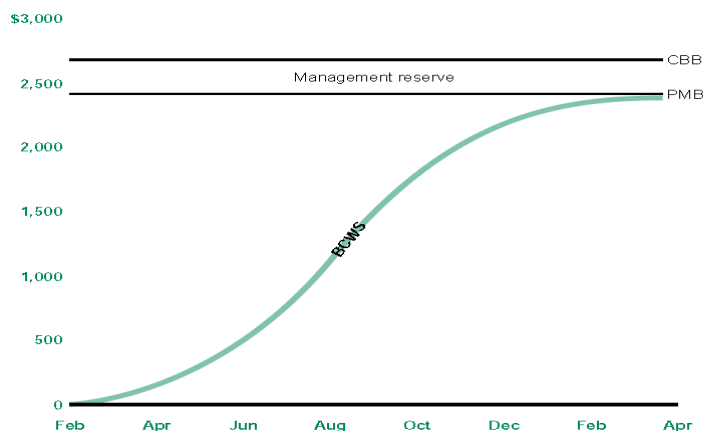


- $PV = 110,000$
- $EV = 123,200$
- $AC = 123,000$
- $SV = 123,200 - 110,000 = 13,200$
- $SPI = 123,200 / 110,000 = 1.120$
- $CV = 123,200 - 123,000 = 200$
- $CPI = 123,200 / 123,000 = 1.001$

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Time-Phased Cumulative Performance Measurement Baseline



Source: © 2003 SCEA, "Earned Value Management Systems."

Note: BCWS = budgeted cost for work scheduled; CBB = contract budget base; PMB = performance measurement baseline.

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180

Performance-Based Payments Structured Contract



Legend		Scheduled	Complete	2005												Performance status		
Milestones	Tasks	▲	▲	J	F	M	A	M	J	J	A	S	O	N	D	Value by M/S	M/S % complete	Total payment
1	Detailed schedule	▲														\$10	100%	\$10
2	Excavation					▲										\$100	100%	\$100
3	Masonry						▲									\$260	0%	\$0
4	Plumbing								▲							\$130	0%	\$0
5	Electrical									▲						\$150	0%	\$0
6	Carpentry										▲					\$200	0%	\$0
7	Roofing											▲				\$140	0%	\$0
8	Acceptance												▲			\$10	0%	\$0
9																		
10	Total project															\$1,000		\$110

(1) Listing of milestones (2) Time phasing (3) Contract values (4) Status complete (5) Total earned

Performance assessment of \$110,000 less a 10% withhold = Payment due of \$99,000

Source: GAO and Quentin W. Fleming at <http://www.quentinf.com>.

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181

Monthly Program Assessment Using Earned Value



Task description	J	F	M	A	M	J	J	A	S	O	N	D	Budgeted	% Complete	Earned
Concrete	▲ 3,000	5,000	2,000	▲									\$10,000	100%	\$10,000
Framing		▲ 5,000	10,000	5,000									20,000	60	12,000
Roofing			▲ 1,000	8,000	6,000								15,000	30	5,000
Electrical					10,000	15,000	15,000						40,000		
Plumbing						6,000	12,000	12,000	5,000				35,000		
Interior										8,000	12,000	15,000	35,000		
Monthly budget	\$3,000	\$10,000	\$13,000	\$13,000	\$16,000	\$15,000	\$21,000	\$12,000	\$12,000	\$13,000	\$12,000	\$15,000			
Cum budget (PMB)	3,000	13,000	26,000	39,000	55,000	70,000	91,000	103,000	115,000	128,000	140,000	155,000			
Earned value (BCWP)	1,000	5,000	15,000	27,000											\$27,000
Actual cost (ACWP)	2,000	7,000	19,000	33,000											

Source: Naval Air Systems Command (NAVAIR).

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182

Forecasting



183

$$EAC_1 = ACWP + (BAC - BCWP)$$

- EAC = estimate at completion
- ACWP = actual cost of work performed to date
- BAC = original budget at completion
- BCWP = budgeted cost of work performed to date

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Forecasting



184

$$EAC_2 = BAC / CPI$$

where:

- CPI = cost performance index
- Other terms as above

$$EAC_3 = \text{New estimate as required}$$

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Forecasting



185

$$EAC_3 = BAC / (CPI * SPI)$$

where:

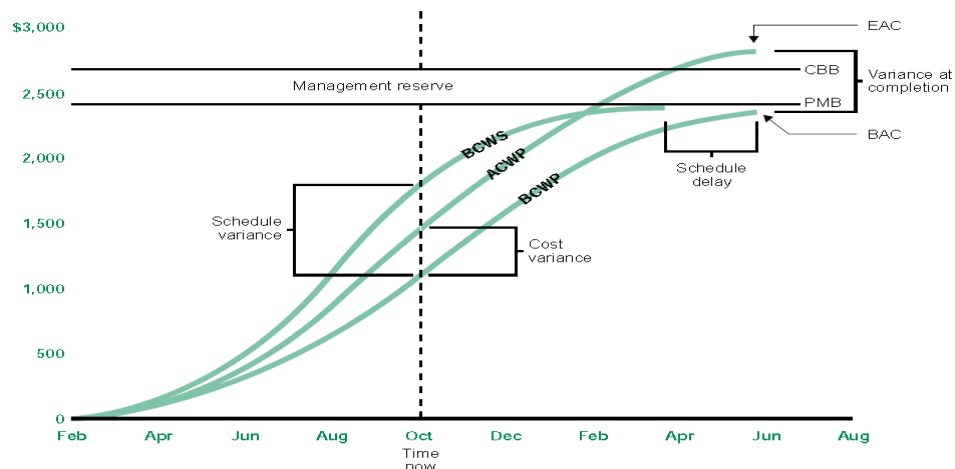
- CPI = cost performance index
- SPI = schedule performance index

$$EAC_4 = \text{New estimate as required}$$

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Overall Program View of EVM Data




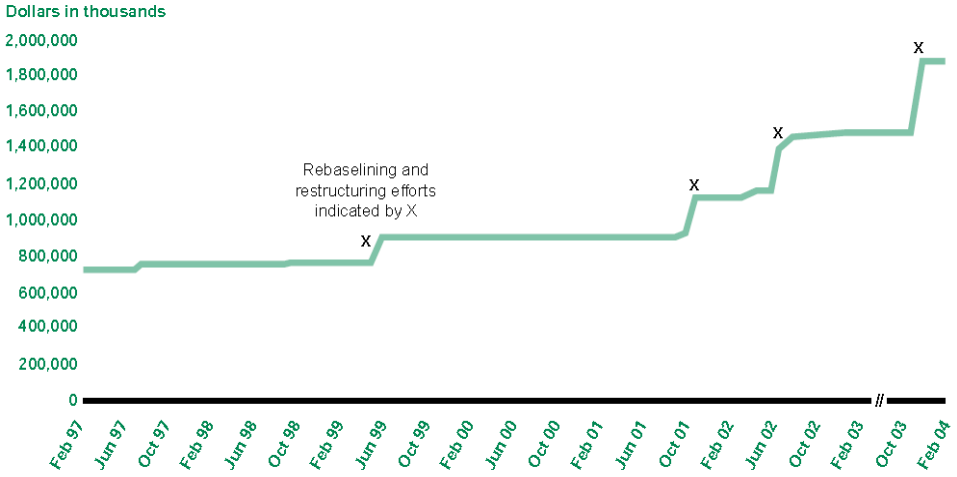
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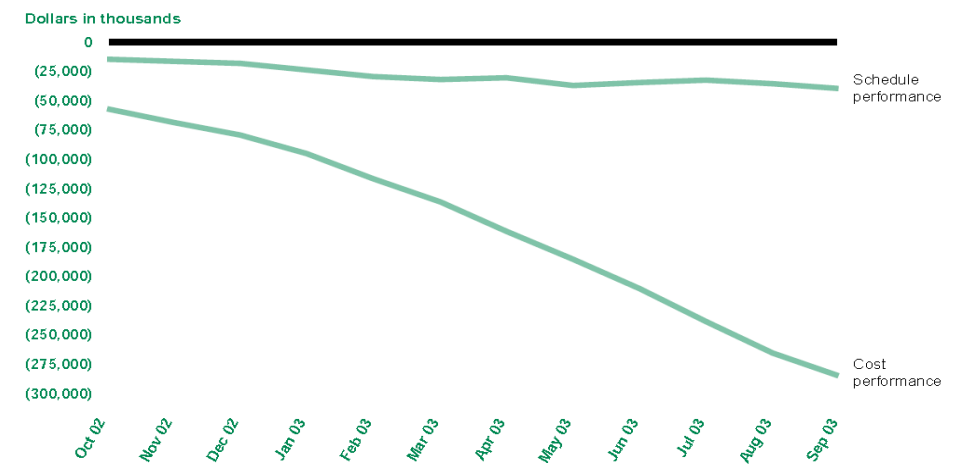
186

Understanding Program Cost Growth by Plotting Budget at Completion Trends

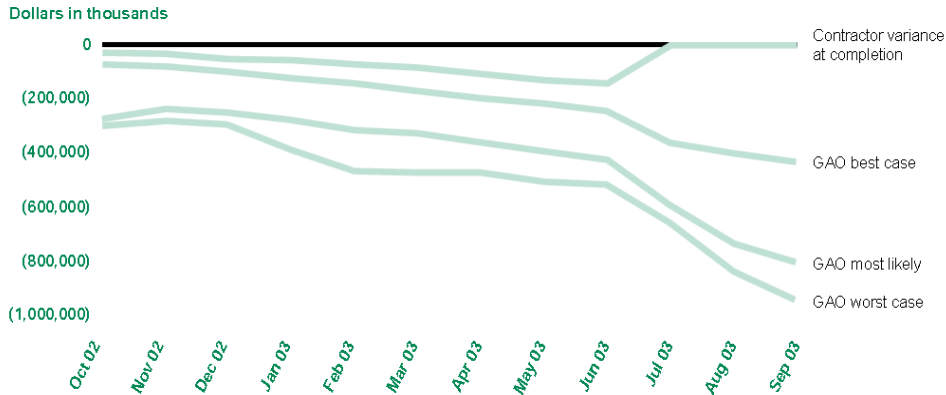
Source: GAO, Prof. Karim El-Dash, www.projacsacademy.com, 187

Understanding Program Performance by Plotting Cost and Schedule Variances

Source: GAO, Prof. Karim El-Dash, www.projacsacademy.com, 188

Understanding Expected Cost Overruns by Plotting Estimate at Completion


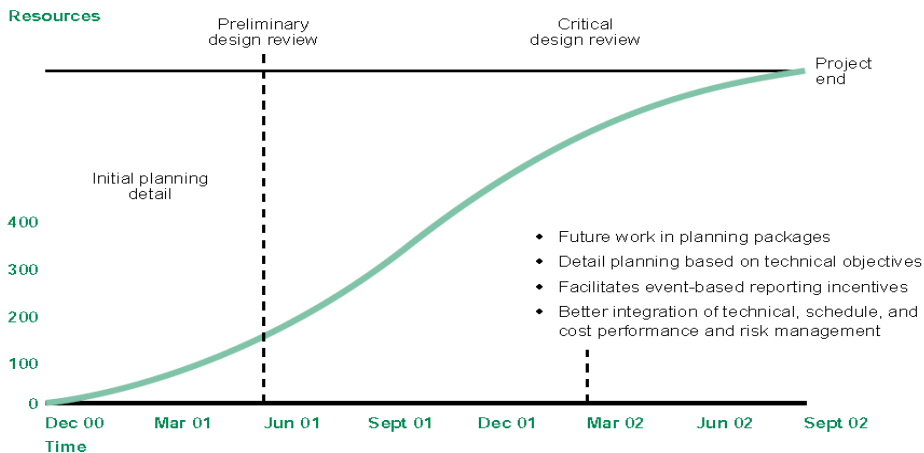
Source: GAO.

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189

Rolling Wave Planning

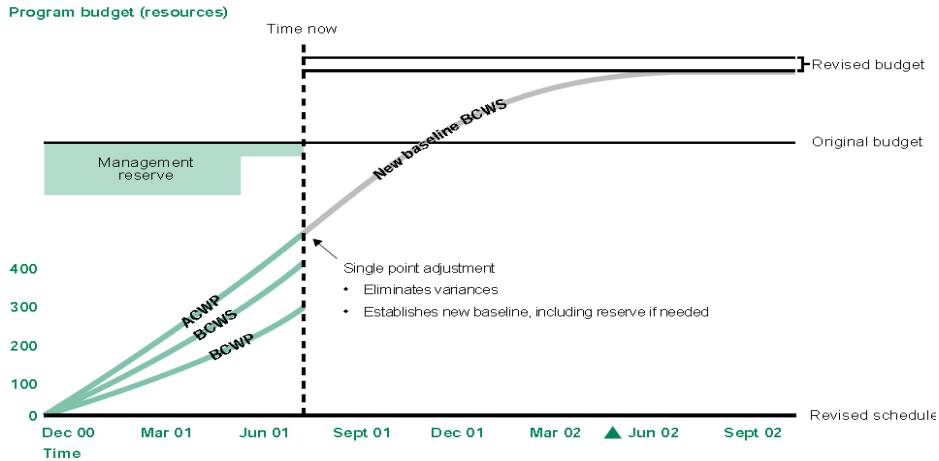
Source: Abba Consulting.

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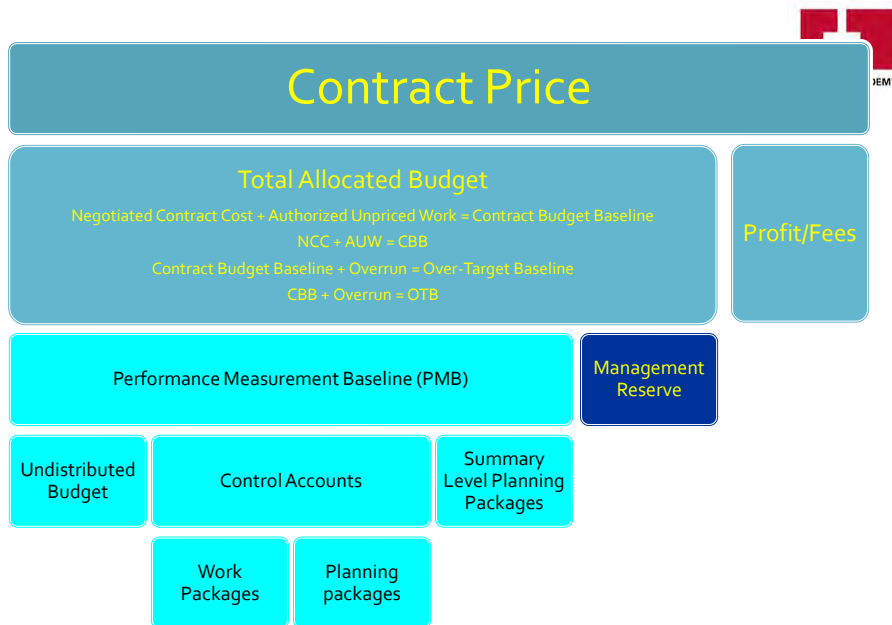
Establishing a New Baseline with a Single Point Adjustment



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Chapter 5

Quality Control / Assurance



Quality Definition

- ISO 8402 Quality Vocabulary
- **Quality:** The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.
- **Quality Assurance:** All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.
 - Continuing evaluation
 - Verification and audits
- **Quality Control:** The operational techniques and activities that are used to fulfill requirements for quality.
 - Monitoring a process
 - Eliminating causes of unsatisfactory performance

RESPONSIBILITIES



Contractor is contractually responsible for the quality

QA or QC activities performed by other parties in no way invalidate the Contractor's responsibility for quality.

The QA/QC program will usually be under the direction of the CE.

Contractor Quality Control



Contractor will provide a CQC Plan.

The CE should require early submittal of the CQC Plan before any construction work is begun.

Forbid commencement of any construction prior to approval of the CQC Plan.

Inspection



Compliance with the terms of the contract.

Reject both unsatisfactory workmanship and materials.

Rejections must be made immediately upon discovery.

Documentation should include photographs where possible.

Work shall not be directed to stop.

Daily inspection reports.

Off-site inspections.

Inspect all materials delivered to site.

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Testing



Ensure that their resources are planned and available.

Follow-on work may proceed.

Cooperate with the Contractor.

Results are distributed to all required parties upon receipt

Reports are to be maintained on file.

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Survey



- Basic survey controls are to be protected.
- Frequent checks on layout to confirm work is accurately installed.
- The CI and surveyors should do regular spot checks of measurements and elevations should be made including pile locations; foundation elevations; anchor bolts for structural framing and major equipment; rooms, recesses and closets to receive furniture, fixtures and equipment fabricated off-site; ceiling heights and space for utilities.
- Final pay items that can be verified.

Non-Complying Work



Non-conforming work was brought to attention of Contractor

Corrective action was taken by the Contractor

Corrective action was pre-approved

Corrective action was observed

Minor non-conformances can be verbally notified.

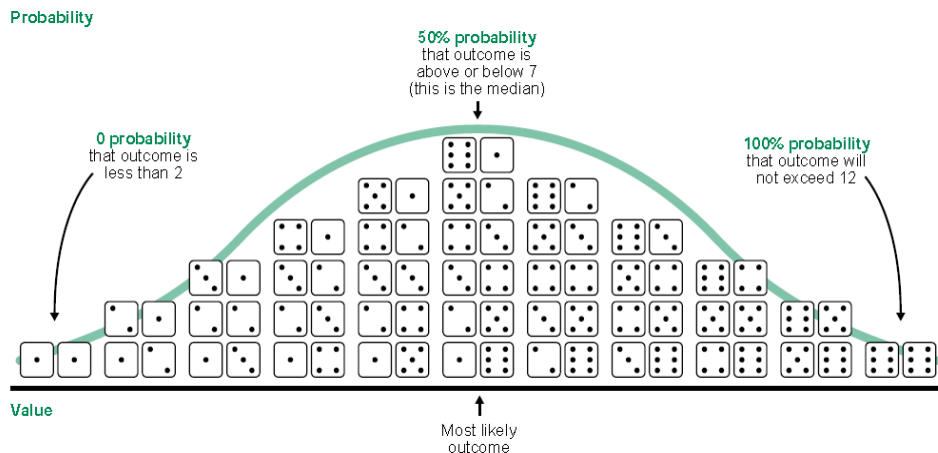
Notification of non-conforming work shall be by means of a Non-Compliance Notice (NCN).



Chapter 6

Risk management

Distribution of Two Dice Experiment



Source: GAO.

Qualitative Description



Location (central tendency)

- **Mean (average):** is the sum of measurements divided by the number of measurements.
- **Median:** is the middle number when the data observations are arranged in ascending or descending order.

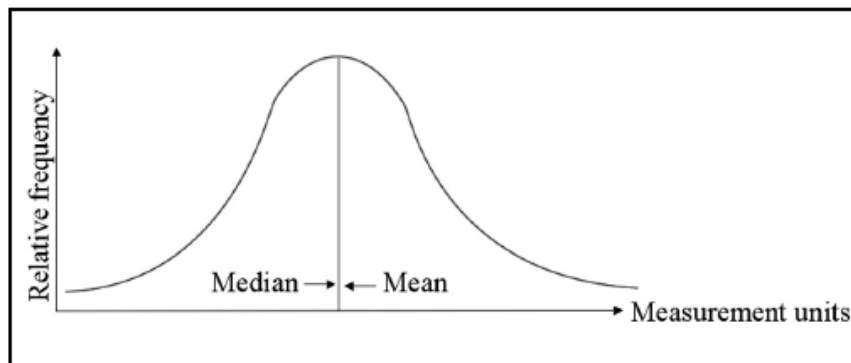
If the number n of measurements is even, the median is the average of the two middle measurements in the ranking.

- **Mode:** is the measurement that occurs most often in the data set.

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Symmetric Distribution

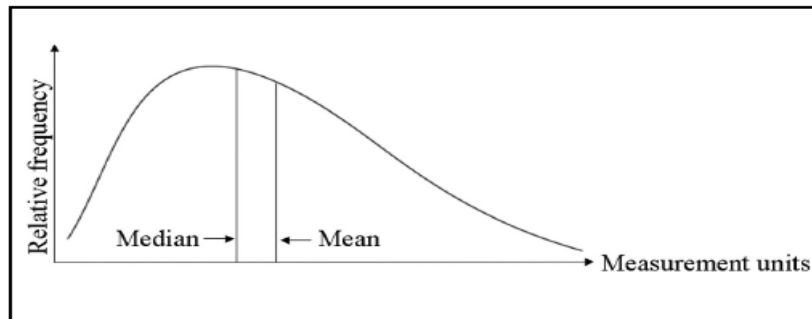


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Skewed Distribution



- Note that the median lies between the mode and mean in all skewed distributions.
- If negatively skewed, the median is higher than the mean.
- If positively skewed, the median is lower than the mean.

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Qualitative Description



Measures of dispersion

- **Range:** is the difference between the largest and the smallest values of the data set.
- The alternative might be to calculate the average absolute deviation. However, this measure is rarely used because it is difficult to handle algebraically.
- **Variance**
- **Standard deviation**

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Variance & Standard Deviation



- Variance of population
$$\sigma^2 = \frac{\sum(x - \mu)^2}{N} = \frac{\sum x^2 - N \mu^2}{N}$$
- Variance of sample
$$s^2 = \frac{\sum (x - \bar{x})^2}{n - 1} = \frac{\sum x^2 - n\bar{x}^2}{n - 1}$$
- Standard deviation is the positive square root of the variance.
- The population standard deviation is denoted by σ .
- The sample standard deviation is denoted by s .

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Qualitative Description



Relative standing

- **Percentile:** the p^{th} percentile is the number with exactly $p\%$ of the measurements fall below it
- **Z-score:** is the number of standard deviations a point is above or below the mean of a set of data.

- The population z-score for a measurement x is:
$$z = \frac{(x - \mu)}{\sigma}$$

- The sample z-score for a measurement x is:
$$z = \frac{(x - \bar{x})}{s}$$

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Random Variables & Probability Distributions



A random variable is a variable whose numerical value is determined by the outcome of a random experiment.

Discrete probability distribution

Example: Two coins are tossed. Let X be the number of heads appeared.

Probability distribution of X

x	0	1	2
$p(x)$	$1/4$	$2/4$	$1/4$

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Expected Value (Mean)



- The expected value μ is:

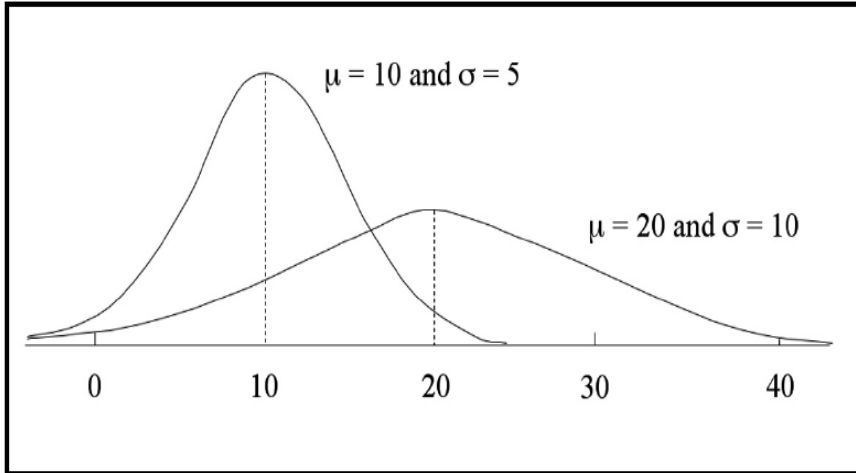
$$\mu = E(x) = \sum x \cdot p(x)$$
- The population variance is defined as:

$$\sigma = E(x - \mu)^2 = \sum (x - \mu)^2 \cdot p(x)$$

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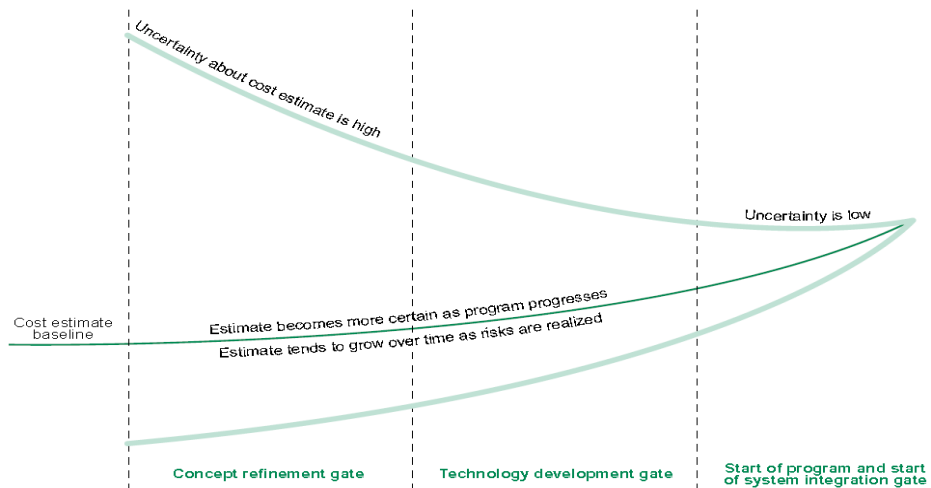
Normal Distribution

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Cone of Uncertainty

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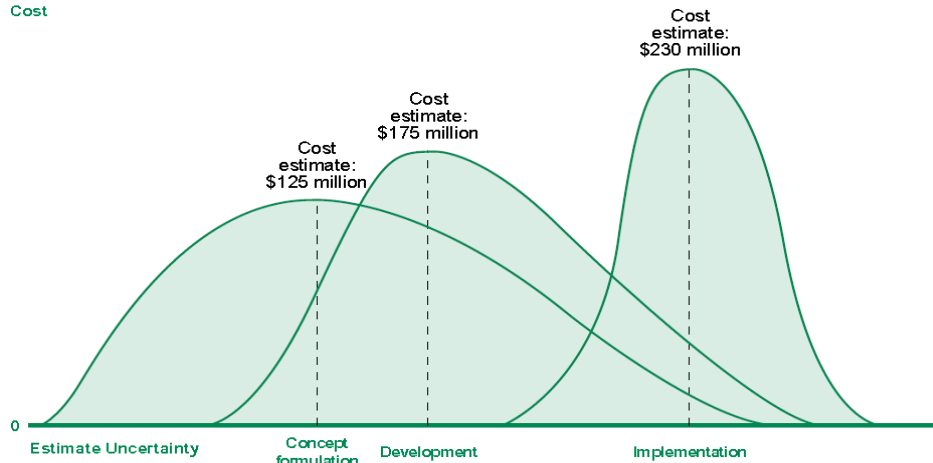
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Uncertainty Across Life-Cycle



Cost



Source: GAO.

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Risk Management



Risk is:

- Enhance opportunities
- Reduce threats

Risk processes

1. Planning
2. Identification
3. Assessment
4. Analysis
5. Mitigation

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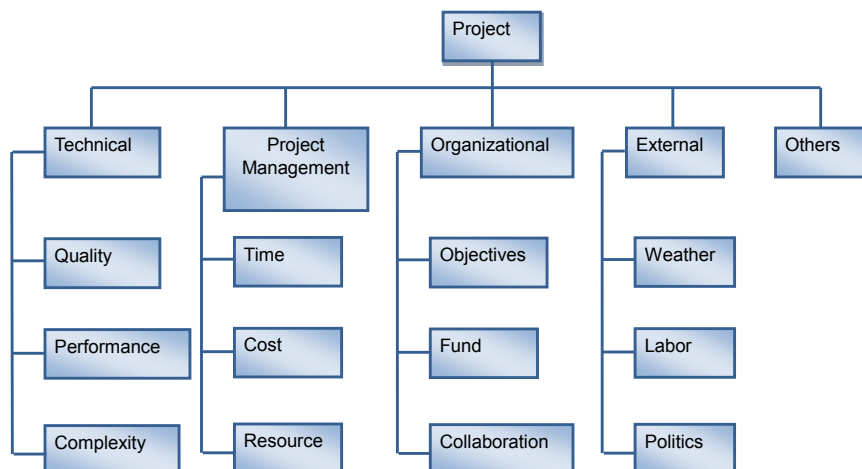
Risk Responsibility Chart				
	Top management	PM	Management Team	Risk Owner
Plan Risk Management	X	X	X	
Identify Risk		X	X	
Perform Qualitative Risk Management		X	X	X
Perform Qualitative Risk Management		X	X	X
Plan Risk Responses		X	X	X
Monitor & Control Risks		X	X	X

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Risk Breakdown Structure (RBS)



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Likelihood Expectations



Level	Likelihood	Expected or actual frequency experienced
1	Rare	May only occur in exceptional circumstances; simple process; no previous incidence of non-compliance
2	Unlikely	Could occur at some time; less than 25% chance of occurring; noncomplex process &/or existence of checks and balances
3	Possible	Might occur at some time; 25 –50% chance of occurring; previous audits/reports indicate non-compliance; complex process with extensive checks & balances; impacting factors outside control of organization
4	Likely	Will probably occur in most circumstances; 50-75% chance of occurring; complex process with some checks & balances; impacting factors outside control of organization
5	Almost certain	Can be expected to occur in most circumstances; more than 75% chance of occurring; complex process with minimal checks & balances; impacting factors outside control of organization

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Impact Scale



Objective	Relative or numerical scales				
	Very low / 0.05	Low / 0.10	Moderate / 0.20	High / 0.40	Very High / 0.80
Cost	Insignificant increase	<10% increase	10-20% increase	20-40% increase	>40% increase
Time	Insignificant increase	<5% increase	5-10% increase	10-20% increase	>20% increase
Scope	Barely noticed change	Minor change	Major change	Unacceptable by sponsor	Product is useless
Quality	Barely noticed	Applications affected	Sponsor approval required	Unacceptable by sponsor	Product is useless

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Stakeholder Tolerance Matrix					
Stakeholder	Requirements	Tolerances			
		Time	Cost	Quality	
PM	Deliver product as requested	More than 10% Phase II	More than 5% Phase II	Conformance to all specs	
Technical Manager	Passing all QC criteria	More than 20% Phase II	More than 10% Phase II	Conformance to all limitations	
Marketing Manager	Verify profits	More than 5% Phase II	More than 2% Phase II	Customer acceptance	
IT Manager	Customer satisfaction (internal & external)	More than 20% Phase II	More than 5% Phase II	Positive feedback	

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Risk Matrix



	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Extreme
Rare	Low	Low	Low	Low	Low
Unlikely	Low	Low	Low	Medium	Medium
Possible	Low	Low	Medium	Medium	Medium
Likely	Low	Medium	Medium	High	High
Almost certain	Low	Medium	Medium	High	Extreme

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RISK REGISTER

Project Title:

Date Prepared:

Risk ID	Risk Statement	Probability	Impact				Score	Response
			Scope	Quality	Schedule	Cost		

Revised Probability	Revised Impact				Revised Score	Responsible Party	Actions	Status	Comments
	Scope	Quality	Schedule	Cost					
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SWOT




Probability – Impact Matrix



Impact	Probability				
	0.9	0.7	0.5	0.3	0.1
0.9	0.81	0.63	0.45	0.27	0.09
0.7	0.63	0.49	0.35	0.21	0.07
0.5	0.45	0.35	0.25	0.15	0.05
0.3	0.27	0.21	0.15	0.09	0.03
0.1	0.09	0.07	0.05	0.03	0.01

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Probability	Threats					Opportunities				
	0.90	0.05	0.09	0.18	0.36	0.72	0.72	0.36	0.18	0.09
0.70	0.04	0.07	0.14	0.28	0.56	0.56	0.28	0.14	0.07	0.04
0.50	0.03	0.05	0.10	0.20	0.40	0.40	0.20	0.10	0.05	0.03
0.30	0.02	0.03	0.06	0.12	0.24	0.24	0.12	0.06	0.03	0.02
0.10	0.01	0.01	0.02	0.04	0.08	0.08	0.04	0.02	0.01	0.01
	0.05	0.10	0.20	0.40	0.80	0.80	0.40	0.20	0.10	0.05

Impact (ratio scale) on an objective (e.g., cost, time, scope or quality)


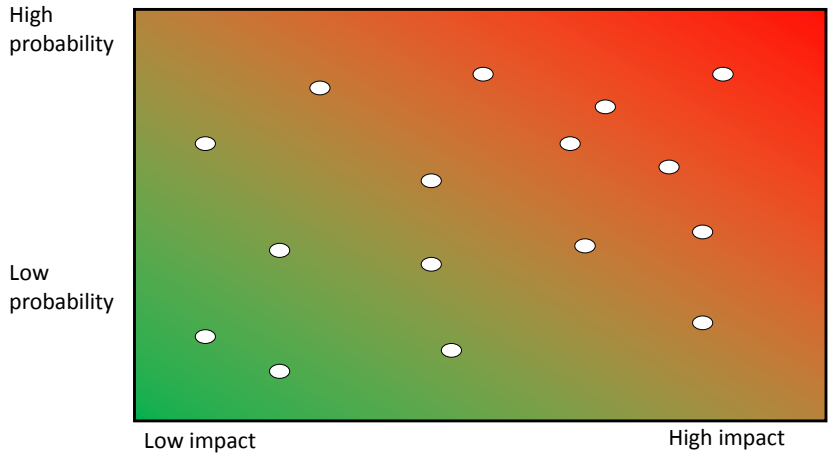
Each risk is rated on its probability of occurring and impact on an objective if it does occur. The organization's thresholds for low, moderate or high risks are shown in the matrix and determine whether the risk is scored as high, moderate or low for that objective.

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Probability – Impact Chart


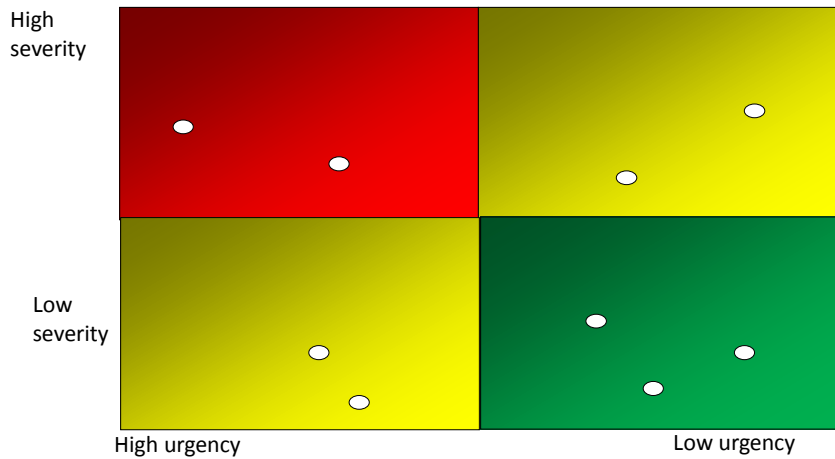



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Critical Events

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Risk Severity

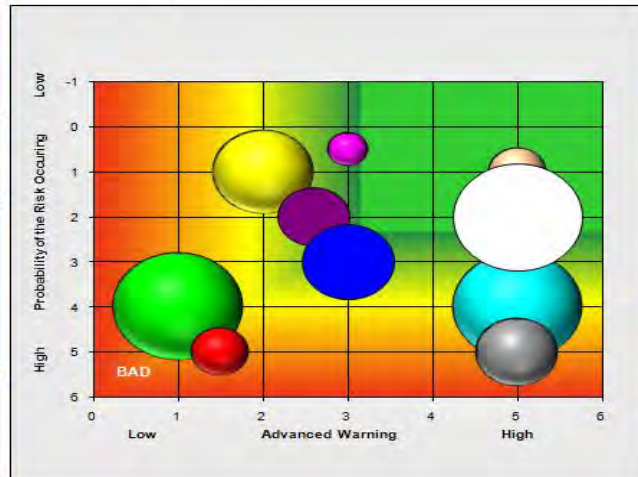


Magnitude is the degree of impact the risk would have on the project if it did become an issue.
1 = Little impact
5 = Very great impact

Probability is an estimation of how likely it is to become a real issue.
1 = 10-20% likely
5 = 80-100% likely

Lack of Advanced Notice is an estimation of how little advanced notice the project manager will have between knowing it will become a real issue and when the issue will impact the project (how much time will there be to respond).
1 = plenty of time
5 = no advanced notice

Severity is based on a calculation of the magnitude of the risk, its probability, and the lack of advanced warning (how much time there will be to respond).



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Three-Point Estimate



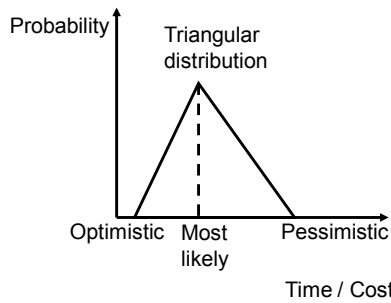
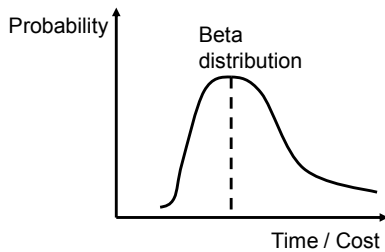
WBS Element	Low	Most Likely	High
Design	\$2	\$4	\$7
Build	\$35	\$45	\$60
Verify	\$5	\$7	\$10
Total	\$42	\$56	\$77

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Probability Distribution





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Point Estimate Probability Distribution

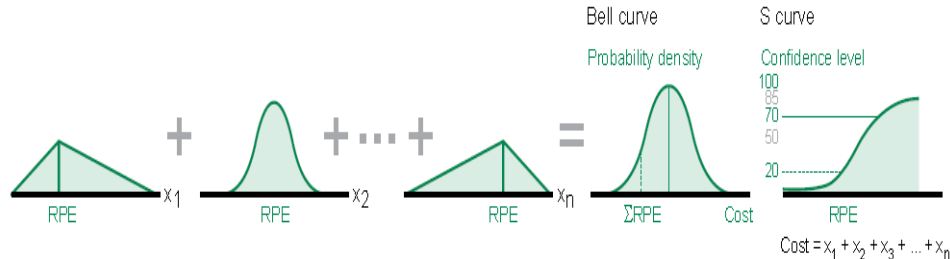


Inputs

Probability distributions for each cost element in a system's work breakdown structure

Outputs

A cumulative probability distribution of the system's total cost



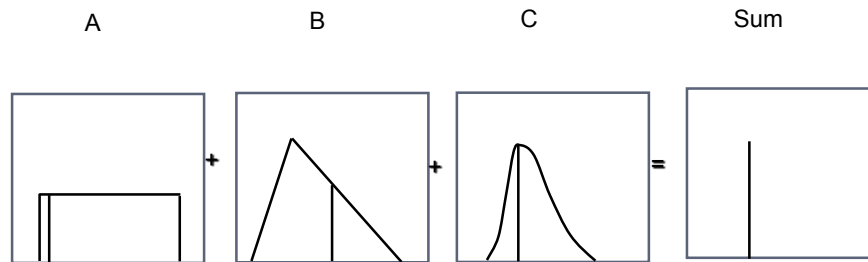
Source: NASA

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230

SIMULATION

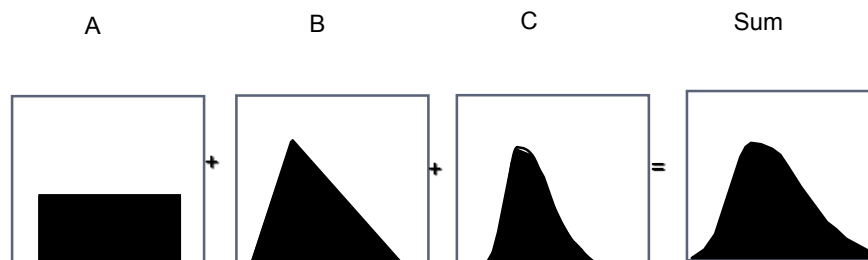


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SIMULATION



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COST ANALYSIS



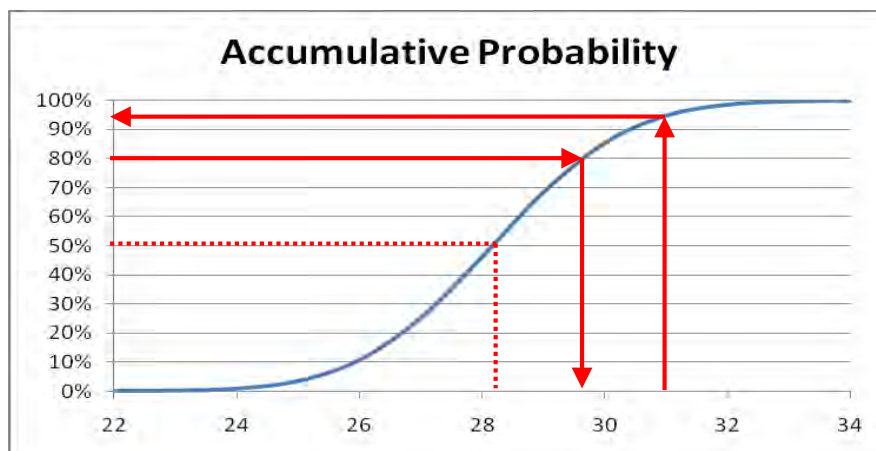
Activity	Min	Most Likely	Max	Distribution	Median (50%)	σ
Design	5.5	7.0	9.7	Trig.	7.3	0.8
Construction	150	190	260	β	205	13.2
Commission	12.0	15.2	19.8	Trig.	15.8	1.2
-----	-----	-----	-----	-----	-----	-----
Total	163.4	210.4	281.4	Simulated	226.2	13.9

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Total Cost Probability Distribution




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Contingency


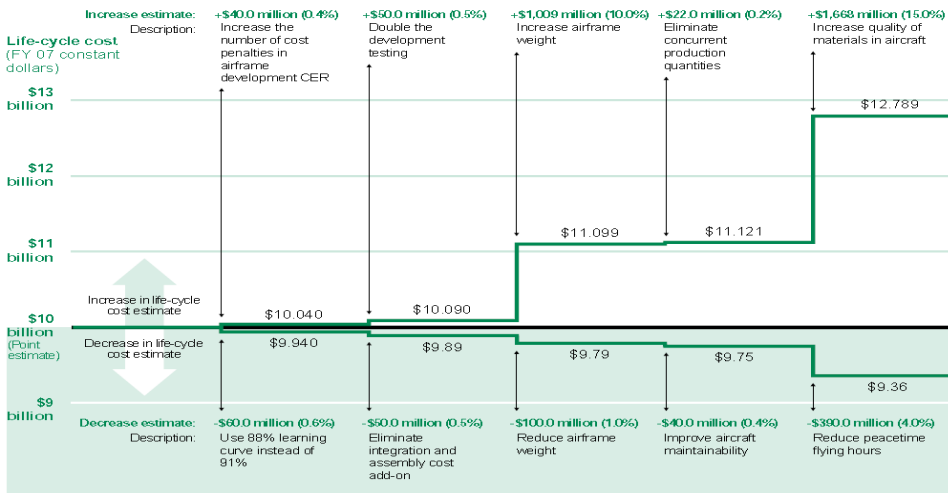


Contingency is an amount added to an estimate or schedule to allow for changes that experience shows will likely be required.

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Sensitivity Analysis

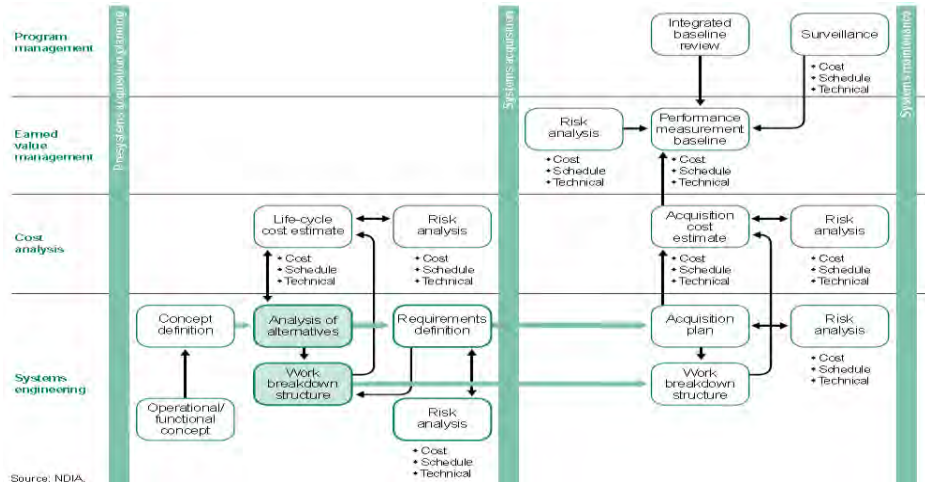



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Integration of Estimate, System & Risk

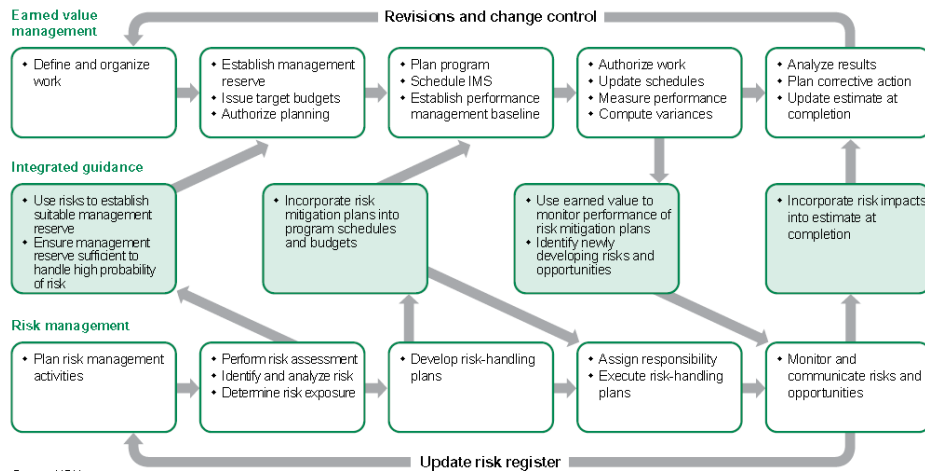


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Integration of Earned Value & Risk

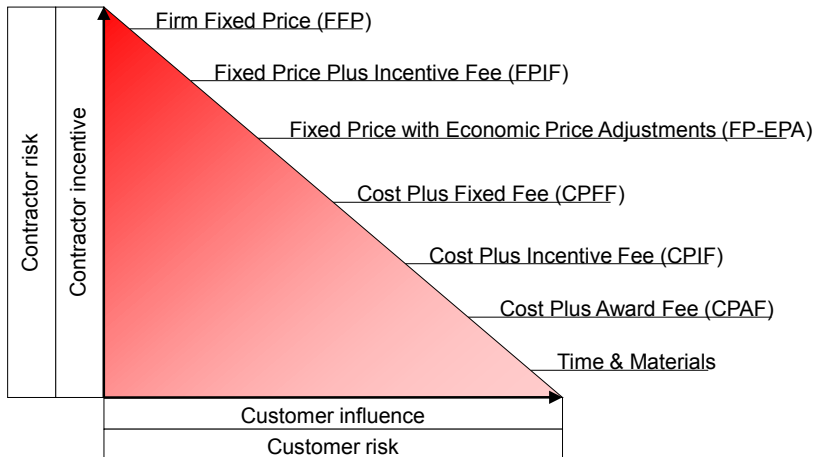


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Risk-Related Contract Decisions



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Chapter 7

CONSTRUCTION ENVIRONMENTAL MANAGEMENT

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Environmental Mitigation Measures



- General Mitigation Processes During Construction
- Mitigation of air pollution
- Mitigation of water pollution
- Mitigation of soil pollution
- Mitigation of Construction Noise
- Construction Vibration Mitigation

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Environmental Mitigation Measures



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Chapter 8

CONSTRUCTION SITE MANAGEMENT

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CONSTRUCTION SITE MANAGEMENT



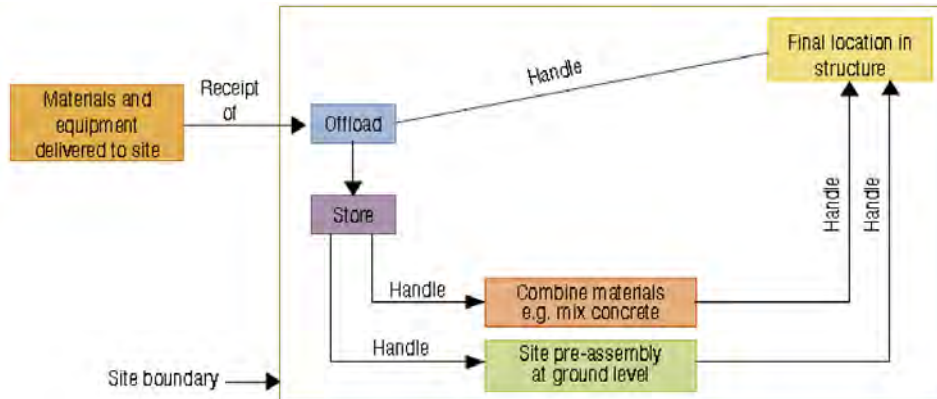
- Map of site
- Plan starting with work and physical sequence
- Identify potential problem areas
- Planning of site access and circulation
- Positioning temporary site services and facilities
- Materials storage and handling

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CONSTRUCTION SITE MANAGEMENT



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Chapter 9

CONSTRUCTION SITE SAFETY

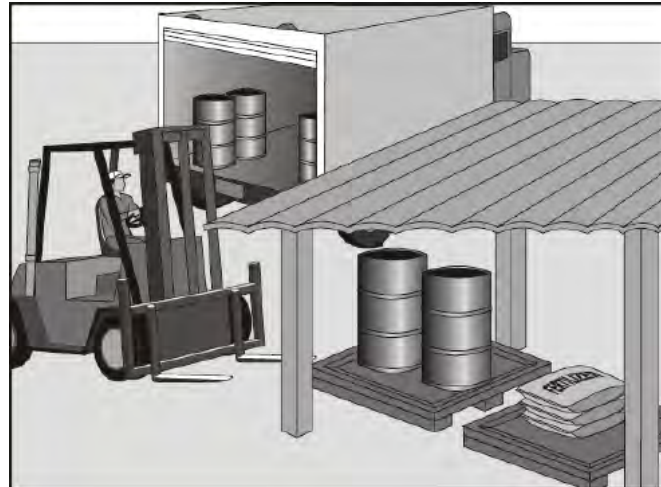


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Material Delivery and Storage

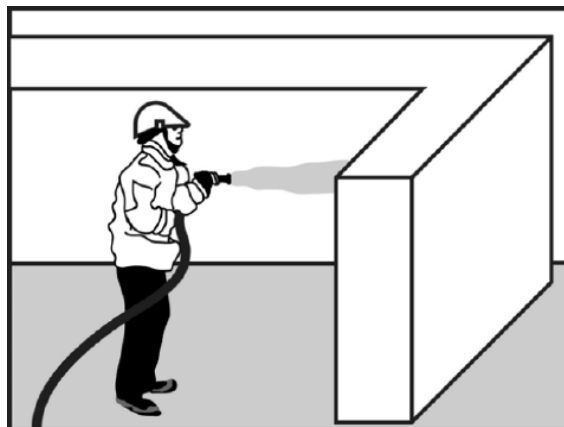


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Material Use

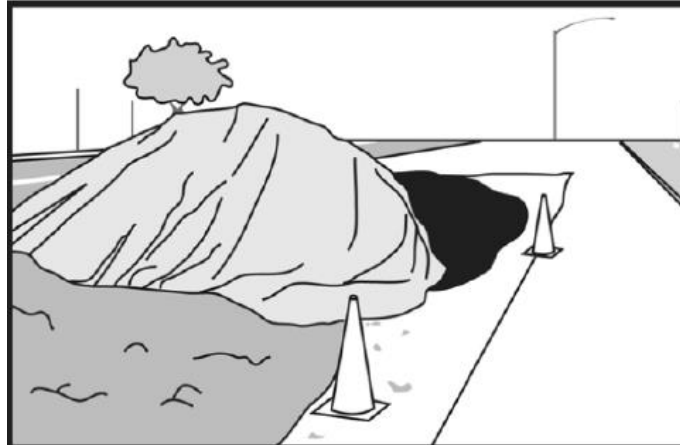


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Protection of Stockpiles

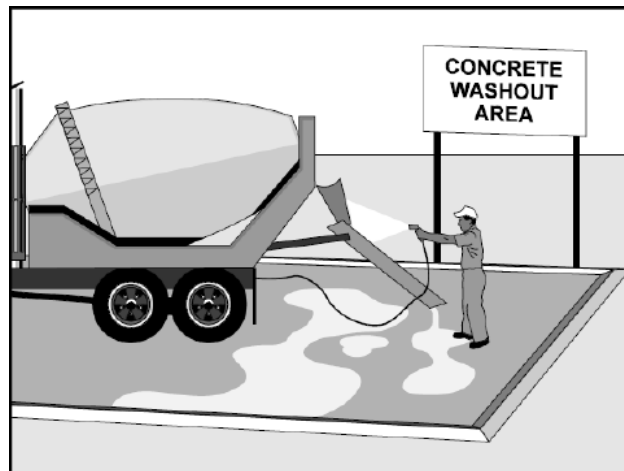


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Concrete Waste Management

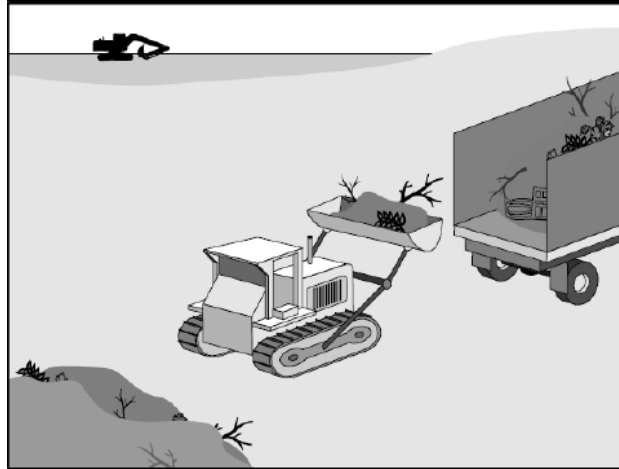


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Solid Waste Management

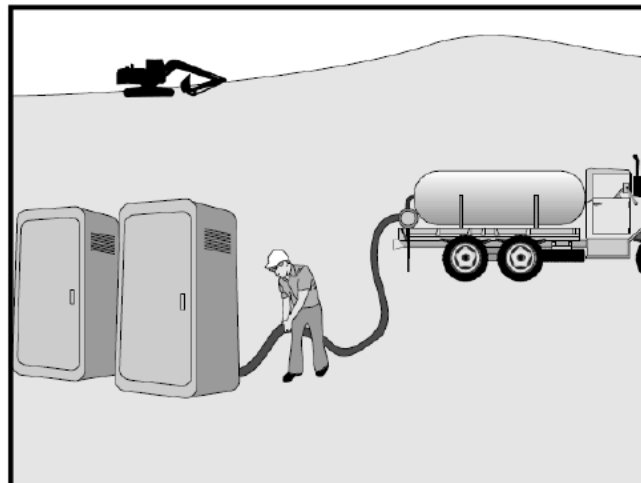


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Sanitary/Septic Waste Management



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Contaminated Soil Management

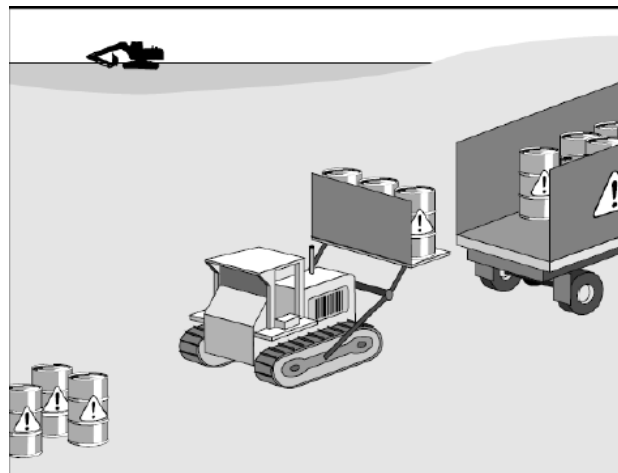


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Hazardous Waste Management

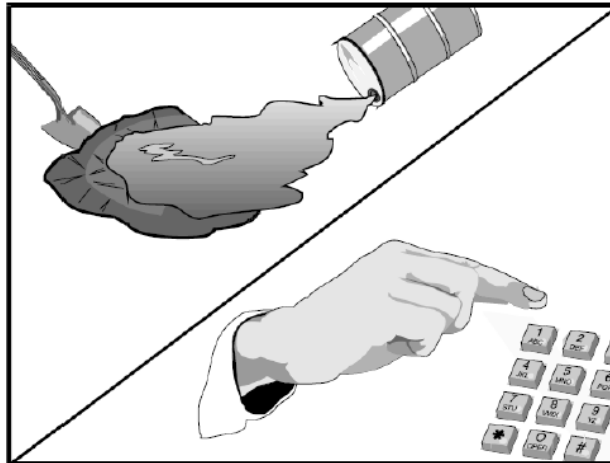


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Spill Prevention and Control

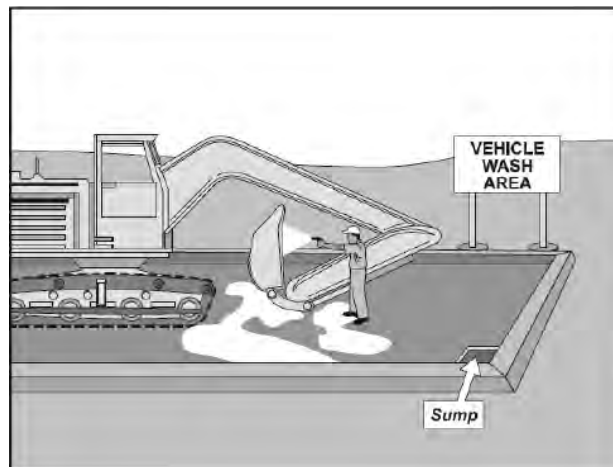


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Vehicle and Equipment Cleaning

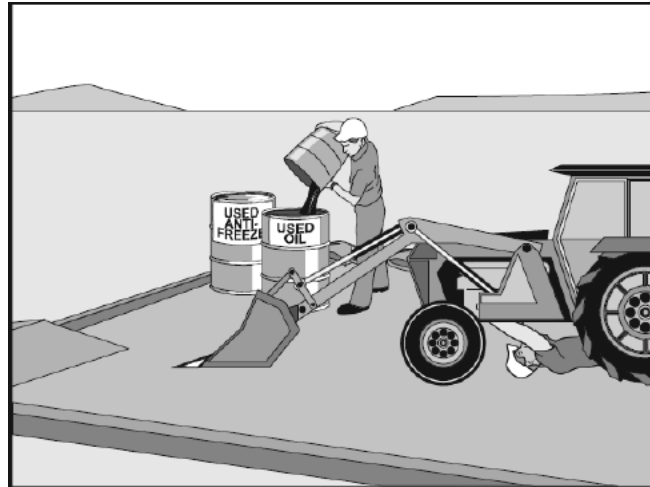


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Vehicle and Equipment Maintenance



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Chapter 10

ADVANCED TECHNIQUES IN THE CONSTRUCTION SUPERVISION



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Burj Khalifa

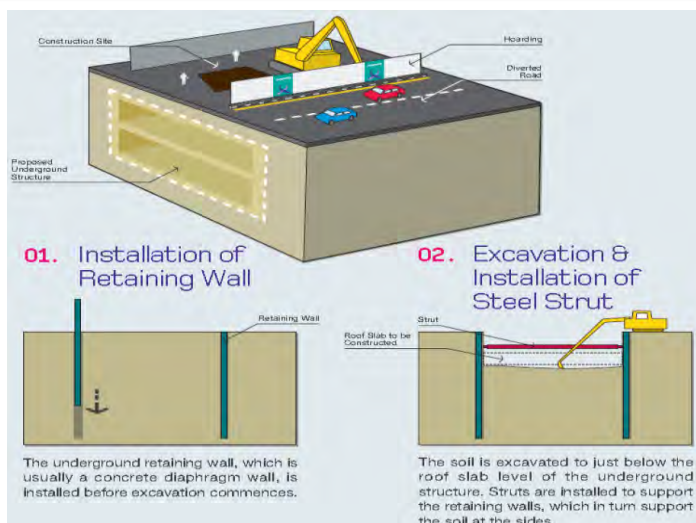


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Top-Down Construction



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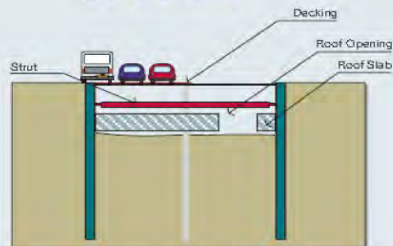
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261

Top-Down Construction



03. Construction of Underground Structure



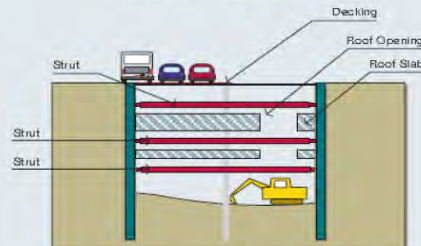
The roof slab is constructed, with access openings provided on the slab for works to proceed downwards. The roof slab not only provides a massive support across the excavation, it also acts as a noise barrier.

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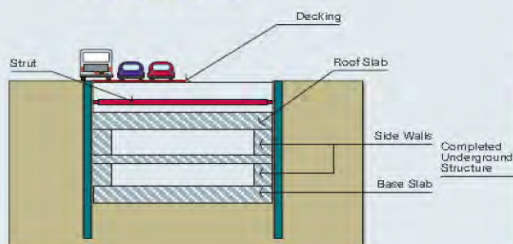
262

04. Construction of Underground Structure



The next level of slab is constructed, and this process progresses downwards till the base slab is completed.

05. Construction of Underground Structure



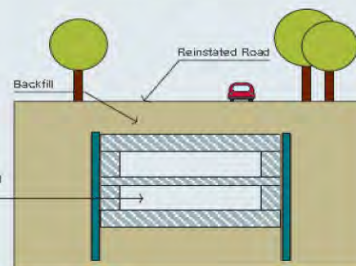
The side walls are constructed upwards, followed by removal of the intermediate struts. The access openings on the roof slab are then sealed.

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263

06. Backfilling & Reinstatement



After the underground structure is completed, the soil is backfilled to the top strut level before the strut is removed. This is followed by completely backfilling the top of the underground structure and finally reinstating the surface areas.

Top-Down Construction





Chapter 11

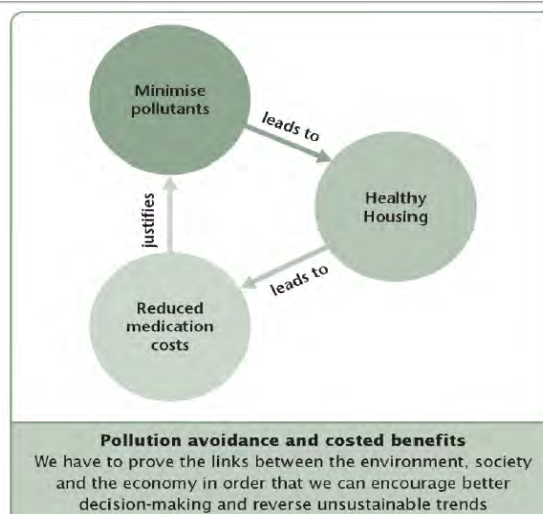
SUSTAINABLE CONSTRUCTION

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264

Pollution and Cost



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265



- Reduced operating costs
- Reduced waste
- Reduced liability
- Enhanced productivity and learning

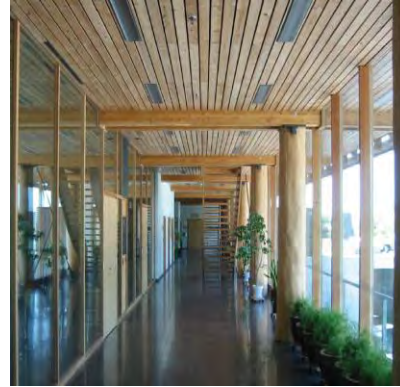
Sustainability Ladder



Material



1. What is the Resource Base?
2. What is the Embodied Pollution?
3. What is its Impact in Use?
4. What is its Final Destination?

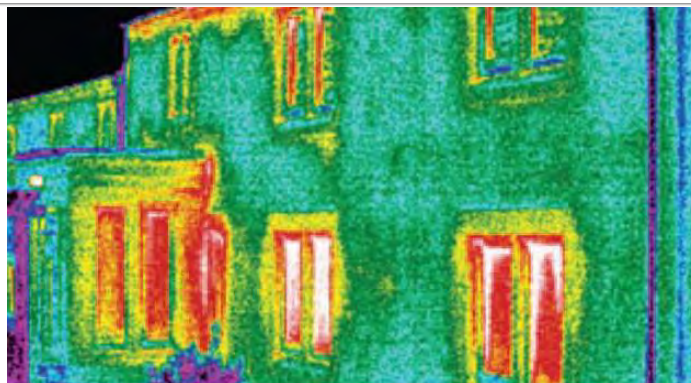


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268

Heat



Thermal image of a house
 Showing leakage through and around doors and windows and badly sealed edges
 (Image: www.irtsurveys.co.uk)

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269

Electricity



- Carbon emissions from buildings.
- Five times as expensive as the unit cost of heat.
- Lack of attention to fan power, pumps, IT and lighting controls.

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270

Light and Daylight



Simple Minds studio
(Architects: Gaia Architects; photo: Gaia Architects)

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271

Ventilation and Cooling System



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272

Chapter 12

CONTRACT COMPLETIONS AND CLOSEOUT



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273

CONTRACT COMPLETIONS AND CLOSEOUT



- CLOSEOUT PROCEDURES IN GENERAL
- AS-BUILT DRAWINGS AND RECORD DRAWINGS
- WARRANTIES, GUARANTEES, AND OPERATING START-UP
- CONTRACTOR'S FINAL PAYMENT/FINAL ESTIMATE
- FINAL MEASUREMENT BY SURVEYORS
- CLOSEOUT DOCUMENTATION
- ARCHIVING FILES AND DRAWINGS