

COST AND SCHEDULE RISK ANALYSIS

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of Engineers®



AGENDA

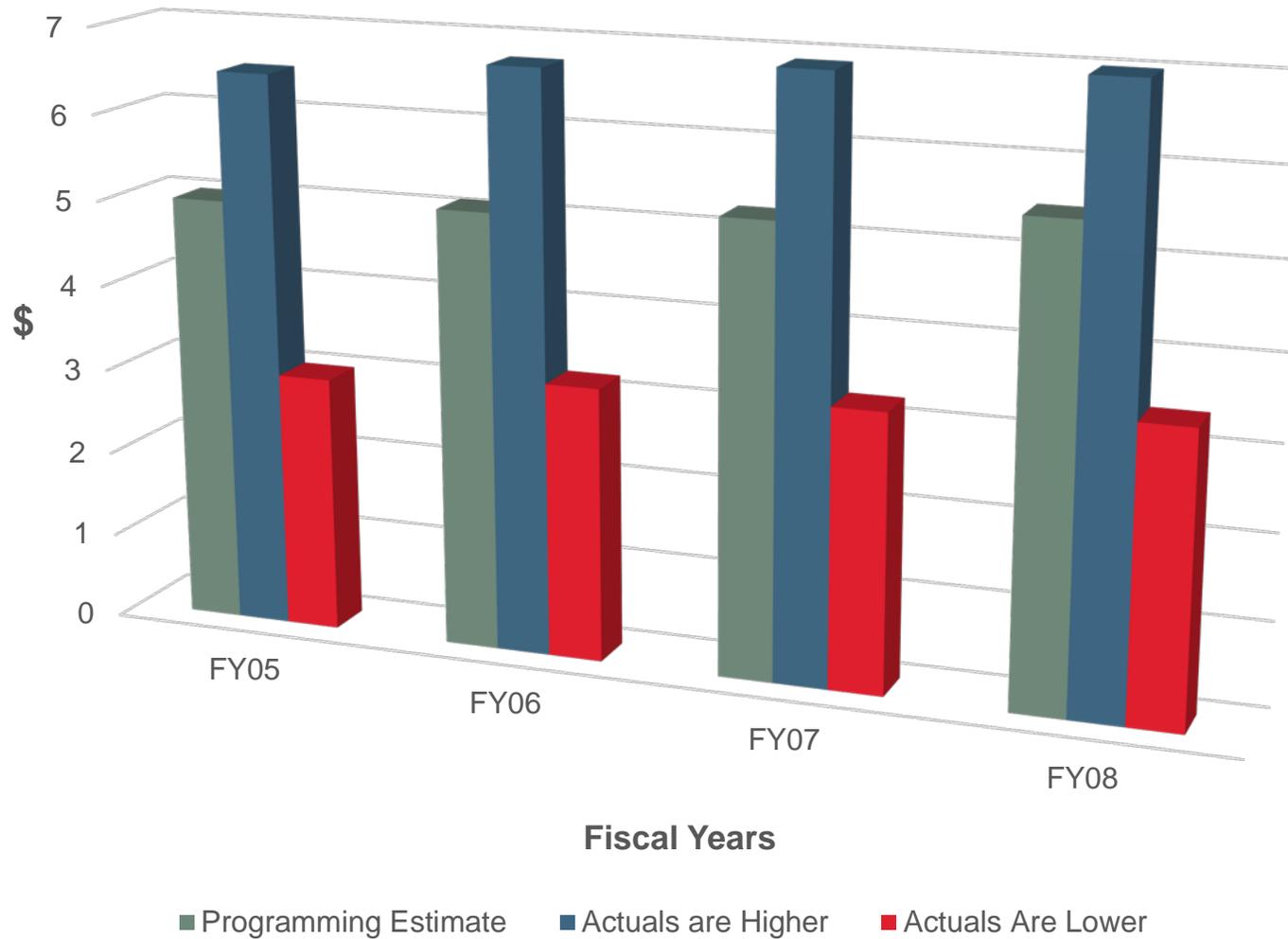


- Definitions and Discussion
- Why Are We Doing This?
- Cost MCX Mission
- Risk Management Methodology
 - Risk Identification
 - Risk Analysis and Quantification
 - Risk Response/Mitigation Plan
 - Risk Monitoring and Control
- Practical Uses/Tips
- Conclusion/Questions



THE ISSUE: PROGRAMMING ESTIMATES SET BASELINE OR BUDGET

Programming Estimate





WHY ARE WE DOING THIS?



- Major General Riley Memo 3 Jul 2007
- E&C Bulletin 10 Sep 07
- ER 1110-2-1150 Engineering and Design for Civil Works Projects
- ER 1105-2-100 Planning Guidance Notebook
- ER 1110-2-1302 Civil Works Cost Engineering
- ETL 1110-2-573 Construction Cost Estimating Guide for Civil Works

Per the PMBoK Guide:

“The objectives of Project Risk Management are to increase the probability and impact of positive events, and decrease the probability and impact of events adverse to the project.”



RISK



An uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives.

Source: PMBoK® Guide, p. 373



WHAT ARE THE FOCUS AREAS?



**Cost
Growth**

**Poor
Quality**

**Late
Delivery**

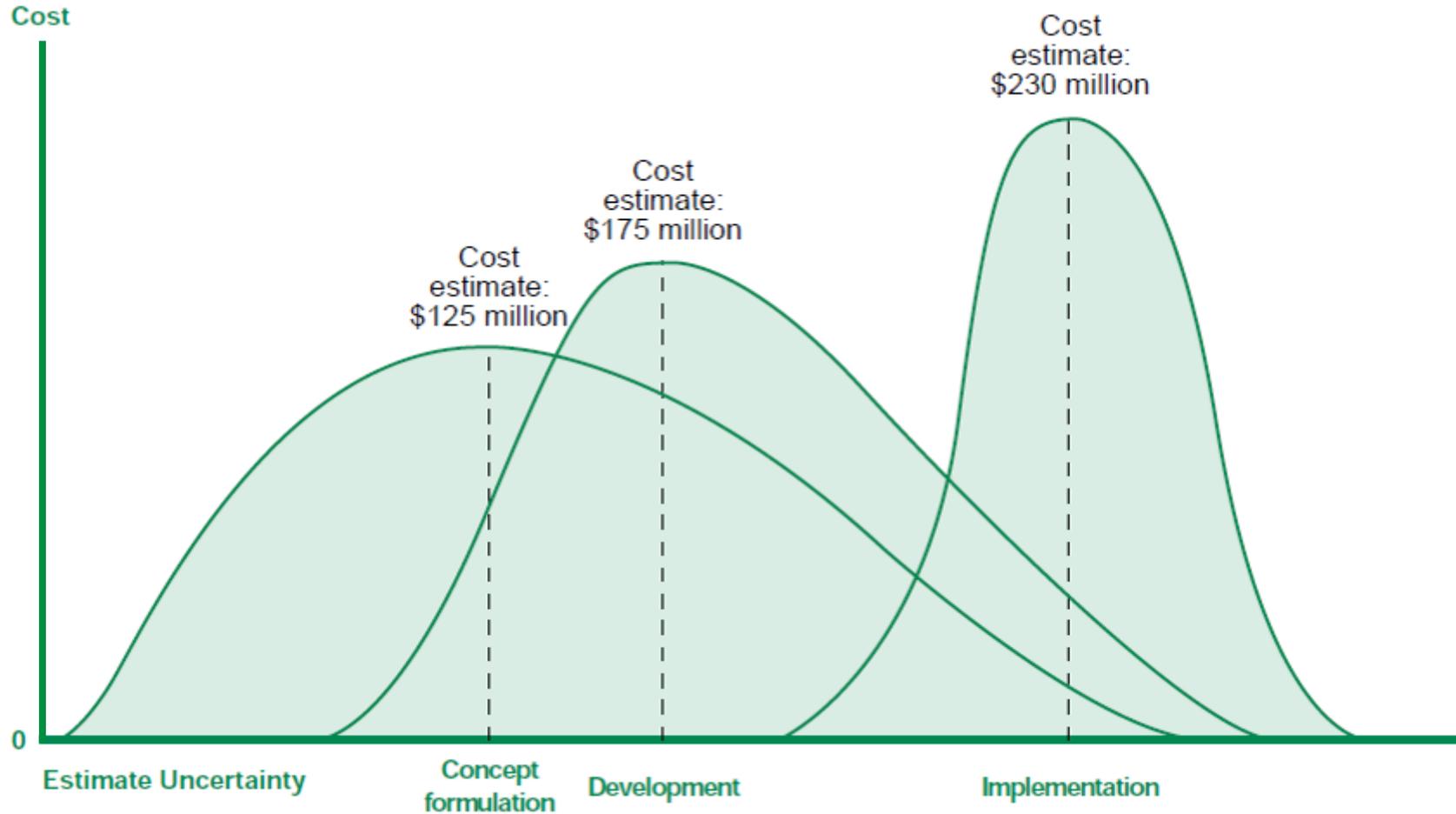
**Political
Fallout**

**Safety
Infraction**

**Loss of
Public
Trust**



ACQUISITION LIFE CYCLE COST UNCERTAINTY

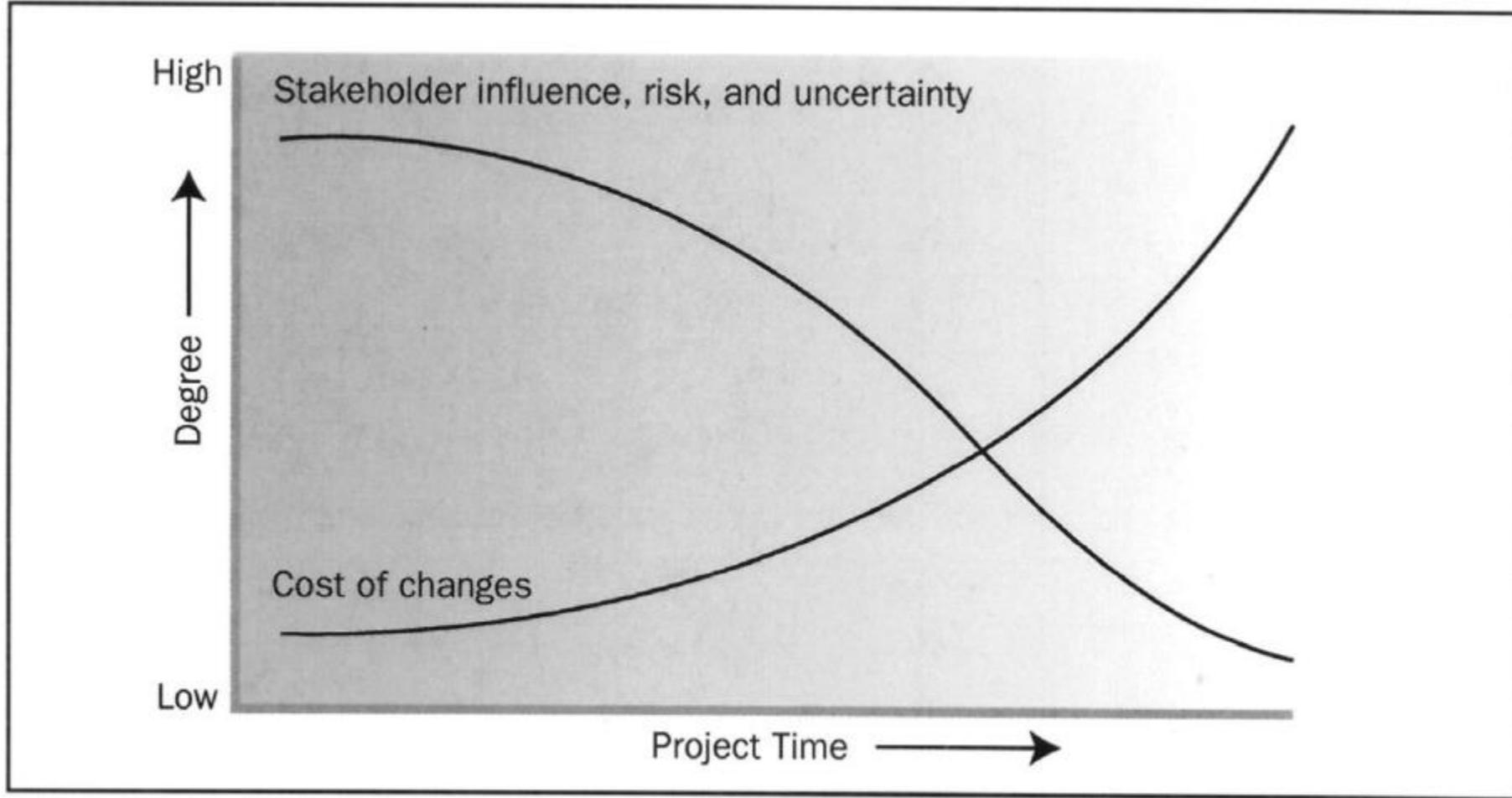


Source: GAO.

Changes in Cost Estimate Uncertainty Across the Acquisition Life Cycle



RISK IMPACT BEHAVIOR



Impact of Variable Based on Project Time

Source: PMBoK® Guide 4th Edition, p. 17



TOP REASONS FOR MAJOR COST VARIANCES



Top Reasons for Major Cost Variances





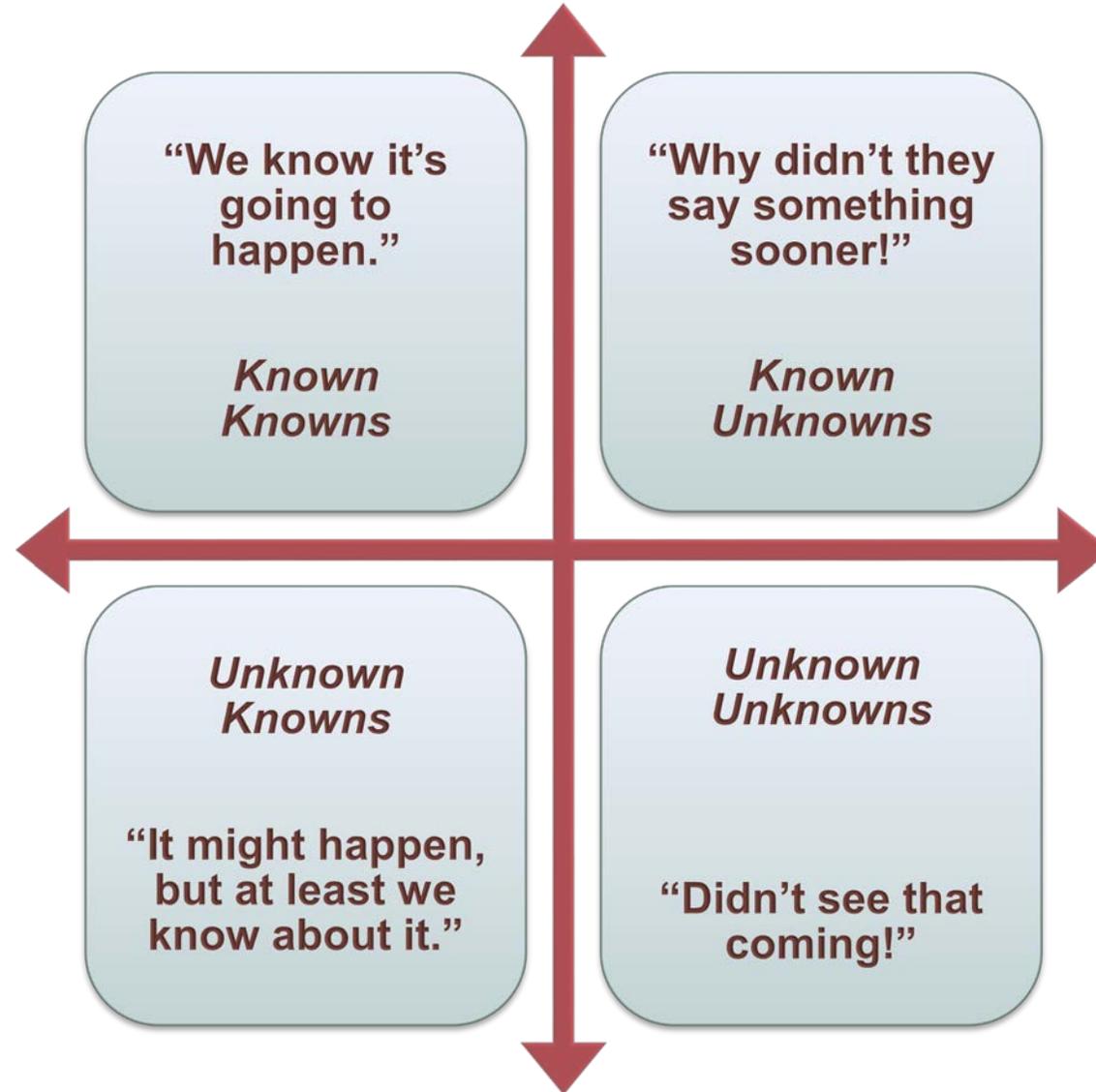
DEFINITIONS



- Internal Risk: An item or activity upon which the PDT has control or influence.
- External Risk: An item or activity upon which the PDT has no control or influence.
- Discrete (Project, Contract, Specific) Risk: An item or activity that only affects a specific feature account.
- Global (Programmatic) Risk: An item or activity that affects multiple or all feature accounts.



BASIC RISK ASSUMPTIONS



Basic Risk Assumptions



PARETO PRINCIPLE



Per the 80/20 rule of the Pareto Principle:

20% of the risks

will cause

80% of the impacts



DEFINITIONS



Risk Management (PMBok® Guide):

“*Project Risk Management* includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project; most of these processes are updated throughout the project.”



DEFINITIONS



Risk Analysis (PMBok® Guide):

Qualitative Risk Analysis: “Prioritizing risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact.”

Quantitative Risk Analysis: “Numerically analyzing the effect on overall project objectives of identified risks.”



COST & SCHEDULE RISK ANALYSIS (CSRA)



- Technique used to improve development of contingencies
- Formal analysis required on all projects requiring authorization and anticipated to be \$40M or more in total project cost
- Relies on qualitative and quantitative studies
- OUTPUT quality is limited by INPUT quality (inputs are estimates and schedules)



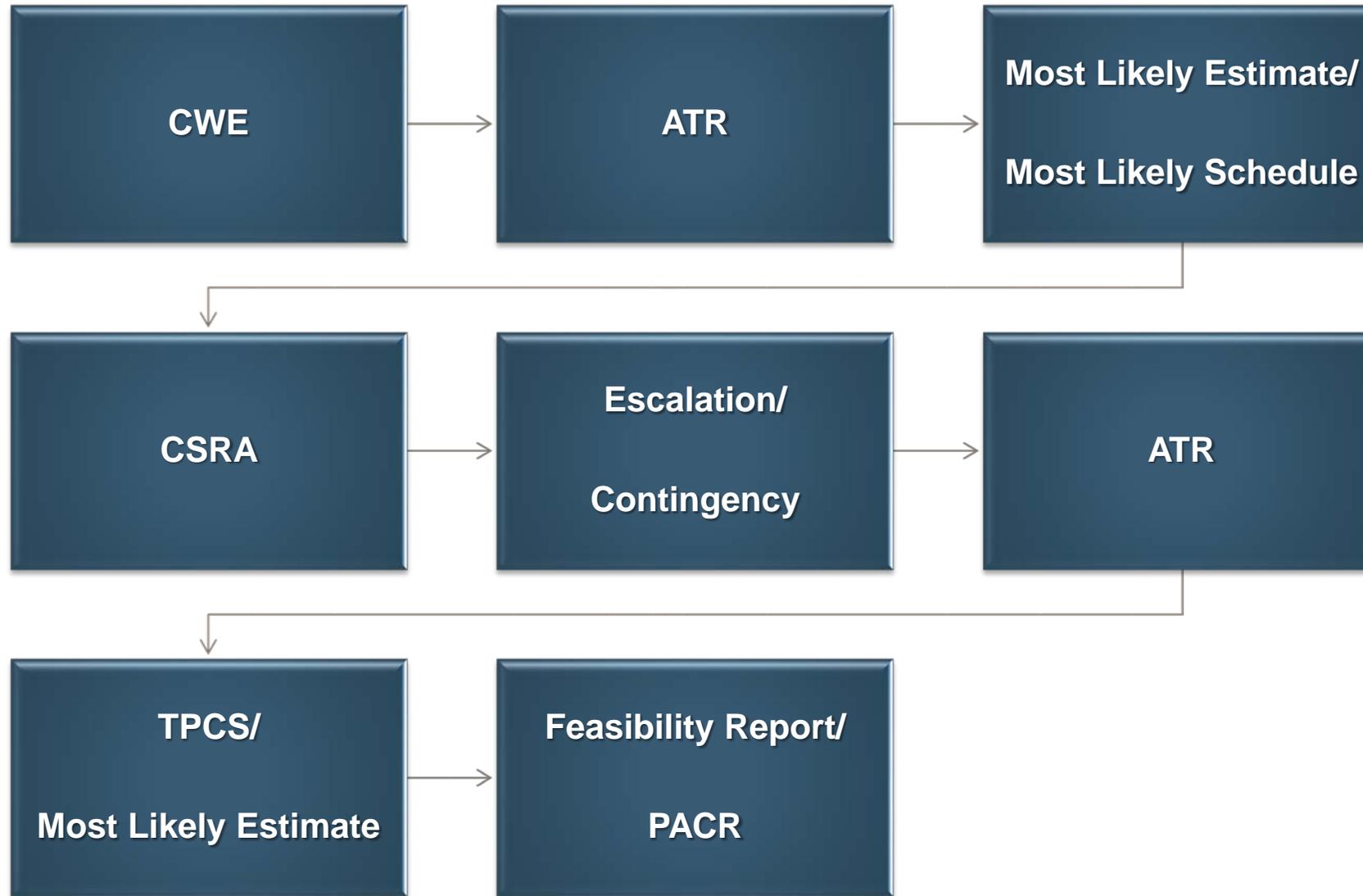
NWW COST MCX MISSION



- Review and certification of cost estimates (including MCACES estimates, schedules, and Total Project Cost Summaries which include contingencies) during feasibility level ATRs for all USACE Civil Works projects going up for authorization and funding.
- Development of risk analysis capability through the Cost Engineering Community of Practice, as well as actually performing cost risk analyses (upon request) in its support for others role for projects with a total project cost of \$40 Million or more.



DISCUSSION/CONCERNS – CWE PROCESS



CWE Process



RISK METHODOLOGY (PMI)



- Project Delivery Team (within PMP)
- Risk Management Planning
- Risk Identification
- Risk Analysis and Quantification
- Risk Response/Mitigation Plan
- Risk Monitoring and Control



RESPONSIBILITIES FOR PROCESSES



Process	Lead	Support
Risk Management Planning	PM	PDT
Risk Identification	PM	PDT
Risk Analysis and Quantification	Cost Engineer	PDT
Risk Response/Mitigation Plan	PM	PDT
Risk Monitoring and Control	PM	PDT

Process Responsibilities



RISK METHODOLOGY (PMI)



- **Risk Management Planning**
- Risk Identification
- Risk Analysis and Quantification
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COST ESTIMATES – WHAT THEY MEAN TO YOU



- Estimates are dependent on SCOPE!
- Estimates form the basis for decision-making (expectation management)
- All Civil Works Construction projects requiring authorization MUST have estimates certified by Civil Works Cost MCX (NWW)
- Estimates are expected to be as accurate as possible



MORE ON COST ESTIMATES



“By Public Law 95-269, all construction cost estimates shall be prepared as though the Government were a prudent and well-equipped contractor. Therefore, all costs, which a prudent and experienced contractor would expect to incur, shall be included in the cost estimate.”

Source: ER 1110-2-1302 Civil Works Cost Engineering, 9-15-08



SCHEDULES – WHAT THEY MEAN TO YOU



- Estimates establish schedules, but schedules may also drive estimates
- Schedules are also dependent on SCOPE!
- Schedules also aid in decision-making (expectation management)
- Schedules are expected to be as accurate as possible



RISK METHODOLOGY (PMI)



- Risk Management Planning
- **Risk Identification**
- Risk Analysis and Quantification
- Risk Response/Mitigation Plan
- Risk Monitoring and Control



SUGGESTED PDT MEMBERS



- Project & Planning Managers
- Contracting
- Real Estate & Relocations
- Environmental
- Designers
- Estimators
- Construction
- Operations
- Sponsor(s)



RISK CONSIDERATIONS



- Organizational
- Project Management
- Contract Acquisition
- Technical Risks
- Estimates and Schedules
- Lands and Damages
- Regulatory
- Environmental
- Construction
- External Impacts



PDT TO IDENTIFY RISK ITEMS



PDT Meets to discuss project scope.

- Cost Engineer explains the Basis of the Government Estimate (“Most Likely Cost”).
- The PDT brainstorms potential risk elements.
- The PDT then assigns the “Likelihood” of occurrence.
- The PDT assigns the “Impact” level if occurrence does happen.
- Based on the previous input, risk level events are identified for further action.

Risk Register

Risk No.	Risk Event	Likelihood	Impact	Risk Level	Notes
1	Bidding Climate – Saturated Local Market	LIKELY	MARGINAL	MODERATE	\$3 Billion construction will be going on in downtown Pittsburgh over the next 5 years.
2	Volatile Real Estate Values	UNLIKELY	NEGIGIBLE	LOW	Little to no Real Estate to be purchased
3	Scope Definition	UNLIKELY	NEGIGIBLE	LOW	Scope is well defined. There is minimal likelihood of scope increase or changes from the current documents used for estimate development.
4	Scope Growth / Reduction	LIKELY	NEGIGIBLE	LOW	Scope is well defined. There is minimal likelihood of scope increase or changes from the current documents used for estimate development.
5	Weather	LIKELY	MARGINAL	MODERATE	Work will be done on the river, unpredictable, poor protection is more vulnerable
6	Schedule Constraints	LIKELY	SIGNIFICANT	HIGH	There are tight delivery windows that will require mitigation efforts if not met.
7	Labor Availability/Pricing	LIKELY	MARGINAL	MODERATE	\$3 Billion construction will be going on in downtown Pittsburgh over the next 5 years.
8	Equipment Availability/Pricing	UNLIKELY	NEGIGIBLE	LOW	Fuel prices will impact equipment operating costs. Fuel prices will impact delivery of materials and the cost of petroleum based materials, steel market will potentially volatile
9	Material Availability/Pricing	LIKELY	SIGNIFICANT	MODERATE	
10	Fuel Prices	VERY LIKELY	SIGNIFICANT	HIGH	\$2.65 per gallon was used in the Oct 08 MCACCS, increase will effect equipment and delivery of materials
11	Potential savings due to innovation, streamlining, and gains in efficiency	UNLIKELY	NEGIGIBLE	LOW	Value Engineering has already been incorporated into the project
12	Acquisition Plan	LIKELY	SIGNIFICANT	HIGH	The estimate was based on full and open competition, with minimal timing of contractor subs. The Acq Plan has not been finalized, therefore there is a potential for additional timing of the contracts.

Risk Register Example



PDT BENEFITS – MANAGEMENT TOOLS



- Highlights Risk Areas
- Highlights Potential Benefits
- Identifies Methods to Manage Risks
- Establishes Platform for Future Risk Studies (the Risk Register)



RISK METHODOLOGY (PMI)



- Risk Management Planning
- Risk Identification
- **Risk Analysis and Quantification**
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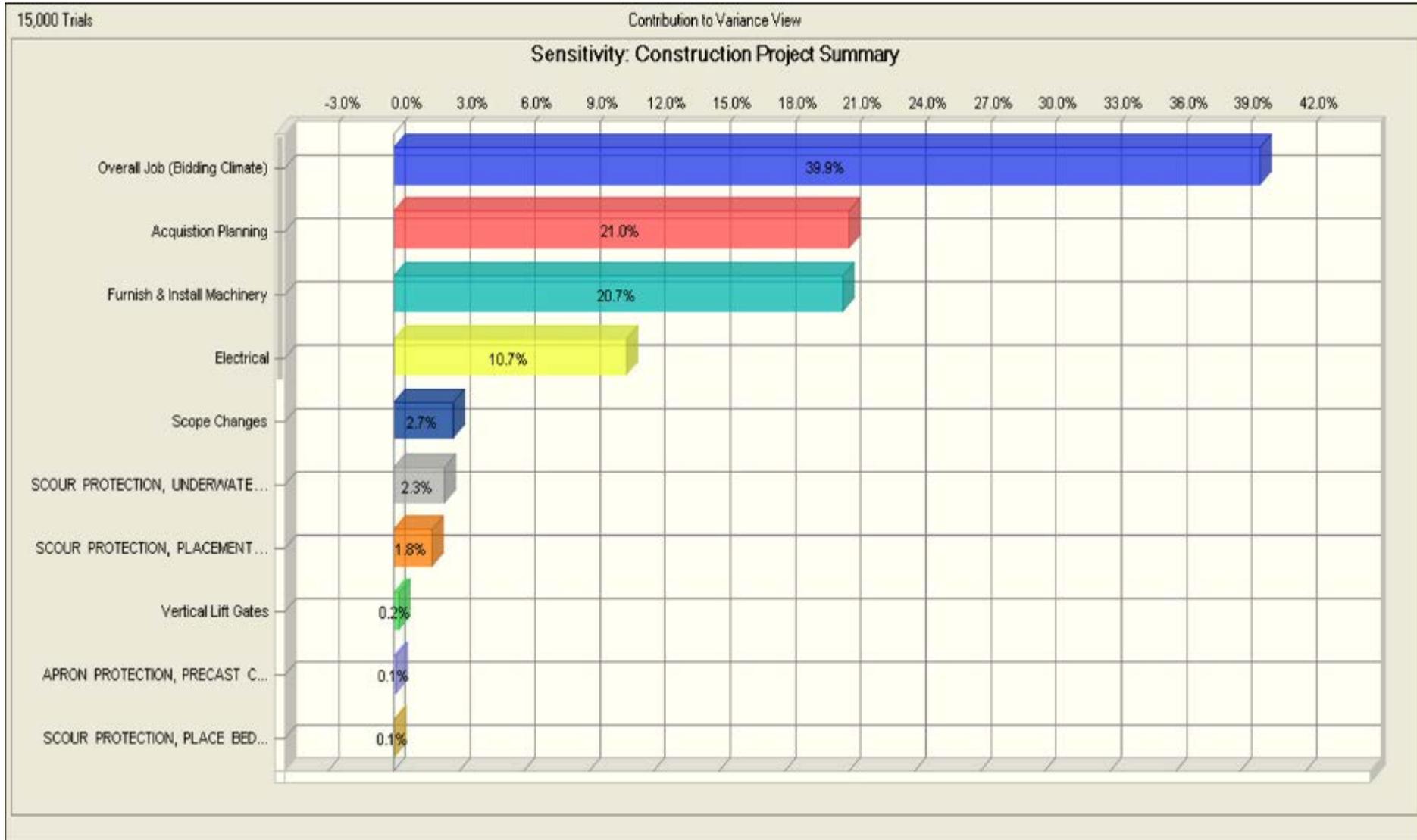
RESULTS OF CRYSTAL BALL OUTPUT



- Most Likely Cost Estimate (Risk Based)
- Most Likely Project Schedule (Risk Based)
- Contingency for Total Project Cost Summary
- Sensitivity Analysis



SENSITIVITY REPORT



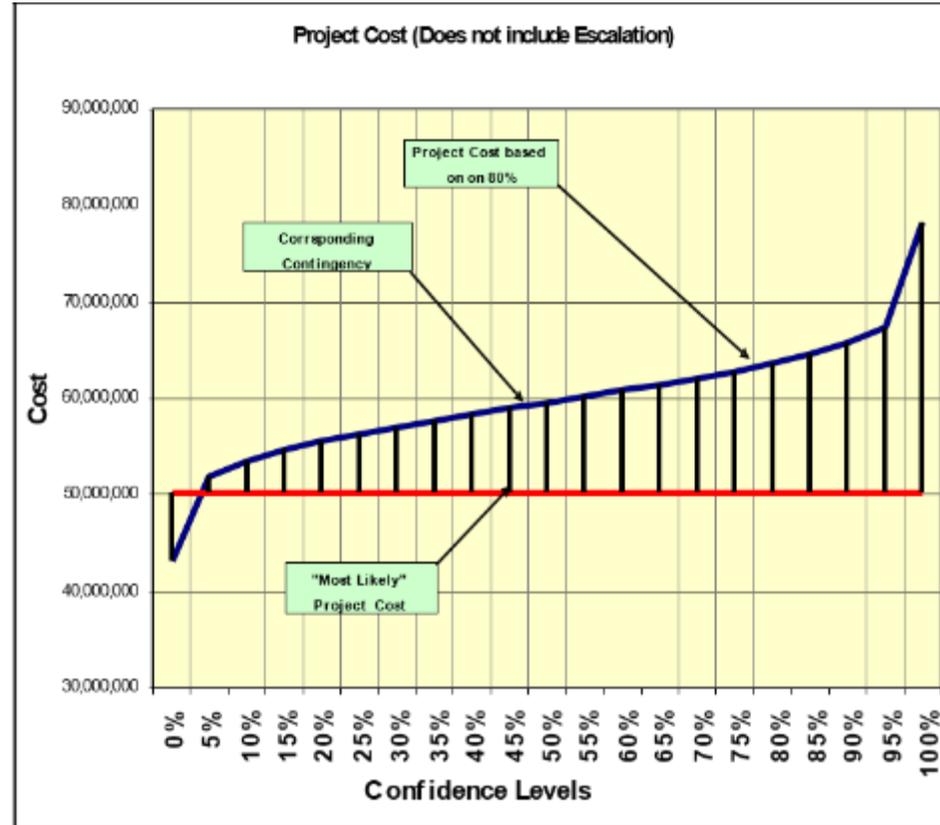
Sensitivity: Construction Project Summary



RISK COMMUNICATION



- Recommended project contingency and corresponding confidence levels are presented to the PM.
- PM and District Management will decide what confidence level would be acceptable for the project.



Project Cost (Does not Include Escalation)



BEYOND THE ANALYSIS



Confidence Level	Value	Contingency
0%	\$35,833,239	-10.45%
10%	\$46,442,558	16.06%
20%	\$48,400,180	20.96%
30%	\$49,744,595	24.32%
40%	\$50,988,057	27.42%
50%	\$52,151,692	30.33%
60%	\$53,286,037	33.17%
70%	\$54,462,516	36.11%
80%	\$55,868,598	39.62%
90%	\$57,672,460	44.13%
100%	\$67,240,463	68.04%

Now what?

Confidence Level, Value, and Contingency



RISK METHODOLOGY (PMI)



- Risk Management Planning
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- **Risk Response/Mitigation Plan**
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RISK RESPONSE STRATEGIES



NEGATIVE

- Avoidance
- Transference
- Mitigation

POSITIVE

- Exploit
- Share
- Enhance



RISK RESPONSE/MITIGATION EFFORTS



- Risk Responses
 - Acceptance
 - Contingent Response
- Risk Analysis Identifies Key Risk Items
- Risk Mitigation → Reduces Impact
- Risk Analysis and Response is Iterative



RISK RESPONSE CONSIDERATIONS



- “Secondary risks”: New risks created as a direct result of response to an original risk
- “Residual risks”: Risks that remain even after response
- Contingency (either cost or schedule) is a response strategy (but not the only one!)
- Every contingent response should also have an accompanying “*fallback*” plan (i.e. contingency)



RISK METHODOLOGY (PMI)



- Project Delivery Team (within PMP)
- Risk Identification
- Risk Analysis and Quantification
- Risk Response/Mitigation Plan
- **Risk Monitoring and Control**



That's great, but...

what do I do with that, exactly?



RISK MANAGEMENT MADE PRACTICAL



- Plan for risk – prepare a risk management plan
- Conduct risk identification meetings – collaborate with the stakeholders (PDT)
- Perform analysis of risks – qualitative and quantitative
- Communicate the key risks and manage them
- Plan responses to key risks



RISK MANAGEMENT MADE PRACTICAL, CONT.



- Mitigate risk occurrence
- Consider secondary and residual risks
- Conduct regular risk review meetings
- Maintain a risk “watch list”
- Control your projects appropriate to the risks (i.e., change control)



CONCLUSION



- Risk management and risk analysis are not rocket science.
- Risk management and risk analysis principles should be employed in ALL projects.

“An ounce of prevention is worth a pound of cure.”
-Benjamin Franklin



REFERENCES



- *A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 4th edition*
- ER 1105-2-100, Planning Guidance Notebook
- ER 1110-1-1300, Cost Engineering Policy and General Requirements
- ER 1110-2-1150, Engineering and Design for Civil Works Projects
- ER 1110-2-1302, Civil Works Cost Engineering
- ER 1110-2-573, Construction Cost Estimating Guide for Civil



TOOLS & INFORMATION



- NWW Cost Engineering Mandatory Center of Expertise
<https://www.nww.usace.army.mil/Missions/Cost-Engineering/>
- USACE publications
<https://www.publications.usace.army.mil/>