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Cost Control

Reevaluating the Challenges that Derail AEC Budgets

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Introduction

Cost overruns have long been a challenge in the AEC industry. In years past, only about a third of projects have come within 10% of the budget. However, a wide range of market disruptions in recent years—coupled with tech-based innovations that demonstrate a path forward—have more owners and developers rethinking the assumption that construction budgets are meant to be exceeded. Building owners and developers can't put together a reliable pro forma if they don't know what their costs will be when it's time to build. Understanding the common factors driving cost overruns can help owners ensure they have a team in place that is addressing these challenges. In this guide, we'll explore the common factors driving cost overruns, including:

- Volatile market conditions.
- Change orders due to misaligned priorities.
- Wasteful design practices.
- Misapplication of value engineering.
- Conflicts between trades in the field.

We'll also identify new strategies for addressing these challenges. With stronger insight into how to address the most common budget-busters, owners and developers can move their next project out to bid with confidence that it can and will achieve their priorities.

CHAPTER 1

Volatile Market Conditions

Bidding a construction project is a careful balancing act: Bid too high and risk losing the job to a competitor, bid too low and risk undercutting your costs. However, this task becomes even more challenging as contractors try to account for future market volatility. Without a crystal ball, architects, engineers and contractors must offer a best guess to cover the potential for labor and material cost volatility, which can quickly drive project cost overruns. The savviest professionals, however, are able to put solutions in place to help mitigate pricing variability.

Examples of volatility

A wide range of factors can impact material costs at any given time. Hurricanes, pandemics and other natural disasters regularly disrupt supply chains. Tariffs on imported goods add to the bottom line while rising fuel prices can impact decisions around the shipment of goods. Labor shortages also can drive up the cost of certain manufactured goods even before construction labor shortages drive up costs of work performed in the field.

Although it's but one of many examples of the volatility around material prices, the 2020 COVID-19 pandemic-driven shutdowns dramatically threw the high cost of supply chain disruption into the spotlight. While pent-up demand for new facilities after pandemic shutdowns has pressured the design and construction industry into moving forward with some projects, projects bid before the pandemic faced dramatically different costs one year later. At the tail end of the pandemic shutdowns, the Associated General Contractors of America (AGC) tracked record-high increases in the producer price index's measurement of the selling price for goods used in construction. The index jumped 3.5% from February 2021 to March 2021 and 12.9% from March 2020 to March 2021, both of these are the highest recorded jumps in the index' 35-year history.

AGC's 2021 Construction Inflation Alert states that the market conditions and the unprecedented intensity of escalating material costs suggest that a "mismatch" between material costs and contractors' prices is likely to prove challenging to building owners for quite some time. However, many of the institutional and other projects out to bid today must move forward, in part a response to the evolving demands of the "new normal." It's important that owners work closely with architects, engineers and contractors to identify strategies for mitigating the impact of material price volatility.

Three strategies for budget protection

Price volatility is not new, but the levels seen in 2021 are setting records for their dramatic rise. While many contractors are putting protective price escalation clauses into their contracts, more experienced architects, engineers and contractors should be able to also demonstrate creativity in working with owners to reduce overall project costs. Below are three potential strategies for managing price volatility.

1. Explore alternative materials

In some cases, AEC teams may be able to identify alternative materials or technologies to replace materials with more volatile prices. For example, when the price of hot-rolled coil steel spiked from $460 a ton at its low in 2020 to around $1,500 a ton in May 2021—a record high that nearly triple the 20-year average—architects began to look at composite panels. Previously considered premium architectural elements, these panels now carried a comparable price but additional benefits for clients.

Similarly, building owners that have considered prefabrication may find now is the time to dive in with a partner who delivers modular solutions. The potential cost benefits from streamlined, more efficient construction strategies can help achieve cost savings by reducing the labor needed in the field.

2. Apply advanced technology to reduce material usage

The cost benefits of prefabrication mentioned above come in part from the manufacturing precision that can be applied to this construction work when done in a factory setting. However, this precision can also be gained by applying advanced technology solutions to conventional design and engineering workflows.

For example, artificial intelligence-backed design tools can be used to identify opportunities to use less material. By optimizing the use of material, owners benefit from both reduced material and labor costs. In MEP systems, being able to iterate virtually countless options to identify the shortest, most efficient layout means minimizing the amount of costly pipe, wiring or ductwork required to meet a project's specific design requirements. With the cost of nonferrous wire and cable jumping 31% from May 2020 through May 2021, using even a little less wiring can drive dramatic cost savings.

3. Lock in contractors and subcontractors early

Locking in a design partner and securing subcontractor bids earlier in the project can help owners stay ahead of cost escalations in the market. By contracting with subcontractors earlier, these contractors can in turn gain more time to lock in the best possible material prices from their suppliers or identify cost effective alternatives. However, this requires quicker design completion with fewer changes that could lead to more dramatic cost overruns at the back end of the project.

The tech advantage

While market volatility is nothing new, AEC professionals today have a distinct edge over their counterparts in previous decades. New technology is allowing greater accuracy in design and construction work and providing better insight into supply chain partners.

When owners work with progressive AEC partners to help protect themselves from material and labor price inflation, they often gain the benefit of faster and more accurate in-the-moment bids. Technologically advanced design partners can also provide greater confidence in bid accuracy every time. With better design, including advanced clash detection, there's less risk of rework in the field. Improving the accuracy of this early work is a critical step in mitigating the unpredictable impact of market volatility.

CHAPTER 2

Change Orders Due to Misaligned Vision

There are countless factors that can drive change orders on a construction project, ranging from drawing errors or omissions to material shortages that require last-minute substitutions. However, one of the most common causes of change orders is also one of the most easily avoidable: Design changes made in the middle of the construction work.

In fact, it is not unusual for builders to begin construction work without final drawings, particularly on design-build projects where the ongoing design process can lead to work stoppages and, ultimately, schedule and cost overruns. However, this challenge isn't unique to design-build projects. Even on projects with complete drawings, contractors too-often run the risk of change orders as the vision comes to life somewhat different from the owner's original intent.

By taking time to better align with the owner's vision and priorities at the start of design, AEC professionals can significantly reduce the risk of change orders during construction.

Striking a balance in meeting priorities

Every construction project has to meet a wide range of criteria. Some areas, such as code requirements, can't be compromised. Some areas, such as sustainability standards, provide a clear roadmap to the end result. Other areas—such as the owner's and architect's aesthetic vision—can be more difficult to capture.

As a project begins to come to life, building owners may find it easier to voice aesthetic priorities vs. determining what they're willing to give up to stay within budget. Yet in most cases, any late-in-the-game changes come at a very high cost. Research indicates that the change order costs on major projects can amount to 10% to 15% of the contract value.

When designers don't latch onto the owner's priorities regarding aesthetics, budget, and performance upfront, and create a plan for how best to balance those priorities, change orders become inevitable. Part of the challenge is that aesthetic design can be very personal. Different architects may take extremely different approaches to the same type of space, and none of those options may match up to the owner's vision. Yet it's the aesthetic details that make a project come alive that are the most difficult to tie down.

Aesthetic priorities include the more obvious selection of appropriate finishes but it may also include more delicate details such as identifying locations for diffusers, devices and fixtures that integrate with the aesthetics of the space, or keeping feature walls free of blemishes such as fire alarms, outlets or thermostats. It's important to understand what details can be compromised and what risks later rework.

Let technology find the right balance

What many building owners may not expect is that today's new technology solutions actually support AEC professionals in better providing a personal touch needed to ensure owners' priorities are understood upfront.

For example, virtual and/or augmented reality visualization tools are increasingly being used to help owners visualize a project before it's built. These tools also help architects obtain a better sense of space before the project physically exists, supporting more accurate and informed decision making. While these technologies are still immature, they have the potential to support the search for aesthetic priorities. However, these tools are solely for visualization; identifying the right project balance is still up to the designer.

In a similar vein, high-resolution point cloud scanning helps engineers to more accurately record existing conditions on remodeling projects, which in turn contributes to the accuracy of the final drawings. These virtual reality capture surveys integrate laser point cloud scans with high-resolution, full-color panoramic photographs. Once compiled, viewers can virtually "walk the site" from one scan location to another, zooming in and out and exploring physical dimensions from any element in the point cloud model, including those areas that would otherwise be concealed from view.

Another potential strategy is to work with a designer that uses AI-driven design software. This new technology can rapidly run through countless potential system layouts, balancing all project criteria as input by the design engineer to ensure an appropriate final design. Because these tools can rapidly crunch data regarding routing and sizing systems, designers and engineers have more time available to work through vision boards and coordination to address the criteria that matters most to the client and then input specific data relative to those requirements in to the AI software. This balance of relationship-building and limitless data-crunching helps ensure the right decisions are made upfront, limiting change orders later on.

Rethinking creativity

Face-to-face relationships always have been, and always will be, a critical part of any construction project, but as in all aspects of life today technology can play a role in growing these relationships. With the right tools in place, AEC professionals can delegate more of the monotonous portions of design to software while spending more time connecting with owners on what they really want in a project. Technology can support greater creativity—without compromising on the schedule or budget.

CHAPTER 3

Wasteful Design Practices

Waste is a significant driver of construction costs. As much as 30% of all building materials delivered to a typical construction site end up as waste. This is a tremendous unnecessary cost that is beginning to be addressed through more efficient design and construction strategies. However, this cost doesn't even begin to account for the waste encompassed within overdesigned systems that wind up being installed on a project.

Wasteful design happens for a number of reasons, but the result is much the same as wasteful construction. More material and labor is purchased than necessary, running up costs. An additional challenge here is that this excess material is installed into overdesigned systems that run up costs during operation. As a result, addressing wasteful design upfront through better, more efficient design strategies can play a major role in saving on both construction and operational costs.

Understanding excess behind wasteful design

There are a number of factors that can lead to overdesign. Chief among them is a potential for architects and engineers to overcompensate for potential risk by overdesigning systems. For example, systems oversized in the name of risk avoidance may be overdesigned to avoid potential liability exposure or to protect the facility in the event of component failure. In other cases, overdesign is the result of speeding up the design process in a failed effort to reduce the cost. In either case, the result is the same: An overdesigned system costs more to install and to operate. Erring on the side of a larger MEP system, for example, ensures that the system will be able to handle the heating and cooling even if there are design errors, however doesn't ensure that it can do so efficiently.

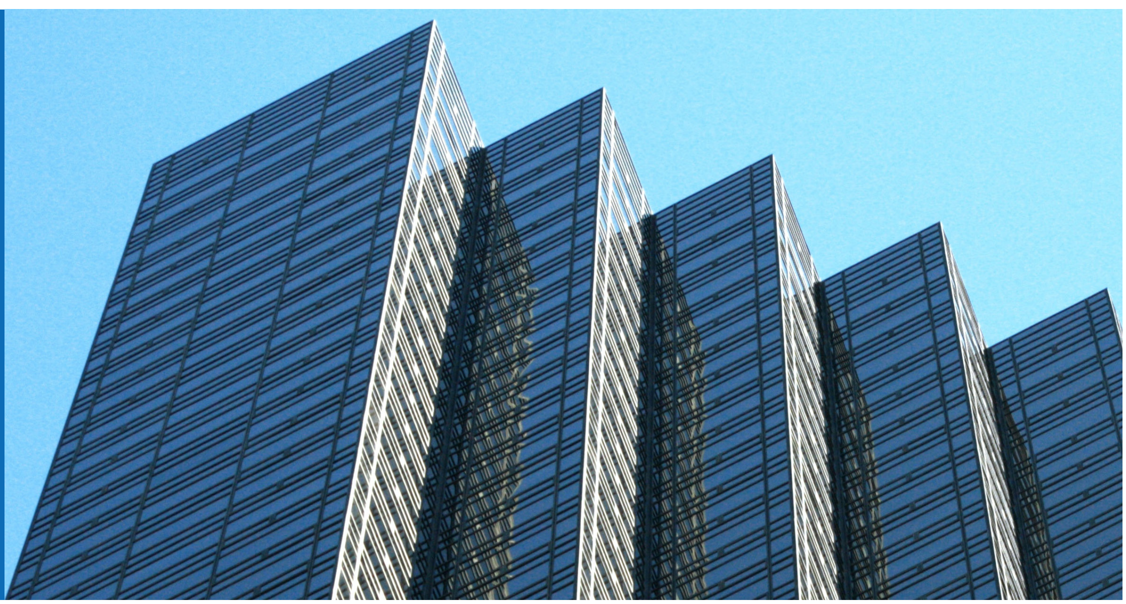
More often, however, overdesign is not a conscious decision but the result of not having the tools necessary to confirm the accuracy of the design. For more complex projects, architects and engineers can't always ensure the designed system is exactly what is needed to meet code and system performance requirements without including unnecessary capacity or excess materials.

For example, not applying the appropriate diversity factors to system loads can result in overdesigned portions of the mechanical or electrical systems. Overly simplified sizing calculation methods can also lead to oversized piping, equipment and wiring. Suboptimal routing decisions compound this waste by not finding the most efficient way to connect the systems.

Regardless of how it occurs, overdesign is costly. In the case of one multi-building mixed-use project, unnecessarily expensive mechanical systems and significantly oversized pipe and wiring contributed to an unnecessary cost overrun of more than $2.5 million. With a technology-supported, value-oriented design approach, the engineering team was able to improve design accuracy and scale the system back to achieve upfront MEP cost savings, as well as significant future operational cost savings.

Strive for more accurate design

Whether the cause is attempts to speed up the process or a lack of insight into the process, advanced design tools can help prevent costly overdesign. AI-driven software solutions, for example, can support more accurate calculations for critical systems and rapidly identify the optimal layout for a building's MEP systems. Shorter, more direct runs, determined with precise calculation methods, require less material, less labor and less time wasted on installation and coordination. They also result in more efficient operation of the systems over the lifetime of the facility. With the right design tools, designers and engineers can better address these cost risks upfront.



CHAPTER 4

Reactive Value Engineering

Value engineering has long been viewed as the go-to strategy for cutting costs after a design has gone to bid and found to exceed the budget objectives, even if it's not a strategy anyone in the AEC process enjoys. After all, value engineering is traditionally about making compromises to fix a problem after a project is already in budget trouble. This is reactive value engineering.

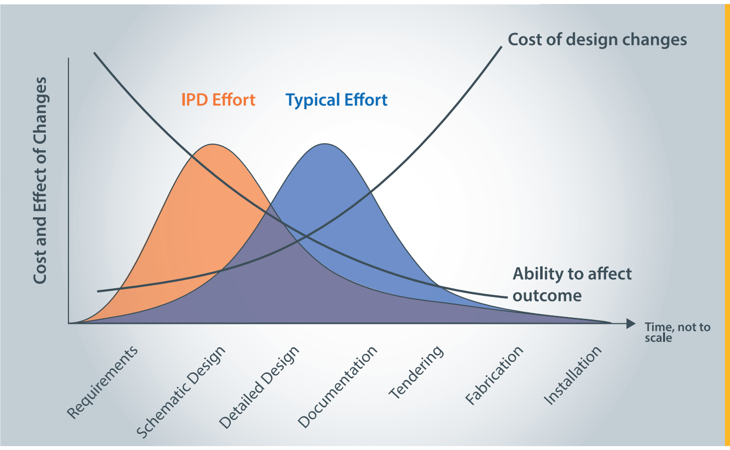
In the face of post-pandemic runaway material costs, many developers are facing inflated costs that are pushing them to decide to sacrifice the quality of the building to get the project built or not build at all, as one developer put it. In this regard, reactive value engineering requires designers to make changes late in the process to better align the budget with the project needs and vision. As discussed in Chapter 2, late-stage design changes only add to schedule delays and cost overruns.

The best solution may very well be to flip the conventional reactive approach to value engineering. By prioritizing a balance of budget and goals at the very beginning of a project instead of at the end, designers and engineers can reduce the risk of wasting materials, time and money and still get the project the owner envisioned. Proactive value engineering entails efficient, budget conscious design, before the project is in budget trouble.

Why value engineering needs to move up

To truly maximize the value of a project's design and engineering process, it's important to minimize as much as possible the number of design changes made late in the process. The early design should closely match design goals and budget, streamlining the entire construction process and reducing costs.

This reasoning for this is best described by the "MacLeamy Curve." HOK CEO Patrick MacLeamy developed this visualization in 2004 to demonstrate the value of front-loading effort during the design process to catch errors early. By prioritizing efficient design upfront and engineering out potential waste, a project shouldn't ever reach the point of having to make cuts during construction.



Strategies to support earlier value engineering

If it was easy to move value engineering upfront, every project would already be doing this. However, controlling cost from the beginning of the project requires more advanced tools and a strong commitment to budget control. Fortunately, more AEC professionals are recognizing the value they can provide by taking time upfront to identify opportunities to save on materials and labor by maintaining a budget conscious approach to all designs.

Applying Lean Engineering design principles at the start of the project is one strategy that can have a tremendous impact on cost management. Lean construction is driven by the goal of eliminating waste at every stage of the project. Lean practitioners are constantly on the lookout for waste, a process that requires a mindset shift in how projects are approached. Rather than pricing a design, the team designs to the allotted budget. Lean teams begin with the end of a project in mind, and work backwards to address potential hurdles early on. Collaboration among partners is strongly emphasized here. The Lean Construction Institute is an invaluable resource that provides support for helping AEC partners on their Lean journey.

Today's cutting-edge design technology, including advanced building information modeling software and AI-driven design tools, can also help design and engineering partners cut out waste early on through more efficient design. These tools can optimize system layouts and better balance a wide range of project objectives before a project ever moves into bidding and construction. With greater visualization of all systems—and options—designers and engineers can move forward with greater confidence that the specified system is the right one.

A new approach to value

Reactive value engineering has never truly been about getting the best value for the project owner. Instead, reactive value engineering often results in reduced quality and inappropriate costing decisions, simply in the name of meeting the budget.

While proactive value engineering may still demand some compromises, these compromises are best made upfront so that all partners go into the project on the same page to achieve the maximum value for the project. With the right approach to value engineering in the earliest stages of design, owners can rest assured that they'll get the project they want at the price they can afford with the minimum number of compromises.

CHAPTER 5

Conflicts in the Field

As mentioned in Chapter 1, there are a number of factors that can drive change orders on a construction project, including drawing errors and omissions. These errors and omissions often aren't identified until work begins in the field, when tradespeople begin to install the various systems around one another. When conflicts between systems or missing systems aren't caught until they are discovered in the field, the fix becomes far more expensive.

By identifying these clashes upfront, architects and engineers can better keep projects on budget and on schedule, and ensure that the as-built project matches the owner's vision.

Common clash contributors

When design drawings are not well coordinated, it can force changes in the field ranging from unnecessary penetrations through beams to lower than desired ceilings, among other project compromises. There are two specific types of clashes that occur.

A hard clash is a type of conflict that involves geometrical issues. For example, when two objects pass through each other or are designed to occupy the same space. This could be a duct colliding with a pipe or a duct running through a load-bearing wall or beam.

A soft clash on the other hand is defined by system clearances and occurs when an object encroaches into geometric tolerances set for other objects. For example, MEP components such as HVAC equipment commonly require some amount of working space to ensure safe and easy maintenance access. However, inappropriate or conflicting positioning of other systems can result in a lack of sufficient working space for the equipment.

The most common clash seen on many projects occurs with regard to ceiling space. Owners often prioritize higher ceilings, however limiting assumptions about the amount of above-ceiling space needed for ductwork, wiring and pipe tend to push down ceilings to allow more room for concealed systems. Having solid design data upfront regarding the amount of space needed for MEP systems can support earlier decisions about the ceiling heights, structural components and otherwise optimize MEP layouts to reduce the risk of both soft and hard clashes occurring in the field, when they are more costly to resolve.

How to eliminate conflicts earlier

Collaboration among trade partners can help design professionals and contractors catch potential conflicts earlier. This is increasingly being done through design-build and integrated project delivery models. However, this approach still has limitations. For example, if a design change is recommended by one trade and is not quickly communicated to other disciplines, installation contractors are left scrambling to resolve work around the conflict in the field, driving up costs.

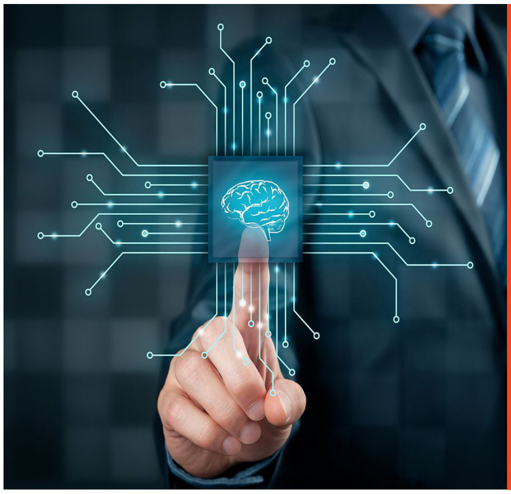
Technology solutions are more frequently being used to streamline workflows and improve clash detection during the design stage. Some architects are working to streamline the design of buildings by shifting to a 3D design environment, using building information modeling (BIM) and clash detection tools to identify problems before materials ever arrive on site. However, inter-disciplinary clash detection is still remains very rare in the industry.

While BIM can support better clash detection, it has the biggest impact when all partners are working in the same 3D modeling environment. A breakdown in this approach commonly occurs when designers, engineers and contractors find themselves communicating across different platforms.

Design and engineering partners can effectively get around this communication breakdown by using AI-driven software to automate and integrate the process of design and clash detection within a single design program.

Using typical methods, an MEP engineer, for example, might design a system in one program, transfer that 2D design into a 3D program, (maybe) send the 3D model into a clash detection program, then send that clash detected MEP model to the shared workspace for another round of clash detection across all other disciplines. This is an inefficient, labor-intensive process. It is made even more inefficient by the fact that it rarely occurs until the designs are in the subcontractors' hands for the real clash resolution work. By then, the pricing has been set and the clash resolution becomes a costly and time consuming change order.

AI-enhanced MEP design software can integrate clash detection within the shared workspace, saving time and money throughout both the design and construction processes. A properly coordinated MEP design available prior to bid not only saves time during construction, but also avoids costly subcontractor change orders, or worse significant design compromises and delays.



Conclusion

Difficult conversations and decisions surrounding costs and budgets late in the game have long been an expectation for most construction projects. At last, this is beginning to change. Innovative technology solutions and disruptive AEC leaders are reducing wasteful design, trade conflicts, and price uncertainty. Project developers are gaining more control and greater insight, earlier than ever, into construction cost containment.

While these technology solutions are becoming more widely available, early adopters still stand to gain the greatest benefit as they can quickly differentiate themselves from lagging adopters. By working with design and engineering partners that place the same emphasis on developing a project that meets all critical criteria, including budget, and have the design technology to back up these values, owners can be confident that their projects will be completed at the best possible price, regardless of price fluctuations in the marketplace.

Schnackel Engineers is an experienced team of MEP, fire protection and IT engineering experts committed to innovation and exceptional service. Backed by the power of our high-efficiency, AI-powered technology, we lead our clients to the best design solution with incredible accuracy and speed, reducing project risk and driving more successful outcomes.

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