"Potential Flaws When Assessing Financial Risks In Capital Construction Projects"

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FLUOR®

Introduction

- Risk is the potential loss, damage, or any other undesirable event - consequences
  - to be exposed to the chance of injury or loss
  - loss of opportunity (for achieving the project goals and objectives)

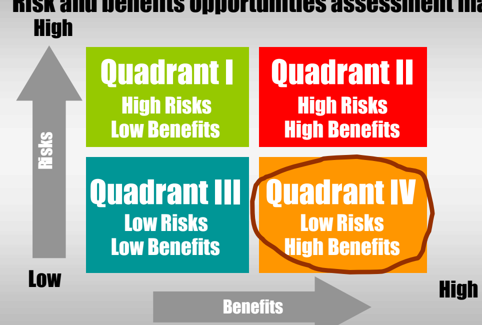
Introduction

- Inherent risk to capital construction projects
  - the degree of risk consequences
- Changing project conditions
- Potential for impact on the plan and initially defined objectives
- Impacting the opportunity for a successful project

✓ time
✓ cost
✓ scope definition

Introduction

Risk and benefits opportunities assessment matrix



Percent (%) of construction cost overrun above the original base line budget.

Introduction

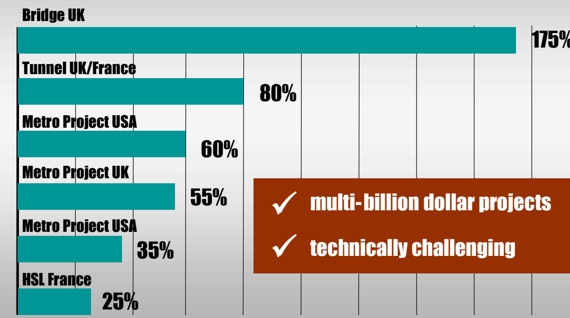
- Technical capacity existance
- Abundance of processes, plans, tools, and techniques
- Striking poor performance records
- Few projects demonstrate's formal risk management
  - survey and study of project performance

✓ 20 projects over $300 million
- no risk structure

✓ 10 projects over $400 million
- some risk management

Introduction

Capital construction budget overruns for mega-projects



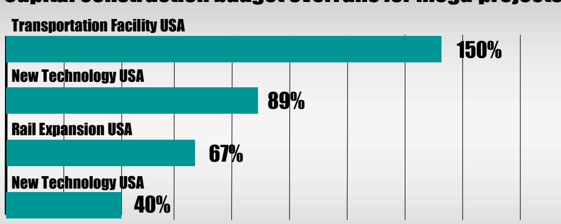
Percent (%) of construction cost overrun above the original baseline budget.

✓ multi-billion dollar projects

✓ technically challenging

Introduction

Capital construction budget overruns for mega-projects



Percent (%) of construction cost overrun above the original baseline budget.

✓ dynamic scope development

✓ integrated systems planning

Introduction

- Need for new methods and practices
  - reducing costs
  - improving performance
- Allowing potential risks to go unmanaged or unaddressed
- Protecting the owners investment and interest
- Identifying, understanding, evaluating and mitigating risks

✓ implement risk management

✓ integrate risk management

Introduction

Risk management flaws to overcome for success

- No. 1 - Poor planning
- No. 2 - Too idealistic assumptions
- No. 3 - Restricting risk information
- No. 4 - Not understanding risk elements and impacts
- No. 5 - Failing to assess and analyze risks impacts
- No. 6 - Incomplete mitigation and contingency plans
- No. 7 - Lack of risk synthesizing
- No. 8 - Not integrating the risk management process
- No. 9 - Unclear and unreliable project metrics
- No. 10 - Not implementing a continuous risk process

Flaw No. 1 - Poor Planning

- Failing to recognize the need for applying risk management processes during the planning and pre-construction phase of the project development

Flaw No. 1- Poor Planning

- Projects contain uncertainty
  - what is the magnitude of uncertainty
  - where there is uncertainty, there is risk
  - implement a risk management process
- Integrated with other key management processes
- Manage and control risks as a process requirement

✓ should not be arbitrary
✓ should be integrated

Flaw No. 1- Poor Planning

- The first step – acknowledging that risks exist
- Various types of risks
  - differing site conditions
  - unavailability of resources
  - unanticipated environmental factors
  - community or political issues
  - financial fraud
  - adverse weather

✓ recovery management
✓ security issues

Flaw No. 1- Poor Planning

- Initiate the risk management process at the very beginning of the project
- Apply strategic perspectives

1 Focus management on high-risk issues

2 Assess adequacy of budgets and schedules

Flaw No. 1- Poor Planning

- Adopt a strategy for integrating the objective efforts
  - identify, analyze, evaluate the risks
  - mitigating and management plan
  - monitor performance
  - assess adequacy of project cost and schedule

✓ credibility of the process
✓ achieving expected results

Flaw No. 1- Poor Planning

Overall strategy of the risk management program

Strategic Risk Process

Successful Project
- Maximize Opportunities
- Minimize Risk Impacts

Added Benefits
- Cost Effectiveness
- Schedule Control
- Contingency Management

Employing risk management processes to help attain success and m eet expectations.

Flaw No. 1- Poor Planning

- Principle objectives when planning a risk management approach
  - construct the framework for how the risk management process will work
  - make sure the entire project environment is working with the same goals, objectives and information

✓ roles and responsibilities
✓ accountability

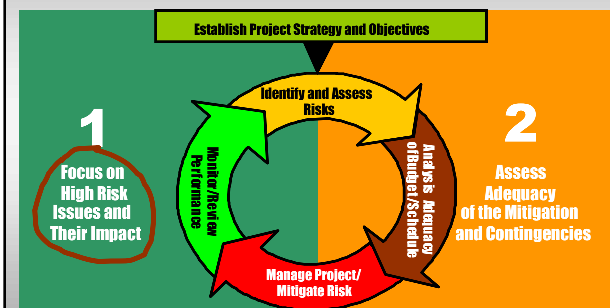
Flaw No. 1- Poor Planning

- Design and Construction Risk Management Plan
  - summarize key definitions and risk terminology (common language)
  - establish program and process policies (organizational structure)
  - document risk identification and mitigation methods through risk allocation
  - clearly identify each stage of the process (uniform and continuous process)

✓ builds confidence
✓ reinforces commitment

Flaw No. 1- Poor Planning

A continuous process for risk strategy and management



An iterative and continuous process for managing risk as it changes and shifts.

Flaw No. 2 – Assumptions are too Idealistic

- Allowing project assumptions to be interpreted in the idealistic manner; influencing the thinking that everything will go according to plan

Flaw No. 2 – Assuming the Ideal Manner

- Everything goes according to plan (EGAP)
- EGAP characteristically means
  - no changes in performance specs
  - no management problems
  - no contract problems
  - no geological, environmental or technological problems
  - no political or administrative commitments or promises are not kept

✓ managing risk v.s. taking risk
✓ EGAP – a fatal flaw

Flaw No. 2 – Assuming the Ideal Manner

- Major causes of known risks
  - design and specification changes
  - geological, natural elements, problems, etc.
  - existing environmental or safety conditions
- Major causes of unknown risks
  - lack of realism in cost forecast
  - underestimated impact of delays
  - contingencies too low

✓ be viewed realistically
✓ be defined explicitly

Flaw No. 3 – Restricting Risk Information

- Restricting risk information and not collecting expert judgments; resulting in biased assessments and analyses

Flaw No. 3 – Lacking Expert Judgment

- Work sessions to discuss methods of a isk analysis process
  - discuss methods of a risk analysis process and gain consensus
- Gathering risk information
  - interviews
  - risk review meetings
  - workshops

✓ expert judgment
✓ collecting group judgment
✓ BOGSAT

Flaw No. 3 – Lacking Expert Judgment

- Include design consultants and others in the risk reviews
  - best source of preliminary information
  - incorporate risk assessments into design features
- Impact results when not coordinating

✓ obtain early input
✓ expert consultants

Flaw No. 4 – Not understanding Risks Elements and Their Impacts

- Not clearly understanding the elements of risks and their potential impacts in the early phases of project planning and development

Flaw No. 4 – Understanding Risks Impacts

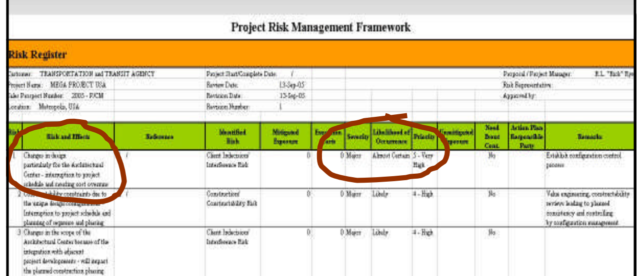
- Identifying as many risk areas as possible
- Not understanding the elements can weaken the best risk management plan
- Qualifying and defining potential values for risk elements

✓ probabilities of occurrence
✓ impact of consequences
✓ priorities of severity

Flaw No. 4 – Understanding Risks Impacts

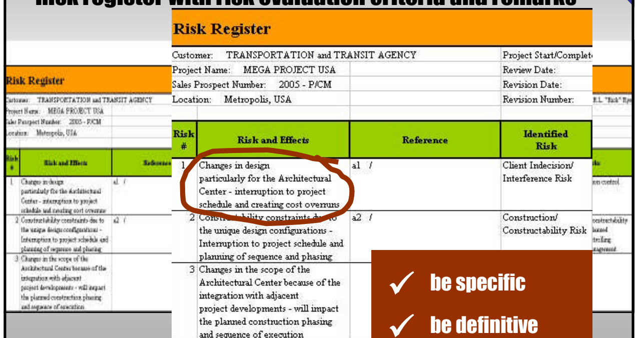
Flaw No. 4 – Understanding Risks Impacts

Risk register with risk evaluation criteria and remarks



Flaw No. 4 – Understanding Risks Impacts

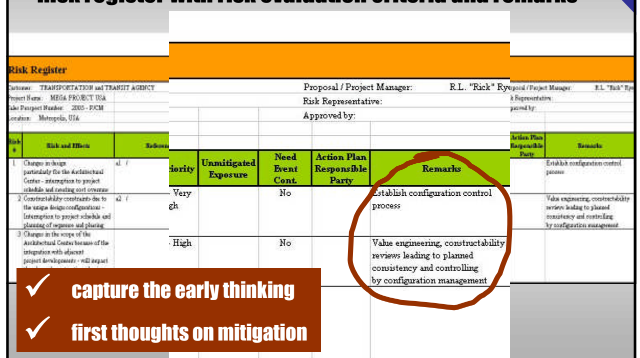
Risk register with risk evaluation criteria and remarks



- ✓ be specific
- ✓ be definitive

Flaw No. 4 – Understanding Risks Impacts

Risk register with risk evaluation criteria and remarks



- ✓ capture the early thinking
- ✓ first thoughts on mitigation

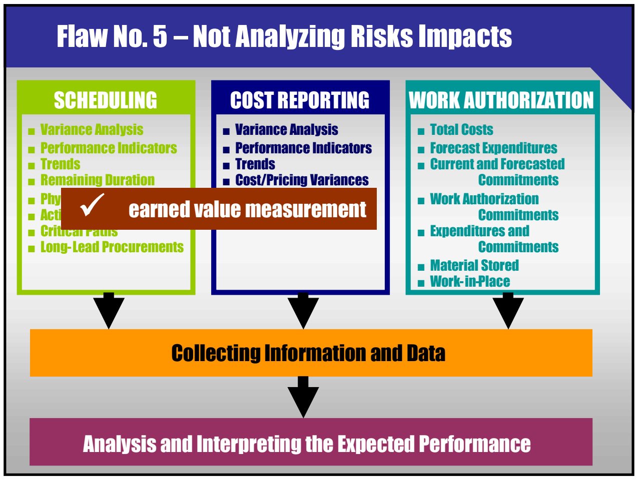
Flaw No. 5 – Failing to Assess and Analyze Risks Impacts

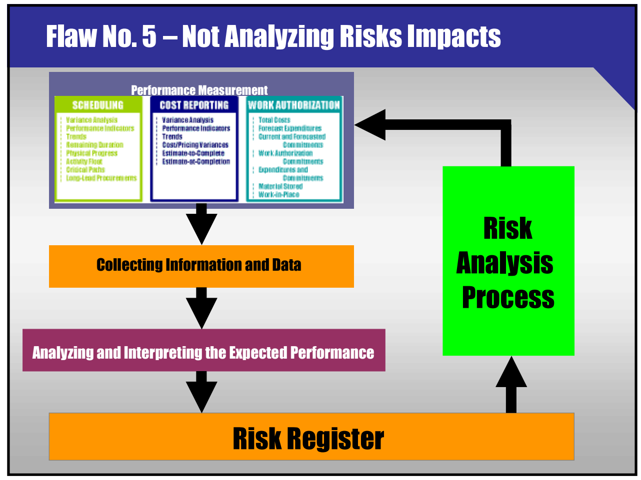
- Not completing the evaluation and analysis of particular risks to the point of determining the impacts they will have on the project goals and objectives

Flaw No. 5 – Not Analyzing Risks Impacts

- Logical way of assessing the probabilities of occurrence and potential impacts
  - evaluation of risk events or opportunities
  - project risk status reporting
- Two major approaches to logical risk analysis
  - deterministic approach
  - probabilistic approach

- ✓ supported by existing systems
- ✓ statistical analysis and modeling





Flaw No. 5 – Not Analyzing Risks Impacts

- Use risk evaluation scoring to assign values to risks
  - numerical interpretation for analysis
- Risk event status
  - probability of occurrence
  - likelihood of the event happening
  - severity of impact (cost or time at stake)

risk event status =
risk probability X amount at stake =

Flaw No. 5 – Not Analyzing Risks Impacts

Risk evaluation scoring criteria for the probability of occurrence to the likelihood of occurrence

Probability of Occurrence	Likelihood	
0% - 10%	1	Rare
11% - 25%	2	Unlikely
26% - 75%	3	Possible
76% - 90%	4	Likely
91% - 100%	5	Almost Certain

Correlation between qualitative description and the quantitative metric

Flaw No. 5 – Not Analyzing Risks Impacts

Risk evaluation scoring criteria for financial exposure to severity of impact

Financial Exposure	Severity	
Up to $10,000	1	Minor
Up to $250,000	2	Moderate
Up to $500,000	3	Serious
Up to $1 million	4	Major
Over $1 million	5	Critical

Associating severity measurements to potential financial impacts or variations

Flaw No. 5 – Not Analyzing Risks Impacts

Consolidated risk evaluation scoring criteria - descriptive

RISK EVENT STATUS

SEVERITY					
CRITICAL	SERIOUS	MAJOR	MAJOR	CRITICAL	CRITICAL
MAJOR	MODERATE	SERIOUS	MAJOR	MAJOR	CRITICAL
SERIOUS	MODERATE	MODERATE	SERIOUS	SERIOUS	MAJOR
MODERATE	MODERATE	MODERATE	MODERATE	SERIOUS	SERIOUS
MINOR	MINOR	MINOR	MODERATE	MODERATE	SERIOUS
	MINOR	UNLIKELY	POSSIBLE	LIKELY	ALMOST CERTAIN

LIKELIHOOD

Relationship of likelihood of occurrence (probability) to the impact (consequences)

Flaw No. 5 – Not Analyzing Risks Impacts

Consolidated risk evaluation scoring criteria - numerical

RISK EVENT STATUS

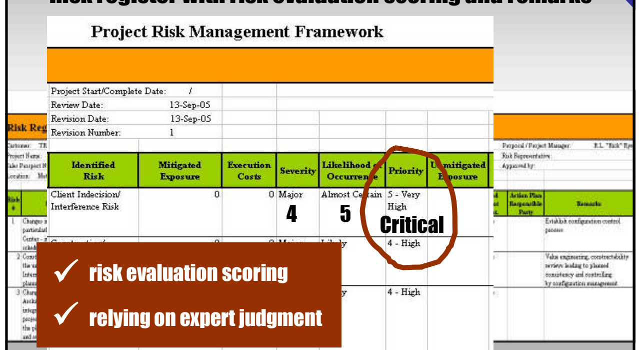
SEVERITY					
5	3	4	4	5	5
4	2	3	4	4	5
3	2	2	3	3	4
2	2	2	2	3	3
1	1	1	2	2	3
	1	2	3	4	5

LIKELIHOOD

Relationship of likelihood of occurrence (probability) to the impact (consequences)

Flaw No. 5 – Not Analyzing Risks Impacts

Risk register with risk evaluation scoring and remarks



✓ risk evaluation scoring

✓ relying on expert judgment

Flaw No. 5 – Not Analyzing Risks Impacts

Top 10 impact risks priorities – the "Watch" list;

1. Compressed design schedule
2. Lack of timely decisions and information flow
3. Changes in design criteria and scope
4. Environmental planning and impacts (NEPA)
5. Very tight security requirements
6. Lack of available resources
7. Logistics problems
8. Unique technology and inno
9. Release for property access
10. Construction critical path impacts

✓ top 5 priority risks
✓ risks priorities shift

Flaw No. 6 – Incomplete Mitigation and Contingency Planning

- Not fully developing mitigation and contingency plans sufficient for the priority or the degree of impact associated with the risks identified

Flaw No. 6 – Not Developing Mitigation Plans

- Risks responses and mitigations strategies include options such as
  - control measures
  - management actions
  - contractual arrangements
  - third party i.e. contractors, insurance, etc.
  - resource provisions
  - contingency and reserve funds

✓ determine effectiveness in actions
✓ mitigations actions cost

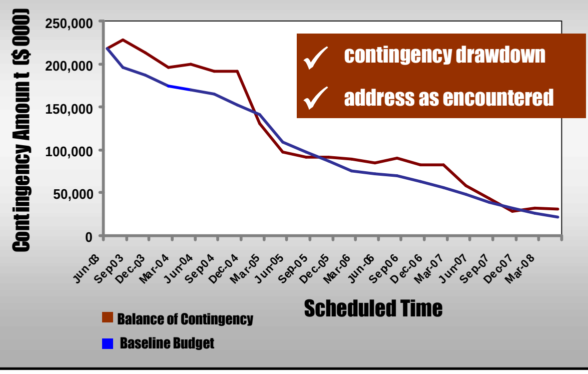
Flaw No. 6 – Not Developing Mitigation Plans

- Contingency is typically an integral part of budget estimating
  - a arbitrary value
  - when added to the base estimate, or schedule, for unknowns
  - when used to offset unclear or unknown issues

✓ covers the risk
✓ increases confidence

Flaw No. 6 – Not Developing Mitigation Plans

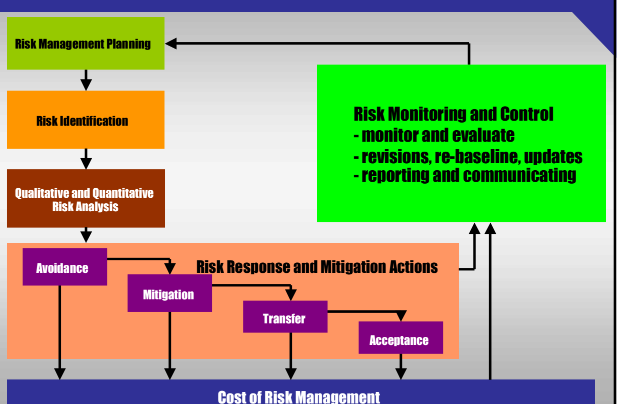
Project contingency drawdown as compared to the baseline



Flaw No. 6 – Not Developing Mitigation Plans

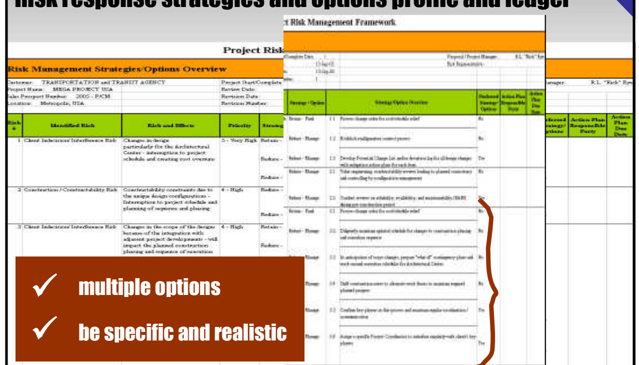
- Evaluate risk response strategies and options
- Project risks as measured by the mitigated probabilities and impacts
- Unmitigated risks as based on no alternative action available
  - contingencies can be overestimated
  - contingencies can be underestimated

Flaw No. 6 – Not Developing Mitigation Plans



Flaw No. 6 – Not Developing Mitigation Plans

Risk response strategies and options profile and ledger



Flaw No. 6 – Not Developing Mitigation Plans

- Risk response actions have a resource value
  - cost (budget or contingency)
  - time (budget or float)
- Not cost effective to transfer all risks
  - adequate contingencies and reserves
- Logical vehicle for predicting the extent of variations
  - forecasting the best case scenarios and worst case scenarios

✓ worst case

✓ most unpopular

Flaw No. 6 – Not Developing Mitigation Plans

- Resource contingency models
  - modeled from the cost estimate and CPM schedule
  - expressed as minimum, maximum and most likely parameters
  - assigned probability factors

✓ correlating the risk event status

✓ variations of risk consequences

✓ applying expert judgement

Flaw No. 6 – Not Developing Mitigation Plans

Contingency model and range estimating with probability

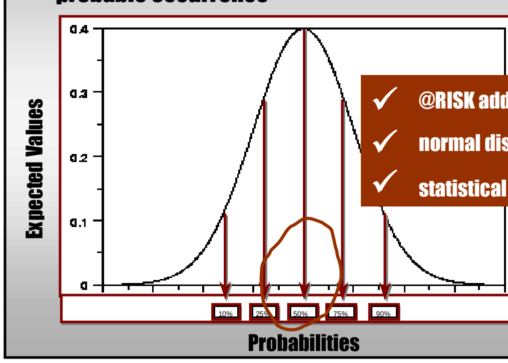
Contractor Costs		$7,485											
				Variance - Cost					Range Estimate - Cost				
									Est.	Like	P	Low	High
Labor	=(Q/P)*LR	Est.	Case	Quantity	Productivity	Labor Rate	Variance	(Q/P)*LR	$3,100		15%	-$429	$679
Q = Quantities		$3,100	Low	-5.0%	7.5%	-2.5%	-$429	0.862					
P = Productivity			Moderate	5.0%	0.0%	0.0%	$155	1.050					
LR = Labor Rates			High	10.0%	-7.5%	2.5%	$679	1.219					
Materials	=Q*U	Est.	Case	Quantity	Unit Price		Variance	Q*U	$1,600		20%	-$232	$336
Q = Quantities		$1,600	Low	-5.0%	-10.0%		-$232	0.855					
U = Unit Prices			Moderate	5.0%	0.0%		$80	1.050					
			High	10.0%	10.0%		$336	1.210					
Equipment	=(Q/P)*ER	Est.	Case	Quantity	Productivity	Equip Rate	Variance	(Q/P)*ER	$1,000		40%	-$183	$270
Q = Quantities		$1,000	Low	-5.0%	[illegible]	[illegible]	[illegible]	[illegible]					
P = Productivity			Moderate	5.0%									

✓ budget elements

✓ event and scope elements

Flaw No. 6 – Not Developing Mitigation Plans

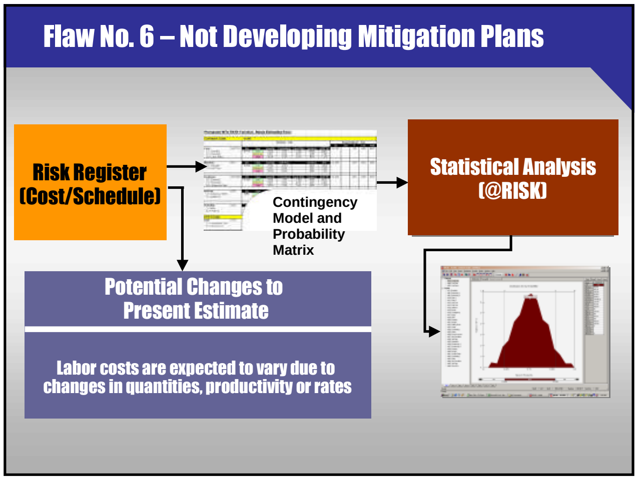
Probability distribution representing variations of probable occurrence

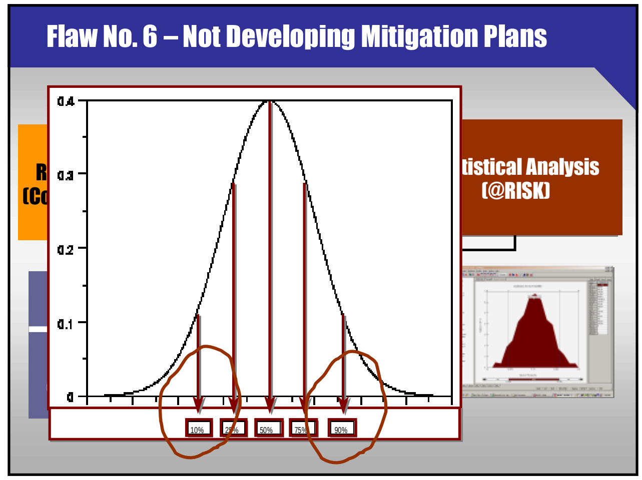


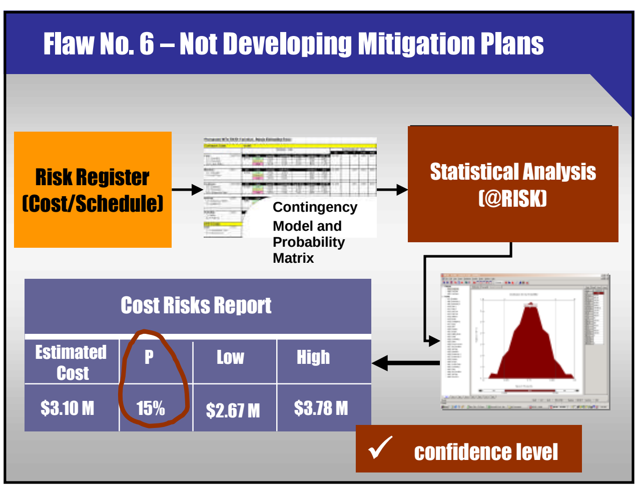
✓ @RISK add-ins

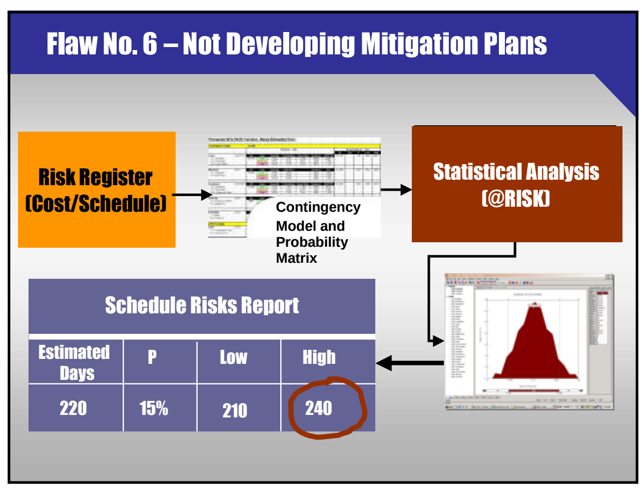
✓ normal distribution

✓ statistical mean


Flaw No. 6 – Not Developing Mitigation Plans
Risk Register (Cost/Schedule)
Contingency Model and Probability Matrix
Statistical Analysis (@RISK)
Potential Changes to Present Estimate
Labor costs are expected to vary due to changes in quantities, productivity or rates


Flaw No. 6 – Not Developing Mitigation Plans
0.4
0.3
0.2
0.1
0
10%
25%
50%
75%
90%


Flaw No. 6 – Not Developing Mitigation Plans
Risk Register (Cost/Schedule)
Contingency Model and Probability Matrix
Statistical Analysis (@RISK)
Cost Risks Report
Estimated Cost
P
Low
High
$3.10 M
15%
$2.67 M
$3.78 M
confidence level


Flaw No. 6 – Not Developing Mitigation Plans
Risk Register (Cost/Schedule)
Contingency Model and Probability Matrix
Statistical Analysis (@RISK)
Schedule Risks Report
Estimated Days
P
Low
High
220
15%
210
240

Flaw No. 7 – Lack of Synthesizing the Risks

- The lack of synthesizing all potential construction risks and determining the total cumulative effect

Flaw No. 7 – Not Synthesizing Risks

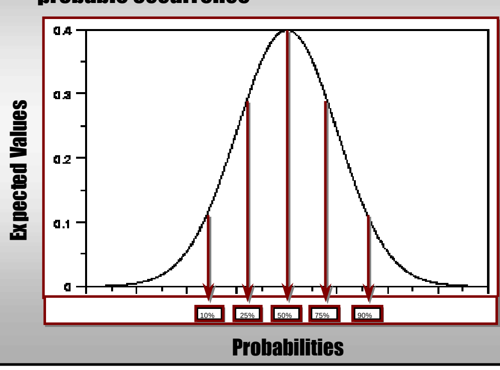
- Deterministic evaluation has limits
- Develop a logical model for overall project risks measurement to mitigate and manage
- Probabilistic methods for overall statistical model analysis and simulation
  - determine that the contingency is adequate
  - giving expectations that the project will meet objectives
  - help provide confidence in the expected project cost

✓ @RISK simulations

✓ Monte Carlo simulations

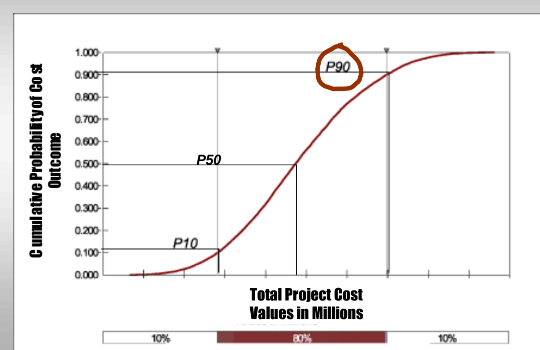
Flaw No. 7 – Not Synthesizing Risks

Probability distribution representing variations of probable occurrence



Flaw No. 7 – Not Synthesizing Risks

Cumulative probability distribution curves



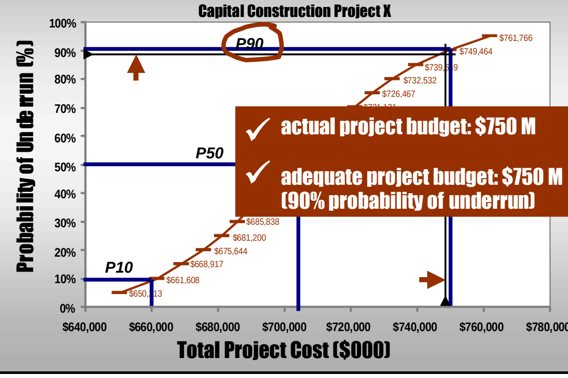
Flaw No. 7 – Not Synthesizing Risks

- Expected value for cost and schedule with probability
  - management decision making
- Need probabilistic analysis run for the entire project
  - probability that the project will meet its goals
  - contingencies assignment that will be adequate to meet project objectives

✓ information to be reliable
✓ basis of confidence

Flaw No. 7 – Not Synthesizing Risks

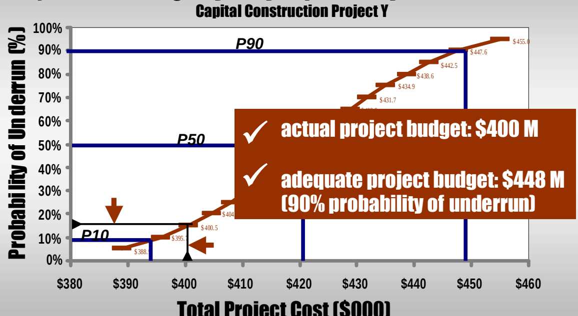
Project cost contingency analysis probability of occurrence



✓ actual project budget: $750 M
✓ adequate project budget: $750 M (90% probability of underrun)

Flaw No. 7 – Not Synthesizing Risks

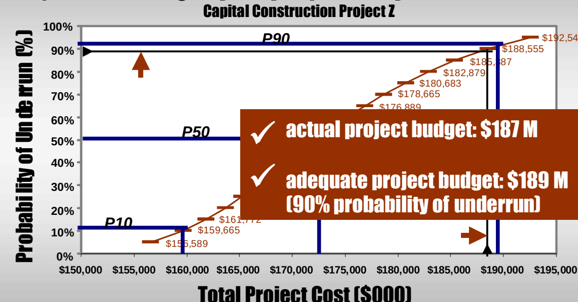
Project cost contingency analysis probability of occurrence



✓ actual project budget: $400 M
✓ adequate project budget: $448 M (90% probability of underrun)

Flaw No. 7 – Not Synthesizing Risks

Project cost contingency analysis probability of occurrence

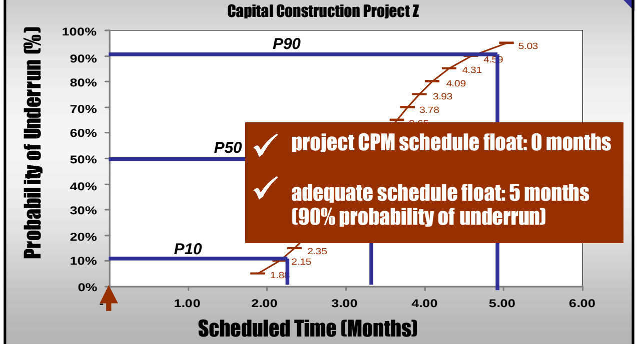


✓ actual project budget: $187 M
✓ adequate project budget: $189 M (90% probability of underrun)

Flaw No. 7 – Not Synthesizing Risks

Project schedule contingency analysis probability of occurrence

Capital Construction Project Z



Flaw No. 7– Not Synthesizing Risks

Project risk based cost contingency report

Cost Contingency Profile with Probabilities

	Project Cost w/o Contingency	Contingency		Total Project Costs
Current Estimate	$1,668.36	$365.59	21.9%	$2,033.95
P10	$1,668.36	$178.64	10.7%	$1,847.00
Mean	$1,668.36	$373.07	22.4%	$2,041.43
P90	$1,668.36	$570.84	34.2%	$2,239.2

Dollar values represent millions ($000)

Flaw No. 7 – Not Synthesizing Risks

- Benefits of probabilistic contingency models and simulations
  - manages more information more accurately
  - provides explicit information for making informed decisions
  - assist in the overall predictability for meeting the owners expectations

✓ measure adequacy of resource contingencies

✓ to the best of our judgment

Flaw No. 8 – Segregating the Risks Management Process

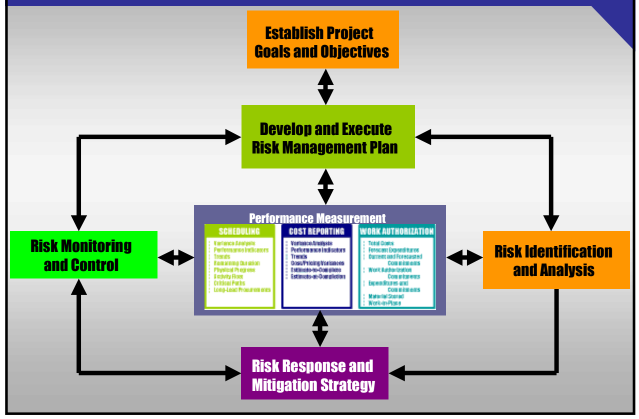
- Not integrating the risk management process with the day-to-day construction project management applications

Flaw No. 8 – Lacking Integration of the Risks Process

- Major objectives of integrated risk management approach
  - sharpening the foresight for potential risks impacts
  - integrating mitigation planning before the consequence
  - enhancing the identification of resources for project management
  - facilitating continuous monitoring, analysis and communication

✓ collaborated
✓ integrated

Flaw No. 8 – Lacking Integration of the Risks Process



Flaw No. 9 – Unclear and Unreliable Project Metrics

- Unclear and unreliable definition of the project performance measurements and metrics

Flaw No. 9 – Unreliable Measurements and Metrics

- Common problem
- Predictable world of cause and effects
- Major cause of project variances
  - lack of realism in initial planning and definition
  - delays underestimated
  - contingencies too low
  - geological and natural elements not clearly defined
  - environmental, safety and existing conditions unclear

✓ can't measure, can't manage

Flaw No. 10 – Not Implementing a Continuous Risk Management Process

- The absence of continuously evaluating the effects of risks through the progress of the project work and intervening when necessary to ensure their mitigation and resolution

Flaw No. 10 – Not a Continuous Risk Process

- Identifying additional risks as the project progresses
- Continuously gathering risk information and conducting reviews as the project progresses
  - reevaluating risks periodically
  - evaluations at the end of each milestone phase
- Continuously assessing the probability of occurrence and potential impact

✓ increase budget confidence
✓ increase success confidence

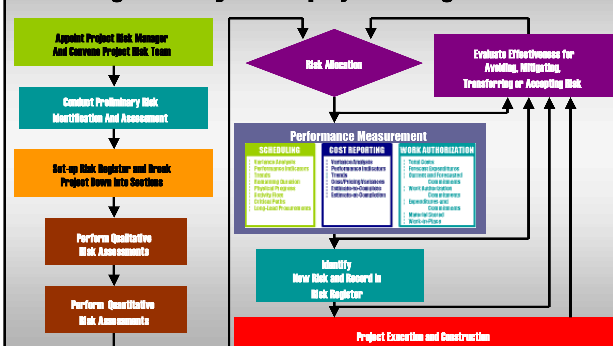
Flaw No. 10 – Not a Continuous Risk Process

- Measurements control against risks managed project baselines
- Unknowns in projects with no preparation for measuring
- Continuous risk analysis with integrative applications rebaseline the impacts

✓ integrated coordination
✓ decision model assessments
✓ comparative analysis

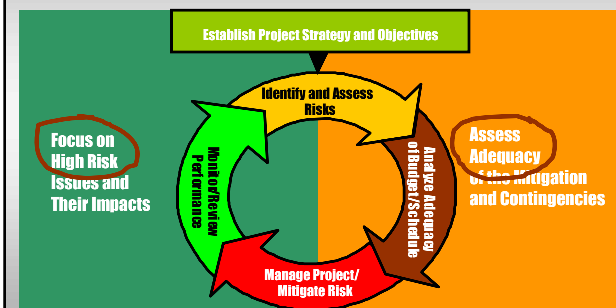
Flaw No. 10 – Not a Continuous Risk Process

Continuing risk analysis with project management



Flaw No. 10 – Not a Continuous Risk Process

An iterative and continuous measuring and evaluation process



Lessons Learned

Lessons Learned

1. Establish an integrated risk management program using risk analysis
   - use both deterministic and probabilistic applications
   - carefully monitor the risk bias that can distort risk elements and mitigation plans to be integrated into the project management constraints process (schedule, cost, scope, etc.)
   - risks mitigation is realized in the form of actions, management, allocation, contingencies and reserves

Lessons Learned

2. Allow risk assertive project managers to participate early in the planning and development phase.
3. The risk analysis approach is even more germane when projects are accelerated and public visibility.
4. Rebaseline risks profiles on key milestone phases such as preliminary engineering, final engineering, construction mid-point, etc.

Lessons Learned

5. Focus on common risk issues that are characteristic
   - environmental impacts and archeological and historical preservation issues
   - property acquisition and land access
   - existing conditions (geological) and infrastructure (utilities and structures)
   - underground construction risks
6. Contract documents allocate risks to the parties who can best control the risk

Lessons Learned

7. High impact risks events to a "what if" scenario
   - track cost saving opportunities
   - iterative cost and schedule risk analysis
   - include WORST CASE SCENARIOS
8. Assign project staff responsibility for risk mitigation
   - have quantitative and qualitative risk assessments
9. Continuous monitoring of risk mitigation

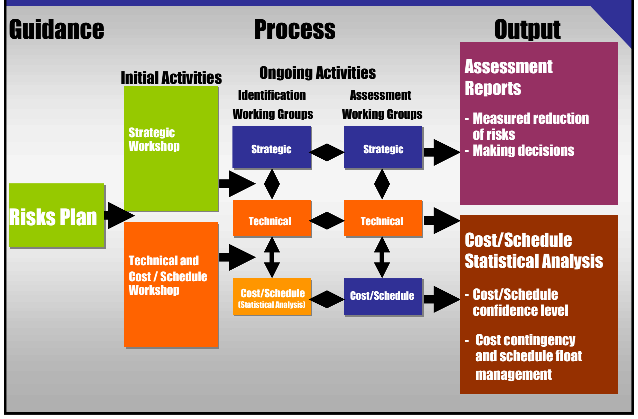
Lessons Learned

10. Assist the owner in analysis and management of capital construction risks
    - help to define the types and phases of risks
    - identify unique risks to the specific project
    - match the risks with the capabilities and resources
    - help define the implementation strategy
    - define methods and applications for monitoring

Conclusion

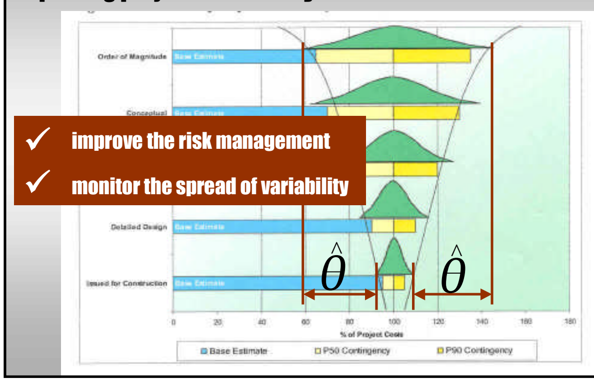
- Risks cannot be eliminated
- Risks can be acknowledged and managed in a better method
  - measured and expressed a great deal better
  - facilitates accountability

Conclusion



Conclusion

Improving project uncertainty and risks control measures



Conclusion

- Think in terms of the following
  - having a risk management plan
  - identifying risks
  - determining the effects of risks
  - assigning contingency
  - building confidence level
  - determining the top risks
  - monitoring and tracking

✓ another project management tool kit

✓ build project culture

Conclusion

- Benefits of the risk management process
  - disciplined framework
  - avoided/reduced large losses
  - improved decision making
  - improved allocation of resources
  - increased project confidence

✓ owners interest protected

✓ risks balanced to adequate mitigation

Questions

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Potential Flaws When Assessing Financial Risk in Capital Construction Projects

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Abstract: The best-planned capital construction project will characteristically contain uncertainty. Where there are uncertainties, there are also risks that have the potential to cause deviation and impact the initial estimates of time, costs and scope definition. This discussion paper focuses on ten specific project management flaws that can lead to the manifestation of risk consequences that can impact financial objectives. We will also discuss risk management processes to help mitigate the potential risk impacts.

Introduction

Risk is known to be inherent to major capital construction projects. This risk can exist in response to the actions and decisions that are made when planning the implementation of the project. For purposes of this discussion, we are focusing on risk consequences, which are defined as potential losses, damages, or any other undesirable events – including the loss of opportunities. There is a prevailing history in the world of capital construction of disappointing projects and failures because of risk consequences. At Fluor, managing risk absolutely has been a critical factor in sustaining our corporate success.

Even the best planned and managed capital construction project is bound to change as the work progresses, creating the potential to deviate or cause significant impact on the initial estimates of time, cost and to scope definition. There are ten project management flaws that are used as discussion points, related to processes that either separately or collectively can contribute to risk consequences. These management flaws are defined in the following ways:

- **Poor planning** – Failing to recognize the need for applying risk management processes during the pre-construction phase of the project development.
- **Assumptions are too idealistic** – Allowing project assumptions to be interpreted in the ideal manner; influencing the thinking that everything will go according to plan.
- **Restrictive risk information** – Restricting risk information and not collecting expert judgments; resulting in biased assessments and analysis.
- **Not understanding risk elements and their impacts** – Not clearly understanding the elements of risks and their potential impacts in the early phases of project planning and development.
- **Failing to assess and analyze risks impacts** – Not completing the evaluation and analysis of particular risks to the point of determining the impacts they will have on the project goals and objectives.
- **Incomplete mitigation and contingency plans** – Not fully developing mitigation and contingency plans sufficient for the degree of impact associated with the risks identified.
- **Lack of synthesizing the risks** – The lack of synthesizing all construction risks and determining the total cumulative effects.
- **Segregating the risk management process** – Not integrating the risk management process with the day-to-day construction project management applications.

- **Unclear and unreliable project metrics** – Unclear and unreliable definition of the project performance measurements and metrics.
- **Not implementing a continuous risk management process** – The absence of evaluating continuously the effects of risks through the progress of the project work and intervening when necessary to ensure their mitigation and resolution.

These ten discussion points are a result of collecting comments and observations from a number of project directors and executives involved with more than 20 major projects collectively totaling over $50 billion.

Poor Project Planning

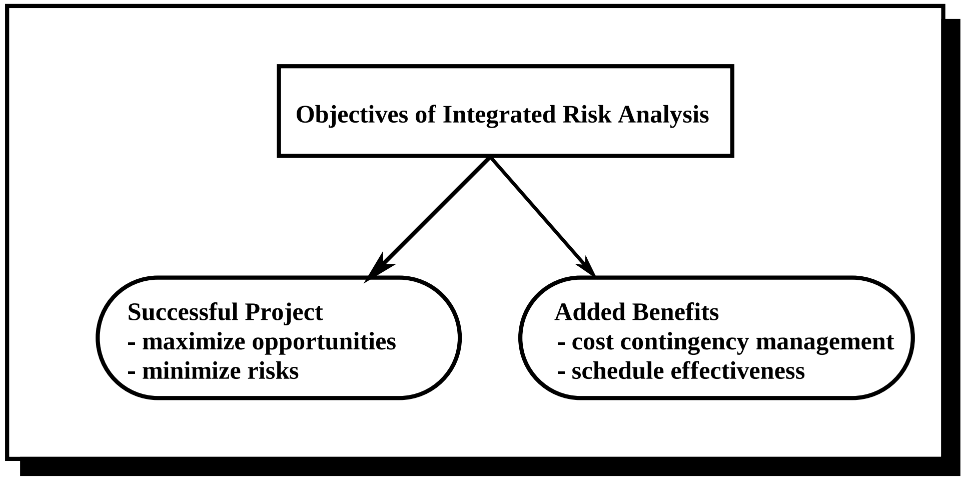
We start looking at the management flaws with the potential for poor project planning that expectedly occurs during the pre-construction phase. All construction project plans are based on estimates that contain uncertainty. The bigger or more complex the project, the more dynamic the consequences can be. One of the problems with planning capital construction projects is the magnitude of uncertainties that exist. Where there is uncertainty, there is also risk of potential unfavorable consequences. The best method for dealing with these uncertainties and the associated risk consequences is to develop and implement a risk management process as part of the construction management application. A structured risk management methodology should be one of the key management processes integrated with the project management applications receiving the same level of attention as budget control and scheduling, decision-making, and claims avoidance. Controlling risks should not be an arbitrary function that is separate or apart from other project management applications. At Fluor, the philosophy across the board is that risk management is expected to be a continuous process on our projects and it is imperative that risk analysis be integrated into the project management processes.

The first step in risk management strategy is acknowledging that the potential for risk consequences cannot be completely eliminated but can be mitigated. Major capital construction projects are commonly faced with all types of risk events, such as adverse weather, differing site conditions, unavailability of specific types of resources, unanticipated environmental factors, or community pressures. The adverse effects associated with these events are normally manifested in the form of increased cost, re-sequencing of construction activities, and delays that have the potential to interfere with successful project delivery.

The risk management process should start at the very beginning of the project with development of a *Design and Construction Risk Management Plan* that details the processes planned for assessing, mitigating and managing the potential risks. The plan should contain a statement of purpose for risk management process and the overall project performance objectives to be achieved. Figure 1 illustrates the overall objectives of the risk management process.

The *Design and Construction Risk Management Plan* should also summarize key definitions of risk terminology, establish program and process policies, and identify each stage of the process. More specifically, the plan should document the risk identification and mitigation methods to be used. This plan in itself should help guide the project teams overall understanding of risk management processes and help create personal connection and commitment for using the risk management methodology.

FIGURE 1. Objectives of the Risk Management Process



Project Assumptions Viewed in the Ideal Manner

An extremely common management flaw is allowing project assumptions to be viewed in an ideal manner, thus influencing the thinking that everything will go according to plan. Of the management shortcomings, this one can be fatal to the interpretation of a successful project. There are many cases where project teams take risk without ever constructively thinking about the ramifications of their actions. This flaw can be the result of extreme political pressures, monetary and time frame pressures, and even inexperience of the project team. This over zealous expectation is sometimes referred to as the EGAP-principal (everything goes according to plan) which characteristically means:

- no changes in performance specs;
- no management problems;
- no contract problems;
- no geology, environmental or technology problems; and
- no political, administrative, or commitment promises are compromised.

For an effective risk analysis, the project expected results, in terms of cost and schedule, must be objective and realistic.

Restricting Risk Information and Lacking Expert Judgments

Restricting risk information and not collecting expert judgment usually results from the lack of proper planning and coordination among the various project participating groups. Effective identification and prioritization of risks can be achieved through interviews, brainstorming sessions, workshops and joint risk review meetings. There are many different agendas apparent when all the groups come together. In Fluor, we have found that in order to ensure group focus and discipline, the risk work sessions should be under the guidance of the professional program/construction manager that have skill sets in organizational planning and strategy.

During the project planning and early development phase, design and engineering consultants should participate in the information gathering process in helping identify the risks that are particular to the project. At this early stage of project development, when scopes of work, cost estimates and project schedules are preliminary at best, no other resource can provide the kind of specific knowledge of project issues that the design team can provide. Not only will their participation be invaluable to the total project team, the design groups can incorporate findings from risk assessments into the design features helping to mitigate potential risk impacts at it's grass roots.

Although risk sessions and workshops are held at the planning and early design phase, additional risks are continually identified. As the project development progresses through final engineering and into construction, it is beneficial that design and engineering consultants continue to participate in the risk process. Also, gathering risk information from key experienced people and reviewing relevant past project risk experiences can be invaluable. These information-gathering sessions should take place during or at the end of each major phase of the project milestone schedules. The continuing risk reviews and evaluation will help increase the confidence that the project budget and overall project objectives will be ultimately achieved.

Not Understanding the Elements of Risks and Their Impacts

Another management flaw is not understanding the elements of risk and their potential impact early in the project planning and development phase, which can weaken the best of risk management planning. Implementing the risk management process starts with identifying as many risks as possible and summarizing the project management's approach to mitigating these risks. This step should also include a measuring of risk by assigning values to risk probabilities, impact, priorities, and other elements that will ultimately fall into the equation of delivering a risk assessment. At this point the risk management process should include a risk evaluation scoring system to assist in the measurement of severity of the impacts caused by a risk event. Figure 3 represents a general scoring matrix that is typically used.

Figure 3. Probability and Impact Matrix Scoring System

PROBABILITY \ IMPACT	MINOR	MODERATE	MAJOR	CATASTROPHIC
ALMOST CERTAIN	SIGNIFICANT	MAJOR	CRITICAL	CRITICAL
LIKELY	SIGNIFICANT	SIGNIFICANT	MAJOR	CRITICAL
POSSIBLE	MINOR	SIGNIFICANT	SIGNIFICANT	MAJOR
UNLIKELY	MINOR	MINOR	SIGNIFICANT	SIGNIFICANT

Although the risk methodology ultimately involves statistical analysis and sophisticated computer simulations, at Fluor we never let these tools become holy grail that substitutes for the fundamentals of good management thinking. It is important to first think in terms of the following:

- **Identifying risks** – Identifying risks to the project schedule and budget early in the project development stage, along with actions to mitigate them.
- **Determine the top risks** – Determining the top risks or the culmination of multiple smaller risks and their impacts.
- **Assigning contingency** – Evaluating whether there is sufficient contingency in the project budget and schedule to cover the risks identified.
- **Confidence level** – Determining the level of confidence that the project schedule will be met.

- **Determine the effects of risks** - Evaluating continuously the effects of risks.
- **Monitoring and tracking** – Tracking monthly trends and the progress of mitigating the top risks, and intervening when necessary to ensure their resolution.

Failing to Analyze Risks and Determining Impacts

Failing to assess and analyze the particular risks and determining the impacts they will have on the project goals and objectives can be avoided by extending the risk reviews and workshops just discussed. This part of the risk management process includes the assessment of the probabilities of occurrence and potential impacts to cost and schedule of individual project risks.

Risk response planning includes allocation of risks by avoiding, mitigating, transferring, or accepting. Figure 4 illustrates the relationship of the risk management stages to each other. By example, risk response strategies can include management actions; contractual arrangements with third parties such as contractors/subcontractors and insurance companies; and the use of contingencies and reserves.

While every effort must be made to develop and implement cost-effective mitigation measures and management actions, it is important to realize that some risks cannot be cost-effectively transferred to other parties, which is why adequate contingencies and reserves must be determined and kept in the project budget. Additionally, the program/construction manager should develop and implement new risk mitigation strategies, while monitoring the performance of mitigation strategies for risks that have already been assessed.

Not Developing Mitigation and Contingency Plans

Not developing mitigation and contingency plans for the risks that are identified will leave the risk management process only half complete. While some project management practitioners do not necessarily perform rigorous risk analysis, many program/construction management teams will respond to project risk by addressing them in a way to mitigate the most serious of impacts.

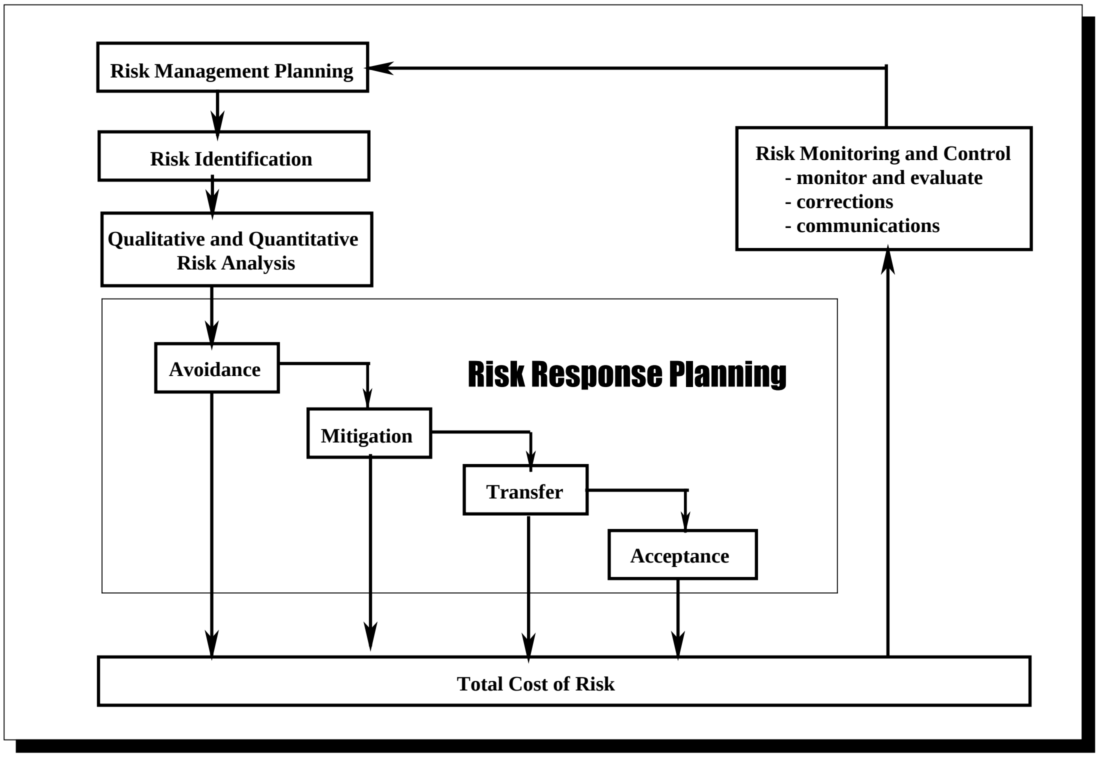
Contingency is characteristically an integral part of the budget estimating process. It is typically added to a base estimate of cost, to cover unknowns. This contingency assignment is intended to increase the confidence level in the capability of the project being delivered within the cost budget. Likewise, schedule contingency is intended to cover the uncertainty and risk associated with the schedule for the project.

The mitigation factor that is frequently used is assigning an arbitrary contingency and then drawing down funds as needed. Figure 5 illustrates a typical contingency drawdown plan profiling the comparison of actual drawdown contingency to the required contingency baseline.

However, in today's highly competitive project environments, owners and program/construction managers must continually seek new methods to reduce project costs and improve performance. In addition, project management teams must be prepared with mitigation strategies that can be implemented when projects don't run according to plan.

One of the key objectives of the risk management effort is to measure the adequacy of the allocated budget for building the project's scope of work. One accepted way to do this is by evaluating whether the project's contingency sufficiently compensates for project risk as measured by the mitigated probabilities and impacts. Mitigated probabilities and impacts should be by consensus of the project team on recognizing the nature of the risk, as well as contractor's and owners ability and willingness to pursue mitigation measures.

FIGURE 4. Relationship Among Project Risk Management Stages



In a disciplined risk management process the step in determining the adequacy of a project's budget estimate and schedule is the development of a cost contingency model. This model is developed in a spreadsheet format and can include separate sections for budget, event and scope elements.

- **Budget elements:** Modeled by including the project cost estimate at a level of detail that line items with similar risk profiles and behaviors are grouped. Each line item is assigned a triangular probability curve that is defined by expected, minimum, and maximum parameters.

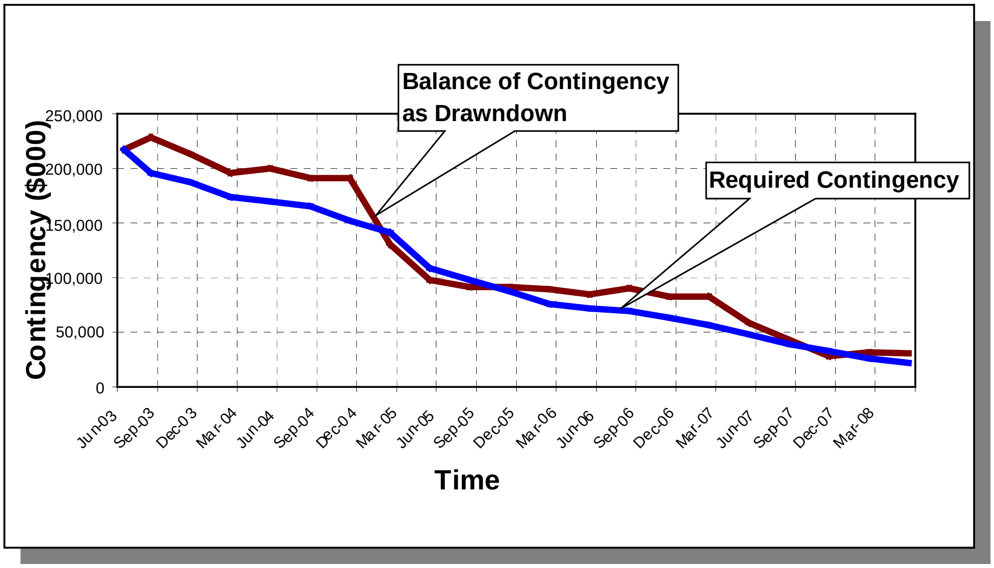
- **Event and scope elements:** Modeled by including all the event and scope risk items that have been identified. The probability curves that best match the expected behavior of risks and their descriptive parameters are chosen in consultation with expert resources. These probability curves may include triangular, uniform, exponential, discrete, and normal distributions.

Once the contingency models are developed and updated, a probabilistic analysis is run for the entire project. This results in providing information related to:

- The probability that the project will meet its established budget
- The contingency the total budget would be adequate to meet the project objectives.

Unmitigated risks can also exist because the assessment finds that there is no alternative project management action or alternative whatsoever. Its important to note that extreme caution should be taken when dealing with unmitigated risks because contingencies can be grossly underestimated or overestimated.

FIGURE 5. Project Contingency Drawdown Chart



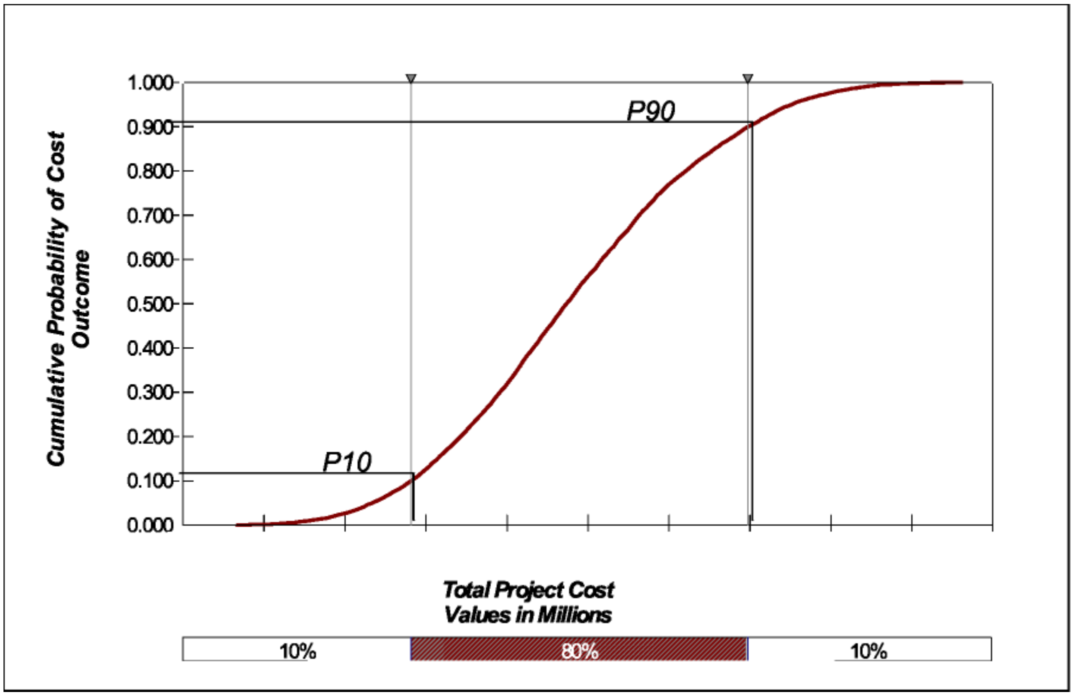
Lack of Synthesizing Construction Risks

The lack of synthesizing all construction risks and determining the total cumulative impact usually results because of the statistical application that is required. Risk measurement and analysis, at least in the context of this discussion, include using an analysis vehicle for predicting the extent of possible variations and forecasting the worst case and the best-case scenario for the project budget and schedule. The most unpopular element of employing risk analysis techniques is using the worst-case scenarios. By using probabilistic methods in risk analysis, the program/construction manager will have much more information when compared to other methods and helps to make more informed decisions.

There are now technology tools available that help in managing risk information when evaluating and quantifying multiple risk scenarios. The use of these tools allows program/construction managers to create reasonable and often realistic forecasts and to assign the needed resources such as time and money, with confidence. The limited scope of this paper does not allow detailed discussion for the calculation of total contingencies. However, it is important to note that risk management software, such as @Risk, Monte Carlo and PertMaster, have become widely used in the construction industry and are thought to provide the most scientific results available. These tools cover statistical risk management techniques and probabilistic calculation methods used in business planning and cost estimation applications. Several of the references listed at the end of this paper provide in-depth discussion and examples on modeling, simulation, and analysis techniques.

Risk analysis uses statistical methods in order to arrive at a set of confidence limits determined for project objectives of cost and schedule. By using a simulation risk analysis technique, a cumulative probability distribution curve, as shown in Figure 6, can be constructed to provide the probability of not exceeding a specified cost or schedule duration. The @Risk simulation calculates numerous scenarios by repeatedly picking random values from the input variable distributions and calculating a risk adjusted estimate.

Figure 6. Cumulative Probability Distribution Curve



As an example, Figure 7 provides a cumulative risk assessment on a real project that resulted with a budget including contingency of $750 million. The @Risk analysis statistically determined that the project had a 90% probability of under-running the $750 million estimate. Assuming that this project risk profile follows a normal distribution with 10% and 90% probabilities of underrun as the best and worse case scenarios respectively, the expected value in project cost (50% probability of underrun) would be $702.9 million. In this specific project risk analysis the estimate of $750 million was the same as the project budget, thus, resulting in an owner's confidence that the project could proceed with an expectation of 90% probability of underrun.

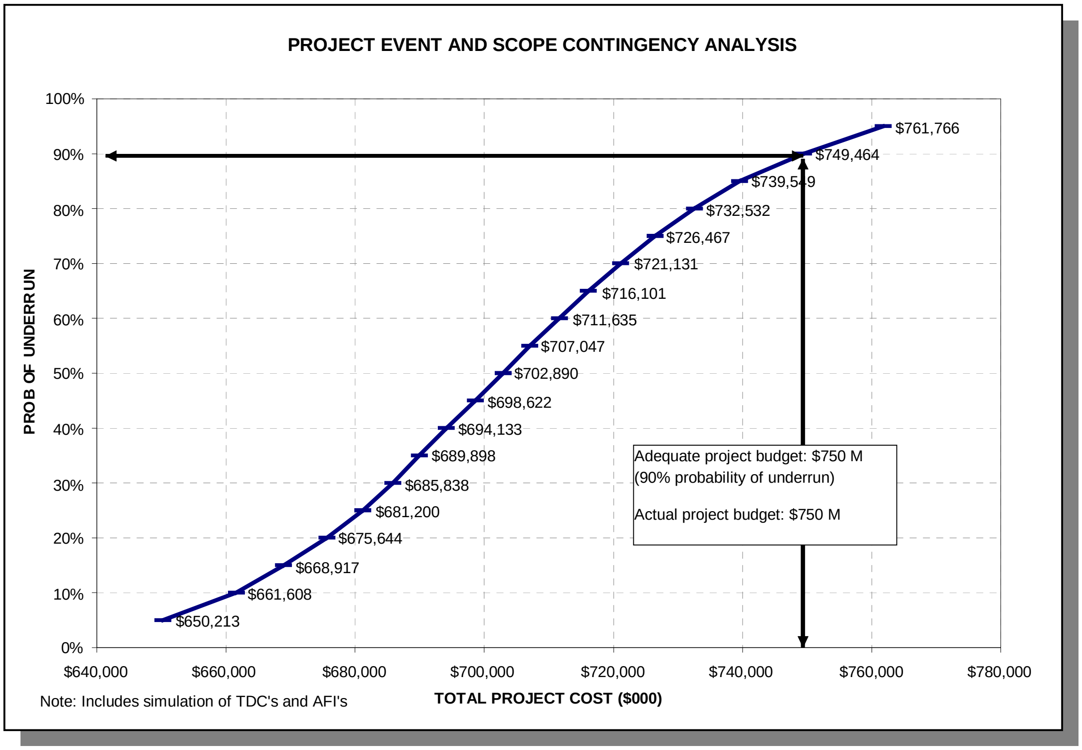
Not Integrating the Risk with Project Management Applications

Experience shows that not integrating the risk management process with the day-to-day construction project management applications is a management flaw. The risk analysis process integrated with project management applications helps to discipline the continuous collection and evaluation of the multiple factors that have an influence to negatively affect the project. It is imperative that a continuous risk analysis methodology become integrated with the day-to-day project management application. The major objectives of an integrated risk management approach are:

- collaborative mitigation planning for risks before they introduce impact;
- sharpening the project management foresight of potential risk issues;
- enhancing the identification of resources or technical assistance that would benefit in the risk mitigation planning; and
- facilitating continuous monitoring, analysis and communication of risk issues.

The risk management process should be implemented to do more than just identify the risk and present a mitigation plan. The risk management process should become a definitive and integrative process as illustrated in Figure 8.

FIGURE 7. Project Contingency Analysis



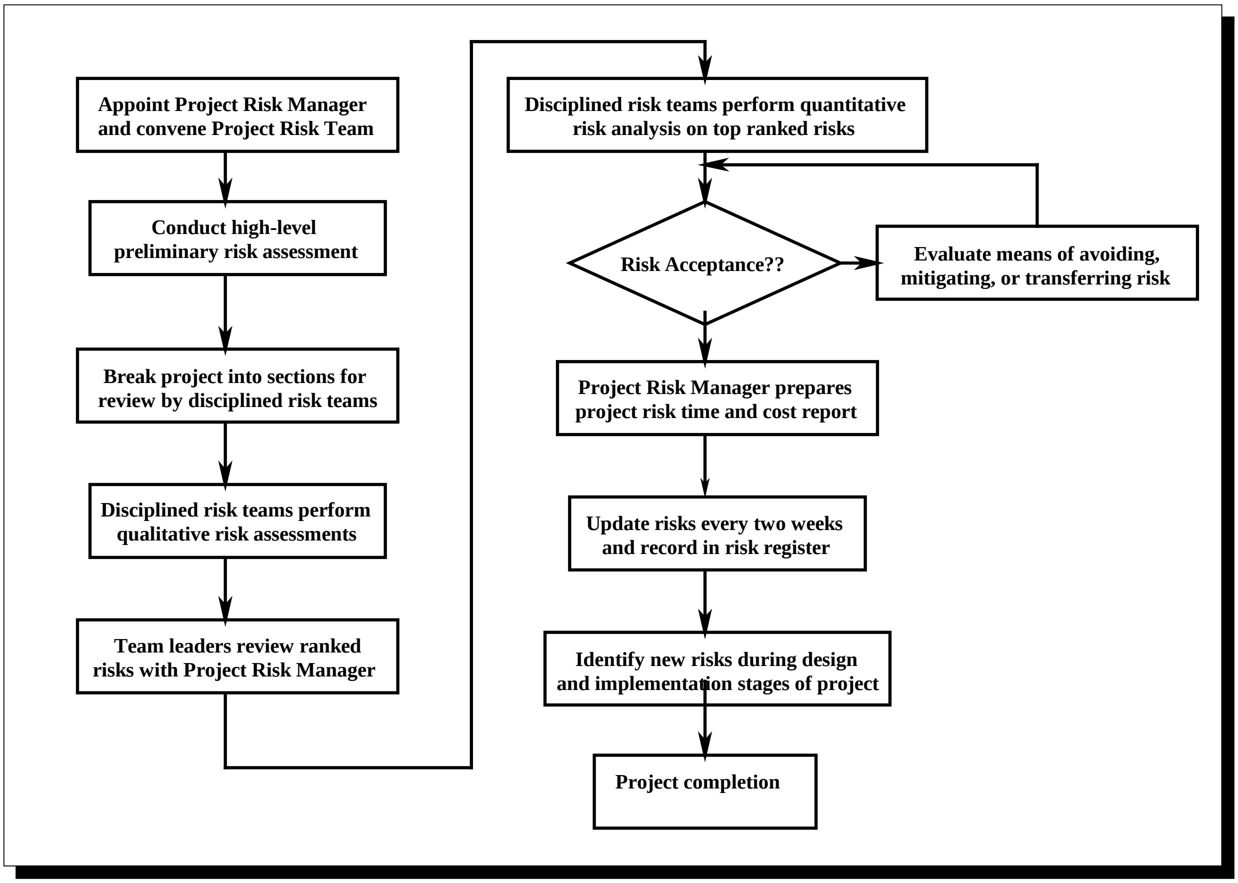
Unclear and Unreliable Project Measurements and Metrics

Unclear and unreliable definition of the project performance measurements and metrics is found to be a common problem. As mentioned in the beginning, most appraisals of projects assume, or pretend, that projects exist in a predictable world of cause and effect where things go according to plan. In reality, major capital construction projects are highly risky undertakings where things happen with certain probability and rarely turn out as originally intended. Engagements with major capital construction projects by the directors and executives interviewed for this paper have found that a number of risks are commonly embedded in the project environment and are frequently the major cause of project variances. The common risks are summarized as:

- lack of realism in initial cost;
- length and cost of delays underestimated;
- contingencies too low;
- geological risks or natural elements are not clearly defined; and
- environmental, safety, and existing conditions are unclear.

The primary reason for this management flaw is that no one wants to be the conveyor of bad news, and information is filtered as it goes up the hierarchy. Furthermore, because those intimately involved with a project are not likely to distribute unflattering and less-than-optimistic forecasts, information is also biased at the source.

FIGURE 8. Typical Process for Integrated Risk Assessment Through Planning and Execution



Absence of Continuous Evaluation of the Risk Effects

Any project can expect to continue to face numerous potential impacts compounded upon the already identified risks. As the project transitions into the implementation phase of final design and construction, the risks can change therefore, risk management cannot be looked upon as an independent function, but rather it should be planned from the beginning as an integrated part of project management. The absence of evaluating continuously the effects of risks through the progress of the project and intervening when necessary to ensure their mitigation and resolution is where the risk management process starts breaking down. There can be many risks outside of the control of the project team that have the potential to cause impacts if not continually monitored. Fundamental principles of a sound, integrated risk management process require the ongoing evaluation and reevaluation of risks as conditions change and having a process in place for implementing new mitigation strategies and options.

A continuous integrated risk management process will help reduce the potential for unidentified negative impacts, will improve the program/construction management's continuous efforts of obtaining consensus, continue coalition building, and maintain a steady focus on the project's constraints and objectives. At Fluor, we find integrating risk analysis methodologies into the project management applications help project teams from making avoidable catastrophic mistakes.

Conclusion

It is not reasonable to think that risk can be eliminated from our major capital construction projects. However, risk events can be acknowledged much more explicitly and managed a great deal better with more accountability than is typically the case. At Fluor we embrace risk. We know it is going to happen. The challenge is to recognize risk, decide what to do about it and manage it. To enhance project delivery and performance, an integrated risk management process should be one of the tools used with the construction management applications. The benefits of the risk management process are expected to include:

- provide a disciplined framework for systematically guiding the process of identifying and managing risk that may not otherwise be considered;
- helps avoid/reduce large losses, as well as lessening the frequency of smaller losses;
- improves decision making through clarifying responsibilities and authorities; and
- supports a better understanding for managing risks leading to increased project confidence and improved allocation of resources.

Although most construction managers recognize the importance of risk management processes and use some method for project analysis, we advocate that the project redefine its risk management processes in terms of another program/construction management tool kit. That is, to make iterative risk assessments that quantify the potential risks, and to build a project organizational culture that focuses on potential risk impacts and its associated mitigation and contingency planning.

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thinking in terms of risk management principles

risk planning	recognizing the need for applying risk management processes
don't be too idealistic	be realistic in making project assumptions
gather expert judgment	understand the risk elements and their impacts by gathering expert information and input
assess and analyze risk impacts	complete the evaluation and analysis of particular risks to determine the impacts they have on the project goals and objectives
develop mitigation and contingency plans	develop mitigation and contingency plans that are sufficient for the priority or the degree of potential impact
synthesize the risks	synthesize all risks and determine their total cumulative effect
integrate the risk process with project management	integrate the risk management process with the day-to-day construction project management applications
clarify all project metrics	make sure all project performance measurements and metrics are clear and reliable
implement a continuous risk management process	continuous evaluation of risk effects throughout the project and intervene when necessary to ensure their mitigation

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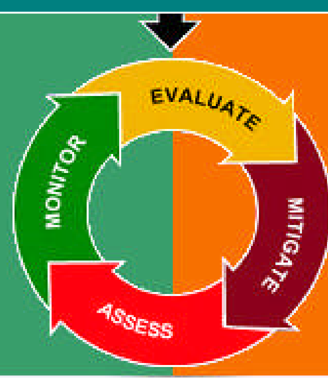
thinking in terms of
risk management strategy

Establish Project Strategy and Objectives



Focus on High Risk Issues and Their Impacts

Assess Adequacy of the Mitigation and Contingencies