

The Monte-Carlo Challenge: A Better Approach

Driver-Based Contingency Estimating

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Objectives

- Describe the Monte Carlo challenge
 - i.e., why it is failing as applied
- Describe contingency estimating best practices
 - Driver-based, consistent with risk management principles
- Describe a contingency estimating approach using these best practices

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Background: Contingency Estimating

- Industry has consensus on the definition of contingency (i.e., defined in AACE's terminology standard; 10S-90)
- There is little consensus, and no AACE recommended practice, on *how* to estimate it

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Contingency Estimating Methods

- There are 4 categories:
 - Expert Judgment
 - Predetermined Guidelines
 - varying degrees of judgment and empiricism
 - Monte Carlo or other simulation analysis
 - risk analysis judgment built in a simulation
 - Parametric Modeling
 - empirically-based, usually via regression
 - varying degrees of judgment used

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Are Methods Working?

- What does research say?
 - Only one empirically-based study known
 - By IPA (presented at AACE in 2004)*
 - Findings
 - "...contingency estimates are, on average, getting further from the actual contingency required."
 - When project scope was poorly defined, the more sophisticated techniques were "a disaster"
 - These techniques tend to involve the use of Monte Carlo

* Burroughs Scott E. and Gob Juntima,
"Exploring Techniques for Contingency Setting"

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Why Is Monte Carlo Failing?

- The methods, as usually applied...
 - ...fail to establish “dependencies” between model variables
 - ...fail to model the relationship or risk drivers to impacts (cost or schedule)
 - ...fail to distinguish between systemic and project-specific risk drivers

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Failure to Establish Dependencies

- Monte Carlo simulations treat all variables as independent unless otherwise defined
- Independent variables mean highs and lows in model inputs tend to cancel each other out in a Monte Carlo sample run
 - i.e., range will be tight; contingency too low
- Use correlation matrices in modeling tools to define dependencies

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Failure to Model

Risk Driver-to-Impact Relationships

- Risk management is all about risk drivers
 - identify, quantify, screen, mitigate, etc.
- Most methods use a “line-item” model with item cost ranges as the sole inputs to the Monte Carlo simulation
- Risk drivers play no part in this method
 - i.e., it violates basic risk management principles

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Failure to Distinguish Between Systemic and Project-Specific Drivers

- Systemic Risks: are attributes of project or process “systems”
 - E.g., level of scope definition, process technology, process or project complexity
 - Driver-to-Impact relationship is stochastic; i.e., hard to say how risk will impact any specific line-item
 - Outcomes predictable for a given project “system” or technology

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Failure to Distinguish Between Systemic and Project-Specific Drivers

- Project Specific Risks: Differ project-to-project within a project system
 - E.g., weather, soils, execution strategy, etc.
 - Driver-to-Impact relationship is deterministic; i.e., easy to see how risk will impact a specific line-item
 - Outcomes highly variable depending on project scope, circumstances, etc.

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Failure to Distinguish Between Systemic and Project-Specific Drivers

- System Risks; only empirically-based parametric models effectively identify driver-to-bottom line impact relationship
- Project Specific Risks; only risk-by-risk deterministic estimating will effectively identify driver-to-impact relationship
- Line-item based Monte Carlo does neither of the above
 - i.e., "a disaster"

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Best Contingency Estimating Practices

- Provide probabilistic outputs
- Tie risk drivers-to-impacts
- Address systemic and project-specific risks appropriately
- Use the method right (i.e., establish dependencies if the method incorporates Monte Carlo)

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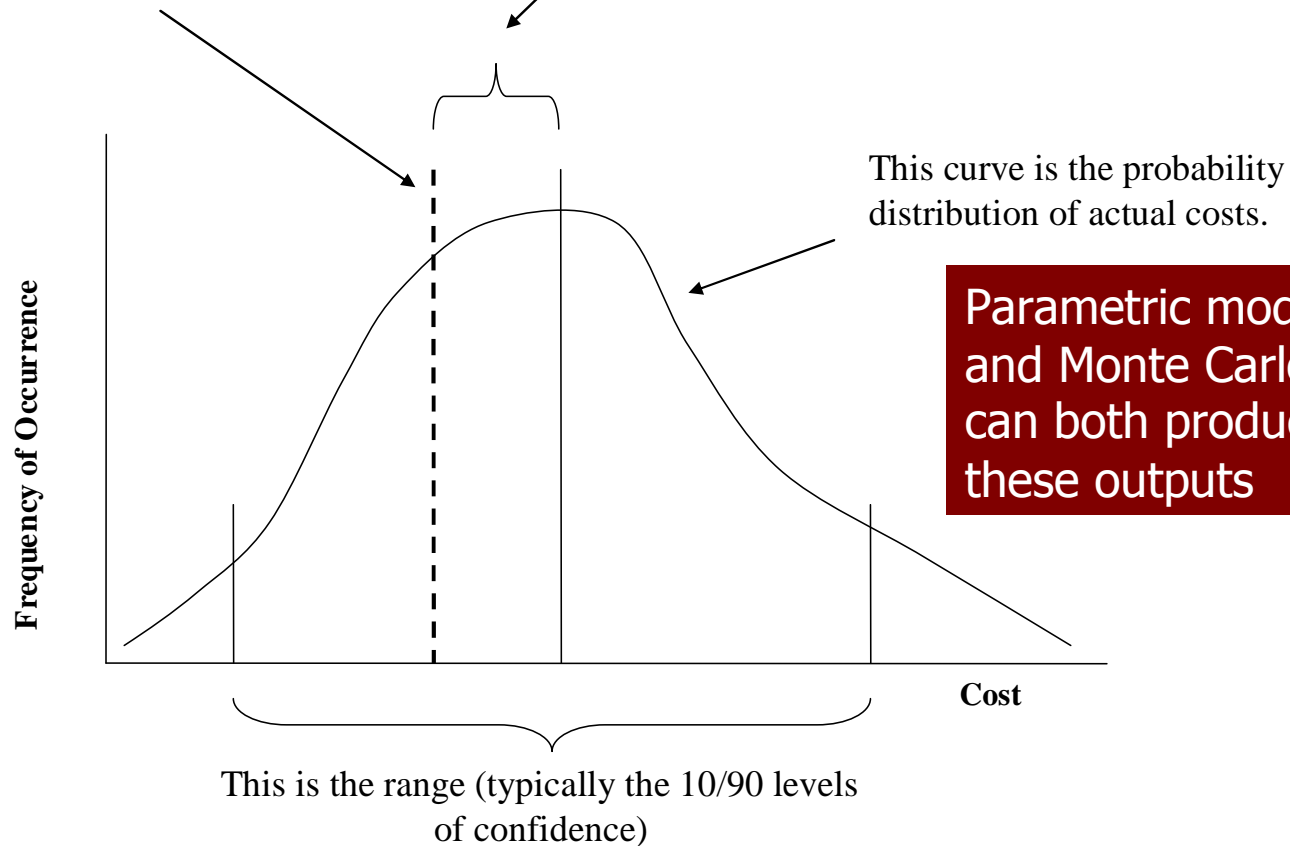
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Methods With Probabilistic Outputs

This is the point estimate
before adding contingency

This cost difference is the contingency
(typically the cost at 50 percent confidence
less the point estimate)



Methods that Explicitly Tie Risk Drivers-to-Impacts

- Empirically-based parametric models
 - Regression inherently correlates the inputs (project attributes and risk drivers) to the outputs (predicted cost growth)
- Expected value
 - The product of the probability of the risk event and the cost impact (if it happens) is the “expected value” (amenable to Monte Carlo application)

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Methods that Explicitly Address Systemic Or Project-Specific Risk

- Systemic risks = parametric models
 - Ideal for modeling how systemic drivers (e.g., level of definition) related to bottom line cost growth
- Project specific risks = expected value
 - Using a risk-by-risk line-item approach, it models how any given risk driver will impact any given line-item

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Monte Carlo Using Dependencies

- Tools such as @Risk have always supported dependency identification using *correlation matrices* (it is just that few bother to use them)
- Need to look at dependencies between risks and between costs

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- **Describe a contingency estimating approach using these best practices**

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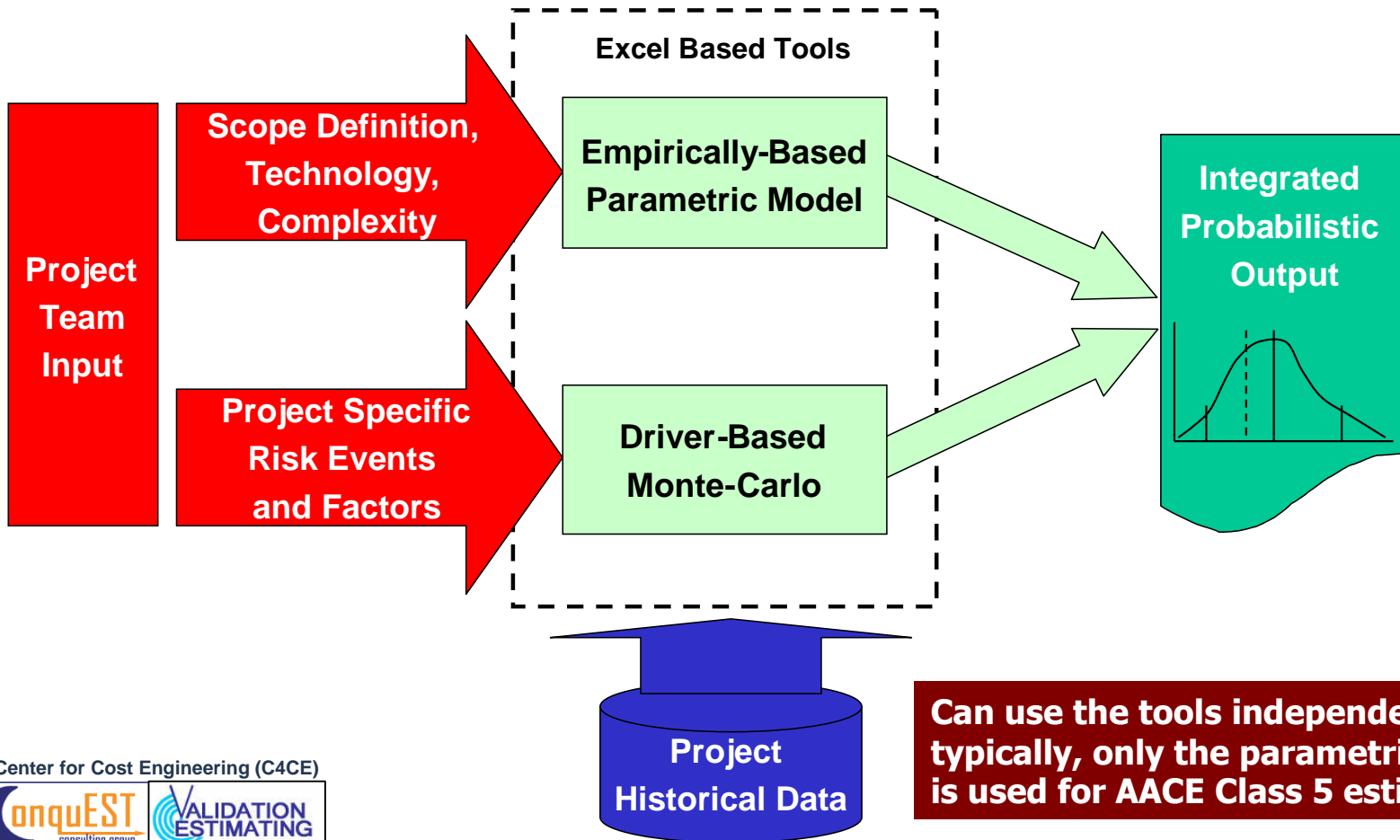
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An Approach Using Best Practices

C⁴CE's Integrated Contingency Estimating Toolset



Center for Cost Engineering (C4CE)



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Example: Parametric Model Inputs

Scope Development/Estimate Maturity Worksheet

General Project Scope

Tailor questions to each company's project system (in this case, using ACE estimating classifications)

Expected Development at Class:			Enter Level 5, 4 or 3	Quoted Class
5	4	3		
general	preliminary	defined	4	
assumed	preliminary	defined	4	
general	approximate	specific	4	
assumed	preliminary	defined	4	
none	preliminary	defined	4	
none	preliminary	defined	4	
			4.0	4

Project Planning

User guidelines for rating criteria provided

none	preliminary	defined	4	
none	preliminary	defined	4	
none	preliminary	defined	4	
none	preliminary	defined	4	
none	preliminary	defined	4	
assumed	assumed	assumed	4	
			4.0	4

Engineering Deliverables

Assess these and other risk factors as a team!

Users simply rate the drivers using objective criteria

none	none	none	4	
none	none	none	4	
none	none	none	4	
none	none	complete	4	
none	none	complete	4	
none	none	complete	4	
none	none	complete	4	
none	none	complete	4	
none	none	started	4	
none	none	started	4	
none	none	started	4	
none	none	started	4	
none	none	started	4	
			4.0	4
Average:			4.0	Est. Class: 4

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Example: Expected Value Tool

= risk model input = estimate entry = risk model output	Risk Driver Probabilities					Risk Totals
	Driver	1-Weather	2-Soils	3-Labor Market	4-Delivery	
	Type	Continuous Trunc-Normal both				
	Distribution					
	Threat/Opport.					
Probability	28%					
Cost Account	Base Estimate	Risk Driver Cost Estimates (Enter Worst Case)				
Project Mgmt	\$ 100	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Engineering	\$ 300	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Constr Mgmt	\$ 100	\$ 3				
Most likely		\$ -				
High		\$ 39				
Low		\$ (8)				
Equipment	\$ 500	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Bulk Materials	\$ 700	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Construction	\$ 1,300	\$ 14				
Most likely		\$ -				
High		\$ 195				
Low		\$ (39)				
Totals						
Base Estimate	\$ 3,000					
Mean	\$ 3,210	\$ 17				\$ 3,227

The costs are estimated for each risk driver and the basis of the estimate is documented (i.e., risk register)

The probability distribution for each cost account is defined

A correlation matrix between cost accounts is defined if appropriate

Each risk driver will have its own @Risk output distribution

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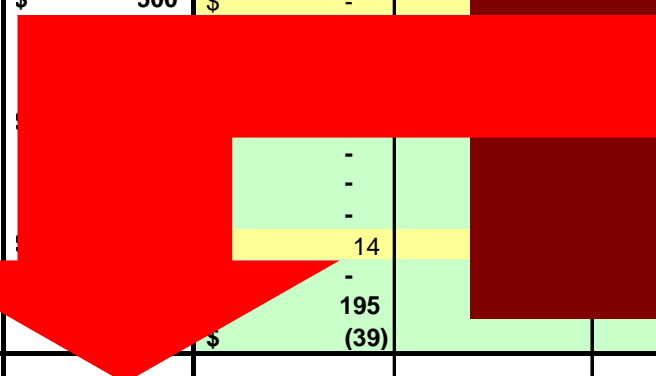
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The Tools Are Integrated

		Risk Driver Probabilities				
		1-Weather	2-Soils	3-Labor Market	4-Delivery	
= risk model input		Continuous				
= estimate entry		Trunc-Normal				
= risk model output		both				
		Probability	28%			
Cost Account	Base Estimate	Risk		Risk Totals		
Project Mgmt	\$ 100	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Engineering	\$ 300	\$ -				
Most likely		\$ -				
High		\$ -				
Low		\$ -				
Constr Mgmt	\$ 100	\$ 3				
Most likely		\$ -				
High		\$ 39				
Low		\$ (8)				
Equipment	\$ 500	\$ -				
Most likely						
High						
Low						
Bulk Materials						
Most likely		-				
High		-				
Low		-				
Construction		\$ 14				
Most likely		-				
High		195				
Low		(39)				
Totals						
Base Estimate	\$ 3,000					
Mean	\$ 3,210	\$ 17		\$ 3,227		

The output of the Parametric model is the first input to the project-specific model (the models are directly integrated)

From Parametric Model	
%	Indicated Total
10	\$ 2,890
20	\$ 3,000
30	\$ 3,080
40	\$ 3,150
50	\$ 3,210
60	\$ 3,270
70	\$ 3,340
80	\$ 3,450
90	\$ 3,620



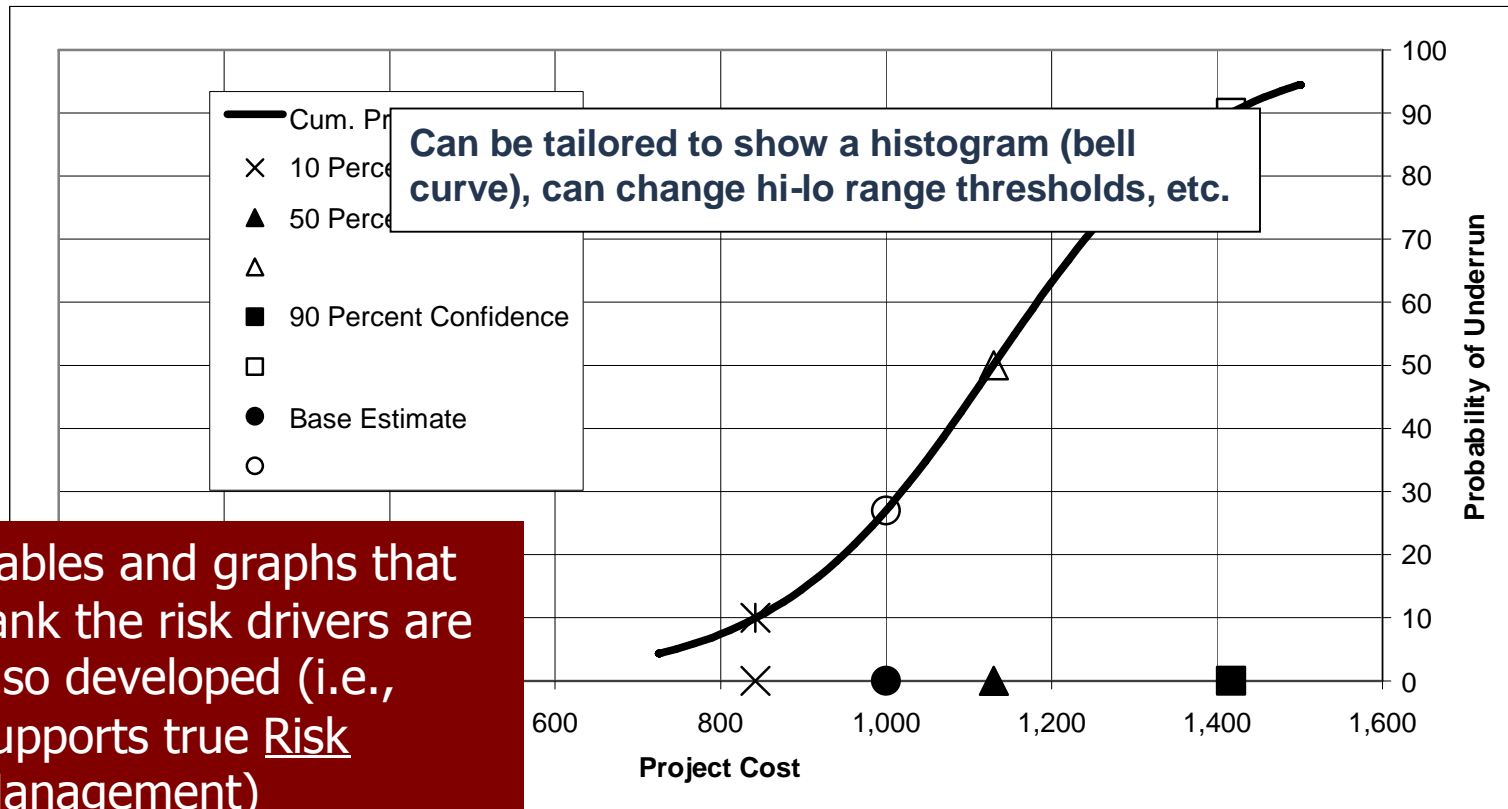
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Tabular and Graphical Outputs Are Tailored to Company Needs

CONTINGENCY ESTIMATE REPORT

Project Title:

enter title



Tables and graphs that rank the risk drivers are also developed (i.e., supports true Risk Management)

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Building Your Own Models

- C⁴CE base models are tailored for each company; it is then your model to improve as you'd like (Excel-based)
- If you have the time, you can build your own models; even if you don't have your own project historical data
- For systemic risks, there are published cost growth models (see paper for details)
 - *John Hackney*
 - *Rand Institute*
 - *CII*

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Building Your Own Models

- Probability-weighted expected-value methods are well described in the literature (see paper for details)
 - *Risk Management: Rita Mulcahy*
 - *Risk and Decision Analysis in Projects: John Schuyler*
 - *Etc....*

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Conclusions

- As typically applied, Monte Carlo has failed for contingency estimating
- Use best contingency estimating practices
 - Always tie risk drivers-to-impacts
 - Address systemic and project-specific risks with methods appropriate to each type
 - Provide probabilistic outputs; if Monte Carlo is used, establish dependencies

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Questions?

■ Contact

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