



Project Planning Guide for Owners and Project Teams

Managing Uncertainty and Expectations
in Building Design and Construction

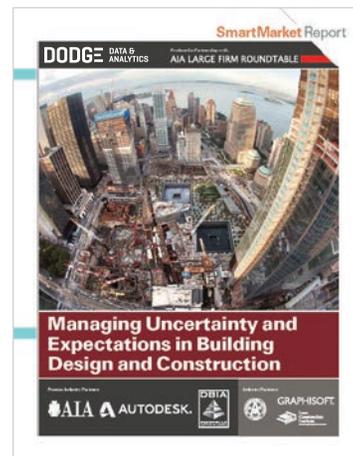
The Challenge

Better Planning for Uncertainty in Building Design and Construction

This project planning guide will help owners and project teams think about risks as they begin building projects and plan to mitigate the uncertainties that we all know are part of the process.

Building design and construction is one of the largest and most complex sectors of the world's economy. The industry includes public and private building owners, planners, architects, engineers, design and technical experts in various fields, construction contractors and managers, craftspeople and thousands of building product and system manufacturers. The design and construction process can be rewarding, but it can also be frustrating—even for experienced building owners and project teams.

This guide is based on unique industry research about uncertainty, expectations and improvement strategies in building design and construction. The guide provides expert advice from owners, architects and contractors based on real data about their experiences.



The original study

The research was sponsored jointly by the American Institute of Architects (AIA), the AIA Large Firm Roundtable, Associated General Contractors (AGC), Design-Build Institute of America (DBIA), Lean Construction Institute (LCI), Autodesk, Graphisoft, and other industry groups. The work was guided and reviewed by an advisory group of respected owners, including Crate & Barrel, Disney, GSA, Hines Interests,

Sutter Health, the University of Chicago and Whirlpool Corporation. The original study is presented in a report entitled *Managing Uncertainty and Expectations in Building Design and Construction*, published by McGraw-Hill Construction (now Dodge Data & Analytics) in 2014.

The *Managing Uncertainty SmartMarket Report* can be downloaded without charge from the Dodge Data & Analytics site: construction.com/toolkit/reports.



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This Planning Guide has been made possible by continuing support from the AIA Large Firm Roundtable, American Institute of Architects, Construction Owners Association of America, Associated General Contractors of America, Design-Build Institute of America, Lean Construction Institute and Graphisoft.

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Sources of Uncertainty

Seven major sources of uncertainty in building design and construction projects identified in recent industry research

Understanding the top causes of uncertainty on construction projects is the first step in anticipating them and managing risk.

Building projects are more complex than most business commitments we make as individuals and organizations. Why? Most of the things we buy are manufactured projects or routine services: things that have been designed, tested and perfected before they are offered to customers.

By contrast, most building projects are one-of-a-kind creations customized to serve an owner's individual goals and requirements. They are constructed in unique locations and site conditions. They represent unique combinations of design features and systems. Many building projects are also undertaken by teams of people who have little or no experience working together in this process.

The *Managing Uncertainty and Expectations* research identified seven major sources of uncertainty in building projects from the

experiences of more than 300 respondents, including owners, architects and construction contractors. The seven challenges were ranked from most to least significant, based on the frequency with which each concern is encountered and the typical project cost impact when it occurs.

1 Owner-Driven Changes. The greatest source of project uncertainty, change and additional cost is change in the needs of owners and building users. Building projects take a long time to complete—many years for large, complex buildings—so it is not surprising that requirements change between the early planning phases and building occupancy. In some cases, the owner's requirements are unclear—insufficiently explored and documented as the basis for design and construction, inviting change late in the process.

Frequency and Cost Impact of Top Causes of Certainty	
TOP FACTORS	INDEX (1-100)
Owner-Driven Changes	84
Design Omissions	59
Construction Coordination	53
Unforeseen Conditions	51
Design Errors	50
Accelerated Schedule	38
Contractor Caused Delays	37

2 Design omissions and communication gaps. The information prepared by architects and engineers for construction does not include every piece of hardware required, or answer every conceivable question about the designer's intent. One builder may assume that certain elements are necessary and include them in a construction estimate or budget, while another builder may not. There may be necessary components that are not fully described in the architect's or engineer's work product. It is therefore common to exchange questions and additional information during construction.

3 Construction coordination. The construction team is responsible for procuring the thousands of individual components required for a building project, assembling them in the right sequence and making the pieces fit together as the designers intended. Preconstruction planning is a critical step. When the design is unique and customized, there will inevitably be some modifications and rework required during construction. Some necessary components may be overlooked in the bidding process and not included in the initial construction prices and contracts.

4 Unknown site or building conditions. This is not the largest source of uncertainty in building projects, but it is a common, widely recognized risk. A builder may encounter rock, unstable soil or buried debris in excavation for foundations or underground utilities not previously identified on a new construction site. Renovation of an older building may uncover structural problems or other hazards that need to be corrected. These kinds of surprises can be anticipated on many projects. A team must address these issues quickly and effectively when they arise.

5 Design or documentation mistakes. Like other professionals, architects and engineers rarely achieve 100% perfection in their work. More than 90% of the owners surveyed in the *Managing Uncertainty* study believe that it is impossible to achieve perfect design documents, and 80% expect to absorb additional cost from minor mistakes. These can result from coordination issues among systems, discrepancies among documents, or simple errors in calculations or details. According to our research, the average cost impact expected by experienced owners is 3%–5% of total project cost.

6 Accelerated design and construction schedules. Demand for shorter design and construction schedules is becoming increasingly common. An owner may want to beat competitors to the market with a new manufacturing plant, hotel or retail center. A school may need to relieve crowded classrooms by the start of the next academic year. Owners may want to take advantage of favorable financing terms. There are several good ways to speed up the process, but faster schedules can result in more mistakes, coordination issues and cost premiums along the way.

7 Delays in procurement, fabrication or assembly. Delays can occur anywhere along the chain of responsibility, from a general contractor to trade subcontractors to vendors, suppliers and product manufacturers. Shortages of labor or material can also cause delays, especially during a strong construction market. Delays can also be caused by bad weather or other “acts of God.” Even if those delays don't significantly raise the cost of construction, missing key deadlines can disrupt the owner's business operations.

Most common project delivery methods

Design/bid/build

1 This has been the traditional U.S. project delivery method for many years. After several phases of planning, the owner's design team completes construction plans and specifications to solicit competing bids from general contractors and their trade subcontractors. The construction contract is usually awarded to the lowest "responsive" bidder for execution of the project. This method leverages market competition, but it can create adversarial team relationships—and the builder isn't involved until after design is complete.

Construction management

2 To bring construction expertise into the design phase, a CM is engaged to take the general contractor's role. They may work on an "agency" basis—providing assistance during the design phase and then bidding and managing separate trade contracts held by the owner—or "at risk" with cost liability based on a price negotiated as the design is completed. Either approach provides more collaboration between designers and builders. The agency option can leave the owner with more financial risk; the "at risk" option can yield some of the conflicts found in the design/bid/build approach.

Design/build

3 This approach has a single party contractually responsible to the owner for both design and construction of a project. The design-build entity can take various forms, including an integrated firm, a contractor- or design-led team, a developer or a joint venture. The design-builder encourages early participation by key trade contractors and awards other trade contracts as a general contractor would. The overall project cost structure may not be as transparent unless done on an "open book" basis. Competitive selection of a design-build team should focus first on qualifications and past performance.

Integrated project delivery

4 Some owners have adopted this innovative delivery approach to encourage alignment, collaboration and more efficient processes among all members of the design and construction team. In general, IPD team members share mutual business incentives, risks and rewards for the entire team's performance relative to explicit goals and objectives. Some IPD projects use multiparty contracts signed by all team members. In many ways, the IPD approach creates a business venture among the owner, designers and builders. There is no single IPD model.

Recommendations

Leadership Lessons From Owners, Designers and Builders

How should owners and project teams anticipate these challenges, plan for them and manage future building projects so they're most successful? Our research identified five important ways to provide better leadership for the design and construction process and achieve the best possible outcomes. The key points are also summarized in a checklist at the end of this guide.

1 Provide strong and consistent leadership within the owner's organization.

Experienced owners acknowledge the importance of providing strong leadership for their building design and construction projects. As the “customer” for the rest of the project team, an owner must be prepared to give clear direction, collaborate in the team's creative work and make timely decisions as required to support the process. This is one of the top two priorities cited by owners in our research about ways to improve project performance. How can you provide this leadership?

- Identify one project leader empowered to represent all the owner's user groups and other stakeholders, facilitate key decisions and provide direction to the rest of the project team.
- Engage the most senior leadership in the owner organization to articulate and reinforce the project's purpose, vision, goals and criteria for success.
- Provide clarity and depth in the owner's team to reflect multiple levels of leadership, decision-making authority, and knowledge of detailed program and technical requirements.
- Avoid making changes in the owner's key leadership roles, which can be very disruptive. If changes are necessary, allow as much time as possible and consider additional costs related to the transition.



WHAT'S MOST IMPORTANT?

OWNER PROJECT LEADERSHIP

- Identify a single project leader
- Keep senior executives engaged
- Be clear about team responsibilities

2 Assemble the whole project team at the right time and in the right way.

Most owners, architects and builders agree that it is important to get the entire project team on board very early in the design stage. More than 75% of owners in our research favored early assembly of their design and construction partners over the traditional design/bid/build approach, which does not bring a builder to the table until the end of project design.

Experienced owners are likely to have established preferences among project delivery methods and established relationships with architects, engineers, builders and key consultants. **Whatever the delivery method, all the principal members of the building team should be identified and engaged at the very beginning: architects, engineers, a general contractor or construction manager, and key consultants.**

Why is this so important? Greater team integration gives everyone a consistent understanding of project goals and requirements. Designers and builders can collaborate on design and technical options. Contractors or construction managers can provide timely cost and constructability advice. Most important, early formation of the entire project team creates a foundation of trust and communication benefiting the entire delivery process.

Project team members should be selected based on their expertise, experience and other qualifications first, with business terms considered as the second step. This “best value” approach is favored by more than 60% of owners in our *Managing Uncertainty* research. This selection process balances professional ability with price, rather than expecting great performance from a group of low bidders. Contracts can be structured to maintain market competition, particularly among construction trades, and create mutual incentives and rewards among principal team members.



WHAT'S MOST IMPORTANT?

ASSEMBLING THE PROJECT TEAM

- Choose a collaborative project delivery method
 - Engage construction partners early in the process
 - Be clear about team responsibilities
 - Select team members on qualifications and experience
-

3 Establish and maintain strong communication within the project team.

Building design and construction can involve a very complex communication process. Information about an owner's requirements is conveyed to the design team, whose design vision is then developed by a variety of technical disciplines, and then transferred to bidders, construction contractors and suppliers. Any weak links in this communication chain can be costly.

Effective working relationships need to be maintained at several levels in large project teams. The owner should designate and empower a very senior executive—ideally its president, CEO or other top officer—to provide overall sponsorship for the project and be the ultimate authority for project vision, goals and resources. This individual should stay actively engaged with the senior principals of the project's design and construction firms, often best accomplished with a “council” of principals that regularly assesses the progress of the entire team and resolves any performance issues.

Others responsible for day-to-day management of the work—again, owners, architects, engineers and builders—must maintain very close relationships throughout the process. In addition, user groups and other stakeholders must be engaged and informed as appropriate to the project's circumstances. There may be dozens of people in the owner's organization who interact with the design and construction team, presenting requirements and reviewing important design and technical options.

Once the project team is assembled, it pays to invest time in aligning the group around the owner's goals and expectations, key project success factors, roles and responsibilities, and project management and communication procedures. This will determine exactly how qualified team members, who may never have worked together before, will function as a unit to support the owner and get the job done.

Two thirds of owners, architects and contractors in the *Managing Uncertainty* research also advocate clearer definition of deliverables among team members during design and construction: who owes what to whom, when and in what form. This is a simple but valuable step.



WHAT'S MOST IMPORTANT?

PROJECT TEAM COMMUNICATION

- Designate a senior executive as project “sponsor”
- Create a council of principals from owner, design and construction firm leaders
- Solicit regular feedback from owner stakeholders
- Invest time in aligning the team

4 Completely define project requirements.

Unclear project requirements are the most important cause of owner changes cited by owners, architects and builders in the *Managing Uncertainty* research. Project teams waste time and money when their goals are not clear from the start.

Good architects, planners and builders are prepared to lead the “problem definition” process before design begins. The process begins with understanding the owner’s organization: who is being served by a building project, what are their needs and priorities, how will decisions be made and what are the owner’s criteria in defining project success?

A project program (brief) documents these fundamental points and provides more detailed requirements for building functions, spaces and relationships. Here is a sample checklist of project requirements an owner can provide, which can be compiled into a single document or some other form.

- Overall project goals and expected outcomes for the owner and facility users
- Desired relationships to other buildings and infrastructure at or near the project site
- Capacities of public and service access, roads, parking and utilities
- Numbers, sizes, capacities and proximity relationships of functional spaces
- Key flows of people, materials and equipment within the site and building(s)
- Area allowances for building circulation and support spaces
- Environmental requirements of functional and support spaces
- Technical data about equipment, furnishings and special utility services
- Desired capacities for future expansion or change
- Budgets for sitework, construction, furnishings, equipment and soft costs
- Project schedule goals and any critical milestone dates
- Applicable zoning ordinances, building codes and other regulations
- Certification targets related to sustainable design and building performance

WHAT'S MOST IMPORTANT?

DEFINING PROJECT REQUIREMENTS

- Define the owner's goals, needs, priorities and success criteria
 - Develop a detailed project program of functional requirements and relationships
 - Identify areas of uncertainty and possible change
-

The program of requirements should acknowledge areas of uncertainty and possible change for consideration by the design team. Where might occupant groups, work processes or technology change significantly before the building is completed? How should the building be designed to adapt as needs change over time?

5 Take advantage of the best proven technologies and design methods.

Digital information technology is revolutionizing the design and construction industry. Manually prepared drawings, the industry's currency for centuries, were largely replaced with computer-aided design and drafting tools more than 20 years ago. Today's best firms use building information modeling (BIM) software, which integrates design and technical information in three-dimensional virtual form.

Most architects, engineers and contractors understand and apply the value of digital modeling, but they often use BIM tools independently to support their own work.

The *Managing Uncertainty* research found the greatest benefit comes when a federated BIM model, with linked discipline-specific BIM models, is shared by all members of the project team. This serves as a real collaboration tool, without compromising the efficiency of using the best tool for the unique requirements of each design discipline. More than 50% of



all the research participants believe the use of BIM and other virtual design tools by the entire project team significantly reduces uncertainty and risk.

It is recommended that owners and project teams adopt shared BIM models for development and use through the entire design and delivery process. This practice requires planning and clear protocols for use of the BIM platform, but it is becoming a best practice for today's projects.

WHAT'S MOST IMPORTANT?

PROJECT INFORMATION TECHNOLOGY

- Adopt most appropriate design and delivery technology platforms
- Share BIM models to the greatest possible extent among designers, constructors and fabricators
- Develop BIM execution plans and protocols among all team members

Managing Uncertainty

Budget Planning for the Known Unknowns

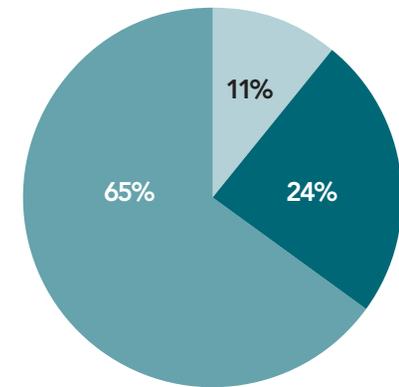
Considering risk assessment and a contingency designated for specific risks throughout the project lifecycle is a best practice for managing uncertainty.

Given all the factors that can impact the cost of a building project, budget accountability is one of the industry's major challenges. A project's cost-to-budget performance is a key measure of project success, and cost overruns usually reflect a team's failure to anticipate and plan for the predictable sources of project uncertainty discussed in this guide.

The potential range of cost for any building project is greatest at the beginning, before design begins, and becomes narrower as decisions are made and possible risks are overcome in the design and construction process. That is why a reserve—a contingency—is so important within any project budget. The design team's cost target should be the "net" budget available after the reserve is set aside. The contingency can be released as a project progresses and risk factors are passed, allowing the owner to save those funds or add improvements to the project.

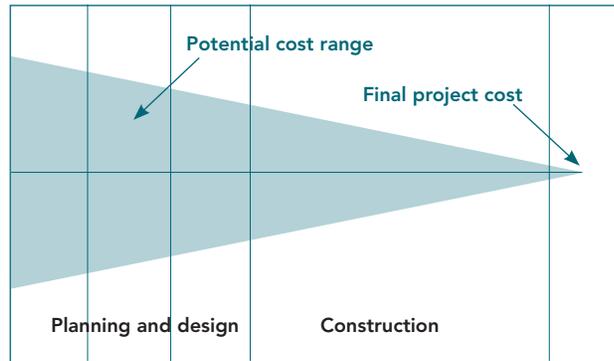
Surprisingly, our *Managing Uncertainty* research found that most owners have no consistent method for determining project budget reserves, or contingencies. Many decline to share budget contingencies with their design and construction teams, missing an opportunity to engage the whole team in better planning and performance.

The key is early budget planning by the entire project team: owner, architect, engineers and builder. A team should have this "adult conversation" before design begins, balancing scope, quality and cost expectations to create a budget for the project. Just as important, the team should consider the specific sources of uncertainty that could affect the project and establish a reserve for these factors—a contingency—to protect the owner's overall construction budget. A project that is out of balance at the beginning—where scope and cost



Do you have a standard risk assessment process to help determine the level of contingency necessary on a project-by-project basis?

■ Yes
 ■ No
 ■ Don't Know



expectations are mismatched—may never recover and will likely end in serious conflict.

This guide provides a one-page contingency calculator to improve this process within any project team. The worksheet facilitates a discussion of major uncertainty factors identified in our research—plus two other important variables—and their possible cost impacts on a specific project. In addition, the calculator asks the team how long each of the risks will be present during design, construction and occupancy, showing the total recommended contingency amount and how it can be reduced.

A working copy of the Contingency Calculator can be downloaded by [clicking here](#).

Uncertainty Factors in the Contingency Calculator

Here are the uncertainty factors considered in the calculator for any project, described in the general order that they are likely to be encountered during design and construction. The calculator is focused on “hard costs,” but it is important for any owner to budget and account for “soft costs” as well.

1 Program complexity. This represents a project team's ability to precisely define program requirements early in the design process. If a building project is intended to accommodate many user groups and highly technical functions and systems, it is likely that some requirements may not be understood until later in design and construction—affecting cost after the initial budget is established.

2 Owner/user changes. Dynamic owner organizations may experience significant changes in strategy, structure, leadership or technologies in ways that affect building projects already underway. This factor anticipates the possible impact of organizational change on a project's scope and cost, allowing the project to absorb changes without budget overruns.

TYPICAL PROJECT

HARD COSTS

- Demolition
- Sitework
- Building Construction
- Landscaping
- Furniture and Equipment

SOFT COSTS

- Owner's Staff and Expenses
- Design Services
- Consultants
- Permits
- Insurance
- Financing

3 Existing site/building conditions. Builders commonly encounter unforeseen problems with subsurface site conditions (rock, poor soil conditions or uncharted utility lines) or with existing buildings that are part of or adjacent to new construction projects. This factor allows for potential surprises in existing conditions that have to be resolved at additional cost.

4 Design imperfection. Most owners agree that it is impossible to achieve perfection in design documents, and design intent may be interpreted differently by different contractors or bidders. This factor provides for incidental scope items omitted from design and construction documents, and for non-negligent errors in design work. Accelerated design schedules and work in existing structures should increase this allowance.

5 Construction coordination issues. This factor anticipates project scope elements not included in trade subcontracts, coordination costs not anticipated in contractor or trade contractor pricing, and delays or rework for which the CM/general contractor and trade subcontractors are not liable.

6 Permitting/regulatory changes. It is not uncommon for building codes or code interpretations to change between the start of construction and building occupancy. Code and regulatory officials have the authority to withhold occupancy permits until new requirements are fulfilled—so it is wise to maintain a reserve for some additional work at this late stage.

7 Construction price variation. A base construction budget may include some allowance for cost inflation—usually to the midpoint of construction—but there may be greater variations in material or labor price conditions when trade contract bidding occurs. This factor creates an allowance for market uncertainty.

8 Project-specific risks. Some projects have unique risks that need to be considered when calculating the appropriate contingency. The last line in the contingency calculator worksheet allows the addition of another risk factor unique to a specific project.

TYPICAL PROJECT

BUILDING CONSTRUCTION COST COMPONENTS

- Foundations
 - Superstructure
 - Building Envelope
 - Interior Construction
 - Environmental Systems
 - Power and Lighting Systems
 - Transportation Systems
 - Built-in Equipment
-

Contingency Calculator

Instructions for using the contingency calculator:
sample shown on the next page

- 1 Basic Project Information.** Enter the project name, base construction budget and date on the top line.
- 2 Uncertainty Factors and Potential Change in Cost (%).** As a team, discuss how each uncertainty factor in the left hand column applies to your project. Under “potential change,” estimate the possible impact of each factor—up and down—on this project's total cost. Most changes will be cost increases, but creative solutions to these challenges could also result in possible savings.
- 3 Probability of Experiencing Potential Change.** Under “probability,” estimate the likelihood that you will actually experience the potential change in the amount indicated in the step above. For example, you may imagine that the project's inherent program complexity could increase its cost by 20% over the initial estimate but assign just a 25% probability to that prospect.
- 4 Total Contingency Contribution for Each Uncertainty Factor.** The green “Total Contingency Contribution” column will show the reserves required based on your input.
- 5 Percentage of Contingency Reserved by Phase for Each Uncertainty Factor.** In the columns under “% Contingency Reserved by Phase,” indicate how much of the reserve related to each uncertainty factor should be maintained through each successive phase of design, construction and occupancy. For example, unforeseen site and existing building conditions are unlikely to be encountered after construction reaches the halfway point, so this reserve can be reduced from 100% to 50% at that point. We recommend carrying reserves for some factors into the first year of building operation, to offset any changes required when the facility is in use.
- 6 Total Contingency Reserve Required by Phase.** At the bottom of these columns, you will see the total reserve to be maintained through each phase and the contingency amounts that can be released at each step. In the example, a reserve of \$1.2 million is maintained for the building occupancy stage.

As the project proceeds, the owner and building team can use the contingency calculator to monitor actual costs relative to the base budget and contingency reserve. Additional costs can be attributed to the uncertainty factors as needed, and the available reserve for each uncertainty factor can be released as design and construction phases are completed.

PROJECT CONTINGENCY CALCULATOR																
PROJECT:		RESEARCH BUILDING EXPANSION				BASE CONSTRUCTION BUDGET:				\$100,000,000				WORKSHEET DATE:	05/01/18	
Uncertainty Factor	Potential Change	Probability	Total Contingency Contribution	% Contingency Reserved by Phase												
				Schem Des	Des Devel	Const Doc	Bid/Negot	25% Const	50% Const	75% Const	100% Const	1-Yr Occup				
Program complexity	+	15%	25%	\$ 3,750,000	100%	75%	50%	25%	20%	10%	10%	10%	10%			
	--	10%	10%	\$ (1,000,000)												
Owner/user changes	+	20%	25%	\$ 5,000,000	100%	100%	75%	25%	20%	10%	10%	10%	10%			
	--	5%	10%	\$ (500,000)												
Existing site/building conditions	+	10%	25%	\$ 2,500,000	100%	100%	100%	100%	100%	50%	50%	10%	0%			
	--	0%	0%	\$ -												
Design imperfection	+	3%	75%	\$ 2,250,000	100%	100%	100%	100%	100%	100%	75%	50%	25%			
	--	0%	0%	\$ -												
Construction coordination issues	+	2%	50%	\$ 1,000,000	100%	100%	100%	100%	100%	75%	50%	10%	0%			
	--	0%	0%	\$ -												
Permitting/regulatory changes	+	5%	25%	\$ 1,250,000	100%	100%	100%	100%	100%	50%	50%	50%	0%			
	--	5%	10%	\$ (500,000)												
Construction price variation	+	15%	25%	\$ 3,750,000	100%	100%	100%	100%	75%	25%	25%	10%	0%			
	--	5%	10%	\$ (500,000)												
Other	+	0%	0%	\$ -	0%	0%	0%	0%	0%	0%	0%	0%	0%			
	--	0%	0%	\$ -												
TOTALS				\$ 17,000,000	\$ 17,000,000	\$ 16,312,500	\$ 14,500,000	\$ 11,562,500	\$ 10,387,500	\$ 6,162,500	\$ 5,350,000	\$ 2,900,000	\$ 1,287,500			
Totals as % of base construction cost				17.0%	17.0%	16.3%	14.5%	11.6%	10.4%	6.2%	5.4%	2.9%	1.3%			
Potential contingency released by phase						\$ 687,500	\$ 1,812,500	\$ 2,937,500	\$ 1,175,000	\$ 4,225,000	\$ 812,500	\$ 2,450,000	\$ 1,612,500			
User input				TOTAL CONSTRUCTION BUDGET WITH CONTINGENCY:				\$117,000,000								

1. Basic Project Information (Name, Budget)

2. Uncertainty Factors and Potential Change in Cost (%)

3. Probability of Experiencing Potential Change

4. Total Contingency Contribution for Each Uncertainty Factor

5. Percentage of Contingency Reserved by Phase for Each Uncertainty Factor

6. Total Contingency Reserve Required by Phase

In the sample contingency calculator above, all yellow cells are open for user input.

A working copy of the Contingency Calculator can be downloaded by clicking here.

Summary Checklist

Key project planning recommendations

This checklist summarizes the most important steps in managing uncertainty for future projects.

Owner's Project Leadership

- Identify a single project leader
- Keep senior executives engaged
- Be clear about responsibilities of the owner's team members

Assembling the Project Team

- Choose a collaborative project delivery method
- Engage construction partners early in the process
- Be clear about responsibilities of the design and construction team
- Select team members based on qualifications and experience

Strong Team Communications

- Designate a senior owner executive as project "sponsor"
- Create a council of principals from owner, design and construction firms
- Solicit regular feedback from owner stakeholders
- Invest time in aligning the project team

Defining Project Requirements

- Define the owner's goals, needs, priorities and success criteria
- Develop a detailed program of functional requirements and relationships
- Identify areas of uncertainty and potential change

Best Technologies and Design Methods

- Adopt the most appropriate design and delivery technology platforms
- Share BIM models among designers, constructors and fabricators
- Develop BIM execution plans and protocols

Budget and Contingency Planning

- Discuss scope, quality, cost and schedule expectations as a team
- Identify uncertainty factors related to project conditions
- Estimate potential cost impacts using the contingency calculator
- Evaluate uncertainty and reduce contingencies during construction

Other Resources for Owners and Project Teams

American Institute of Architects (AIA)

Founded in 1857, AIA consistently works to create more valuable, healthy, secure, and sustainable buildings, neighborhoods and communities. Through more than 200 international, state and local chapters, AIA advocates for public policies that promote economic vitality and public well-being. In addition, the institute engages civic and government leaders and the public to find solutions to pressing issues facing our communities, institutions, nation and world.

Resources for the architectural profession and larger design and construction industry include

- business intelligence tools and reports: aia.org/business-intelligence
- AIA Global Practice Primer: aia.org/resources/25876-aia-global-practice-primer
- AIA Best Practices: aia.org/bestpractices
- AIA Practice Management Knowledge Community: network.aia.org/practicemanagement/home
- AIA Center for Practice: aia.org/practice

Design-Build Institute of America

The Design-Build Institute of America, another sponsor of the *Managing Uncertainty* program, defines, teaches and promotes best practices in design-build project delivery. Its publications include *Choosing a Project Delivery Method* and *Competitive Acquisition of Design-Build Services*. The organization's website is dbia.org.

Construction Owners Association of America (COAA)

COAA promotes facility owner leadership and continuous improvement in the planning, design and construction process through education, collaboration and information exchange. COAA is the leading organization for owners seeking to continuously improve the quality of project delivery. Learn more at coaa.org/home.aspx#&panel1-2.

Associated General Contractors of America (AGC)

AGC represents more than 26,000 construction-industry firms, including general contractors and specialty-contracting firms, suppliers and service providers. The Collaboration Chronicles are an ongoing effort by the AGC Public/Private Industry Advisory Council, the AGC-AIA Joint Committee and COAA to capture and share results from successful project collaborations. This resource is available here: agc.org/connect/agc-groups/building-division/collaboration-chronicles.

Maximizing Success in Integrated Projects: An Owner's Guide—CII with Charles Pankow Foundation

This is an empirical study of more than 200 capital facility projects, emphasizing the importance of overall project delivery strategies. Its findings coincide with many of the recommendations in this

guide. Here is a link to this research report: projectdelivery.weebly.com/

Lean Construction Institute

The Lean Construction Institute offers several research reports on Lean Construction and Integrated Project Delivery techniques. Find them at leanconstruction.org/learning/research. LCI also offers publications to help with understanding and getting started with Lean. More information may be found at leanconstruction.org/learning/publications/. Finally, LCI's educational resources page includes information on online training programs now in development: leanconstruction.org/learning/. Many training sessions also occur through the LCI network of 30 local Communities of Practice around the country. See the LCI website for information on a group active in your area.

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