INFORMATION MATTERS

Revolutionizing the Construction Industry through the Adoption of Technology

Mark Brian Bodner

Founder & CEO, Foresee Consulting

&

Gregory Lance Coburn, Esq.

Partner, Procopio, LLP

FORESEE CONSULTING
Creating Collaboration to Contain Costs

Table of Contents

Executive Summary

Project delays and cost over-runs are a fact of life for many construction projects around the world. In recognition of these challenges, the Project Management Institute (PMI) created a construction extension of the Project Management Body of Knowledge guide in 2003, in order to forestall the shortcomings that plague project management in the construction industry.[1] Unfortunately, such guidance has failed to reduce construction inefficiencies. Study after study shows that not only are delays and budget overruns rife, but productivity in the industry is lacking greatly. As a result, there is a growing cry for the construction industry to do better.

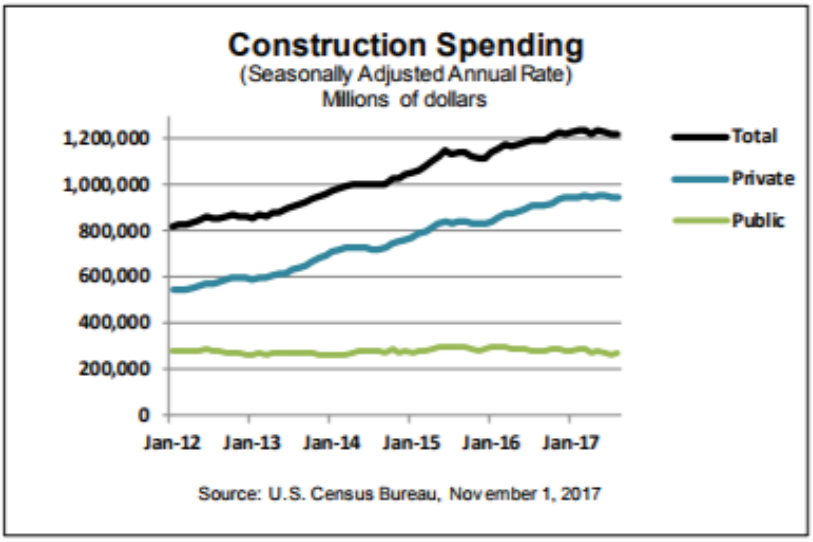
Asymmetry of information – a situation in which one party is better informed than the other party and exercises control over the flow of information – is one of the most critical (but often over-looked) factors responsible for this state of affairs. Inconsistency of access to information and control over such information is hindering efficiency in the sector and causing delays and cost over-runs.

Because Owners often do not get the information they need from Contractors (or do not have the necessary expertise to interpret the information), they essentially lose control over their projects while the Contractors exercise a monopoly over information and the project itself. This paper examines four key elements required to avoid this problem. In particular, it focuses on the role that the adoption of technology can play in revolutionizing the industry by reducing the phenomenon of asymmetric information.

[1] Pmi.org. (2017). Construction Extension to the PMBOK Guide | PMI. Available at: https://www.pmi.org/pmbok-guide-standards/foundational/pmbok/construction-extension

Introduction

The construction industry represents an interesting dichotomy of growth and inefficiency, of progress and stagnation. On one hand, buoyed by rapid expansion in major cities and unprecedented economic growth in emerging economies, the global construction industry has enjoyed a boom in the last decade. Not only is there an increase in the number of construction projects worldwide, those projects are increasingly larger, more complex, and having significant impacts on national economies. In September 2017, for example, the United States' construction spending for that month alone was $1,219.5 billion[2]. Annualized construction spending for 2017 is forecast to top $1.5 trillion. With that level of spending, it should not come as a surprise that the industry is perceived to be robust and healthy.

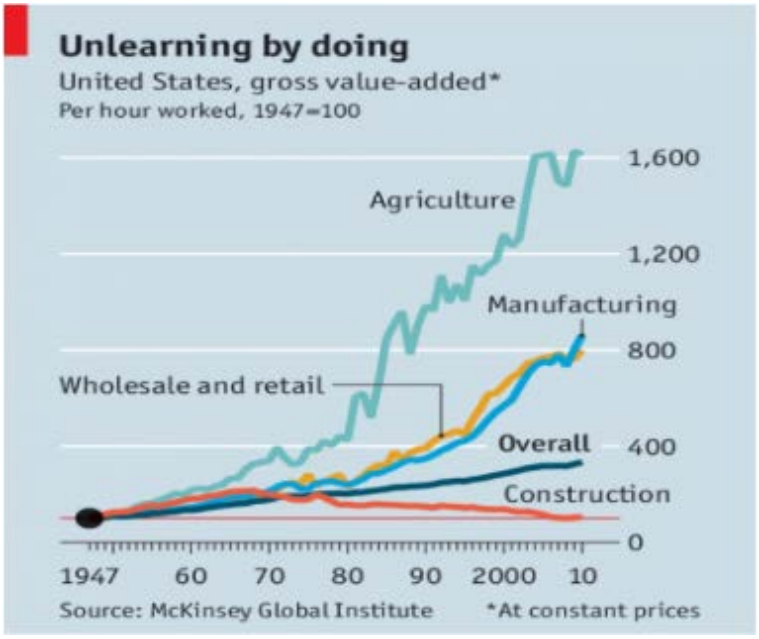


And yet, on the other hand, the industry has a dismal record when it comes to efficiency in the management and execution of projects. That contradiction can be something of a shock to those outside the industry. Surely, an industry whose very essence is in the execution of projects would be the poster child for efficiency and best practices in project management? Sadly, the data suggests that the opposite is often the case. Construction projects are fraught with delays, inefficiencies, and cost over-runs.

[2] United Sates Census Bureau Monthly Construction Spending, September 2017, Available at: https://www.census.gov/construction/c30/pdf/release.pdf

According to The Economist, 90% of all construction projects are either late or over-budget; frequently both.[3] McKinsey, the global consultancy firm, reports that construction has the lowest productivity gains of any industry in the U.S. – an abysmal 1% per annum![4] Value added per hour has been shrinking since the 1960s. Only 31% of projects are completed within 10% of the projected budget, and only 25% are completed within 10% of the set deadline.[5]

Is this malaise perhaps attributable to the complexity and size of today's projects? Not according to the data. This has been the trend for several decades now. In the U.S., the trend for productivity in the construction industry has dropped and/or remained flat for decades, and it is now half of what it was in 1960.



Naturally, this state of affairs has significant implications for the U.S. economy. The issue is expanded upon by author and lawyer, Barry LePatner, in his excellent book, *Broken Buildings, Busted Budgets*. LePatner observes that inefficiency and waste cost the U.S. over $120 billion annually, including $1.2 billion in lost productivity for Architect/Engineering firms working on capital facilities.

[3] Economist.com. (2017). *Efficiency eludes the construction industry*. Available at: https://www.economist.com/news/business/21726714-american-builders-productivity-has-plunged-half-late-1960s-efficiency-eludes

[4] McKinsey, The construction productivity imperative https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/the-construction-productivity-imperative. 2015.

[5] KPMG (2015). Global Construction Survey. Climbing the curve. KPMG International, p.6. Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/04/global-construction-survey-2015.pdf.

What that means for the U.S. economy is lost opportunity and income that could potentially be put to good use:

> *By January 2007, construction was a $1.23 trillion a year industry in the United States. A one-time improvement in construction productivity of 10 percent would boost America's GDP by $123 billion. That sum, compounded annually at 3 percent for thirty years, would mean a real per capita income over $273 billion higher in 2037 than if the construction industry remains unreformed. Put another way, reform of the construction industry could generate enough economic growth to save Social Security as it is currently constituted.*[6]

In addition to direct costs and lost productivity, project inefficiency also comes with legal costs, as projects often become the subject of litigation. The dollar value of construction claims can be as much as 5% - 10% of project cost, which translates to up to $150 billion per annum; extended litigation costs could add as much as the equivalent value of the claim.

Interestingly enough, these challenges are not a uniquely U.S. problem. Around the world, the story is often the same. Even countries such as Germany and Japan, which are looked upon as bastions of efficiency, battle the same challenges. The Berlin Brandenburg Airport is a good example. Originally projected to cost $2.44 billion dollars with a completion date in 2012, that project has morphed into a national embarrassment for Germany, with costs currently sitting at $6.9 billion dollars, and completion expected in 2020.[7]

Predictably, such cost overruns and project delays are often portrayed in the media as scandals of incompetence and/or corruption by entities – individual and corporate – involved in the projects. However, research suggests there is often more to it than that.

[6] LePatner, Barry B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
[7] Brook, B. (2017). *Berlin's massive new $8bn airport was supposed to open in 2012. Some say it may never*. Available at: http://www.news.com.au/travel/world-travel/europe/the-ongoing-multibillion-dollar-disaster-of-berlins-new-international-airport/news-story/ff684d8f7bee04c3776c381258d92f3a

The Primary Factor Driving Inefficiency

There are multiple factors responsible for inefficiency in the industry – poor management, ineffective supervision and insufficient investments in technology, to name a few.[8] However, one of the biggest drivers of inefficiency is the very nature of the construction business and the standard methods and procedures used industry-wide. From the immediate outset, there is often an asymmetry of information, which is driven by the power dynamics inherent in a project, which in turn changes with the stages of the project. It is a power dynamic that revolves around the control of information between Owners and Contractors.

At the outset, project owners find themselves in a rather complicated position in which they have to balance power, responsibility and control in three different contexts:

- As the Owner, they are in a position of power because of the competitive nature of the bidding phase, and because they have control over the project budget. Additionally, Owners have control over the actual information collected from both the bidding and budget phases of a project.
- At the same time, Owners are accountable to their organization's Board and have ultimate responsibility for the project's success or failure, with the potential personal financial and professional reputational costs.
- Once the execution phase of a project begins, however, the power dynamic changes significantly. Owners have very little control during project execution, because they must yield control over the project to the Contractors who have the requisite expertise.

With the first two aspects, control of information primarily lies with the Owner. With the third aspect, however, the balance of power shifts to the Contractor. Once awarded the project, the Contractor quickly establishes a monopoly over the project and associated information. The Contractor attempts to recoup any profits it may have sacrificed during the bidding process, when it may have submitted a lower bid in order to win the contract. To accomplish this, the Contractor resorts to Change Orders. Once the project is under way, Owners have very little recourse but to yield to the Contractor's demands for more funds and time extensions, otherwise they risk incurring even greater delays and costs. At this stage, the management of

[8] LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.

the construction project is a mystery to most Owners because information is held (and hoarded) by the Contractor.

The situation in which one party (usually the Contractor) is better informed than the other party is described as "asymmetric information". When asymmetric information occurs, it can have significant economic repercussions for the other party, as well as inefficient execution of the project.

How Asymmetric Information Affects Projects

- Asymmetric information puts pressure on Owners to make hasty payments without necessary due diligence. In a bid to ensure timely completion, Owners are usually quick to make payments, sometimes without a thorough understanding of what work the payment is for. Owners are often unable to track expenses, making contractor accountability difficult.
- Oftentimes, payments are made for changed work that is in progress without the Owner having proper insight or knowledge about the specific "extra" work being performed out-of-contract. The Owner may even be unknowingly paying for "changes" that are attributable to some misstep on the part of the Contractor that the Owner shouldn't be paying for at all!
- Dealing with non-conforming work and quality assurance becomes difficult. Without access to accurate information, the Owner pays for work performed before realizing it is not up to specifications. Conversely, the Owner may be forced to withhold payment when it becomes aware there is a gap between the specifications and the final product, a step that could lead to work stoppages and even litigation.
- Acceleration cost becomes a source of major dispute between Owners and Contractors[9] when there is asymmetry of information. When delay happens (due to a number of reasons), the Contractor asks for an extension of time (EoT). Ideally, the Owner's first point of action should be to establish if the delay was self-inflicted or caused by unforeseen circumstances beyond the Contractor's control. Without adequate information, it is impossible for the Owner to determine where faults lie within their attendant contractual implications.

[9] Maritz, T. (2017). The calculation of acceleration costs on construction projects: review article. Available at: https://www.academia.edu/800911/The_calculation_of_acceleration_costs_on_construction_projects_review_article?auto=download

The fact is that too many Owners fail or refuse to devote adequate resources to key aspects of the project during the contract development phase. Often, they lack adequate project management skills. Research shows that many Owners do not have confidence in their ability to hit project schedule, budget and quality targets. According to a study by the International Project Management Association (IPMA), nearly three quarters (72%) of CEOs/COOs and Project Managers surveyed identify the ability to manage projects efficiently as critical or absolutely critical to the future growth of their businesses. And yet, only 11% of those CEOs/COOs and Project Managers were very confident in their ability to manage business critical projects in the most efficient way.[10]

This gap in the Owner's project management skills, ability or knowledge raises the need for a third party – an effective intermediary – with the right sets of skills and expertise to fill the gap. That role was traditionally filled by architects who acted on behalf of Owners, but this has since changed. Instead, construction managers (who are often viewed by many industry insiders as simply contractors with suits and ties)[11] fill that position without much advantage to the Owner. Without a knowledgeable intermediary contracted to serve the Owner's interests, the Owners find themselves in a predicament in which the Contractor is both the final determinant of cost and also in charge of construction.

Ultimately, asymmetry of information, together with the absence of effective intermediaries to offset the knowledge gap of the Owner, leads to serious project complications such as predatory contractor behavior, mutable contract cost, and probable litigation. Effectively, the Owner "drops the ball," and is at the mercy of the Contractor, who has greater monopolistic power in negotiations.[12] The ideal situation, therefore, would be for all parties to have proper, adequate, timely, and equal access to information so they can make informed decisions.

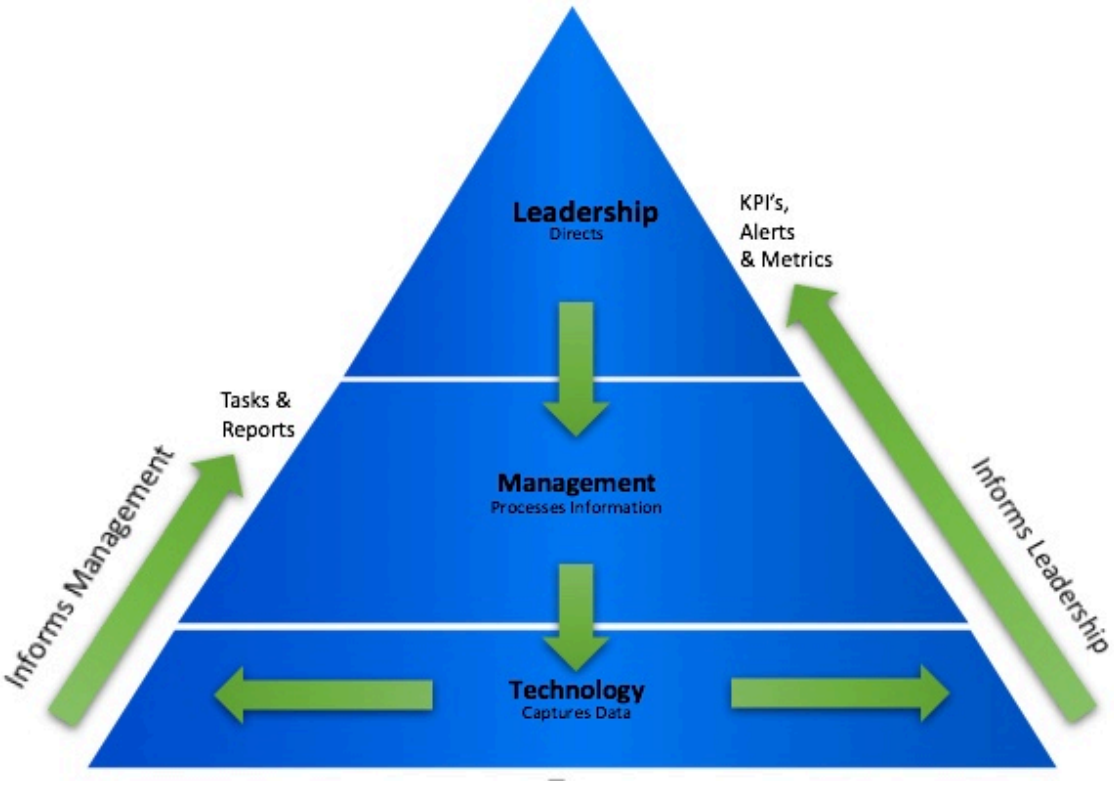
[10] International Project Management Association Study, September 2010
[11] LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
[12] Hillebrandt, P., Hughes, W., Greenwood, D. and Kwawu, W. (2006). Procurement in the Construction Industry. 1st ed. Hoboken: Taylor & Francis Ltd., p.11.

Achieving Low Levels of Asymmetric Information

In order to avoid the problems discussed above and achieve true cost containment, projects need to strive for low levels of asymmetric information between Owners and Contractors. The key to achieving low asymmetric information is aligning the project team around three key elements that serve to inform all constituents and executing those elements with a four-pronged approach. These elements include:

Three Key Elements

- **Leadership** that directs the delivery approach, organizational strategy and contractual methodology. This paper will further expound upon the imperative for Leadership to be fully engaged in the project delivery adoption strategies, as well as;
- **Management** that implements the strategy by managing information and processing tasks in alignment with the strategic direction of leadership; and
- **Technology** that captures the project record, facilitates communication, affords visibility of compliance and ensures the veracity of project information and reporting.

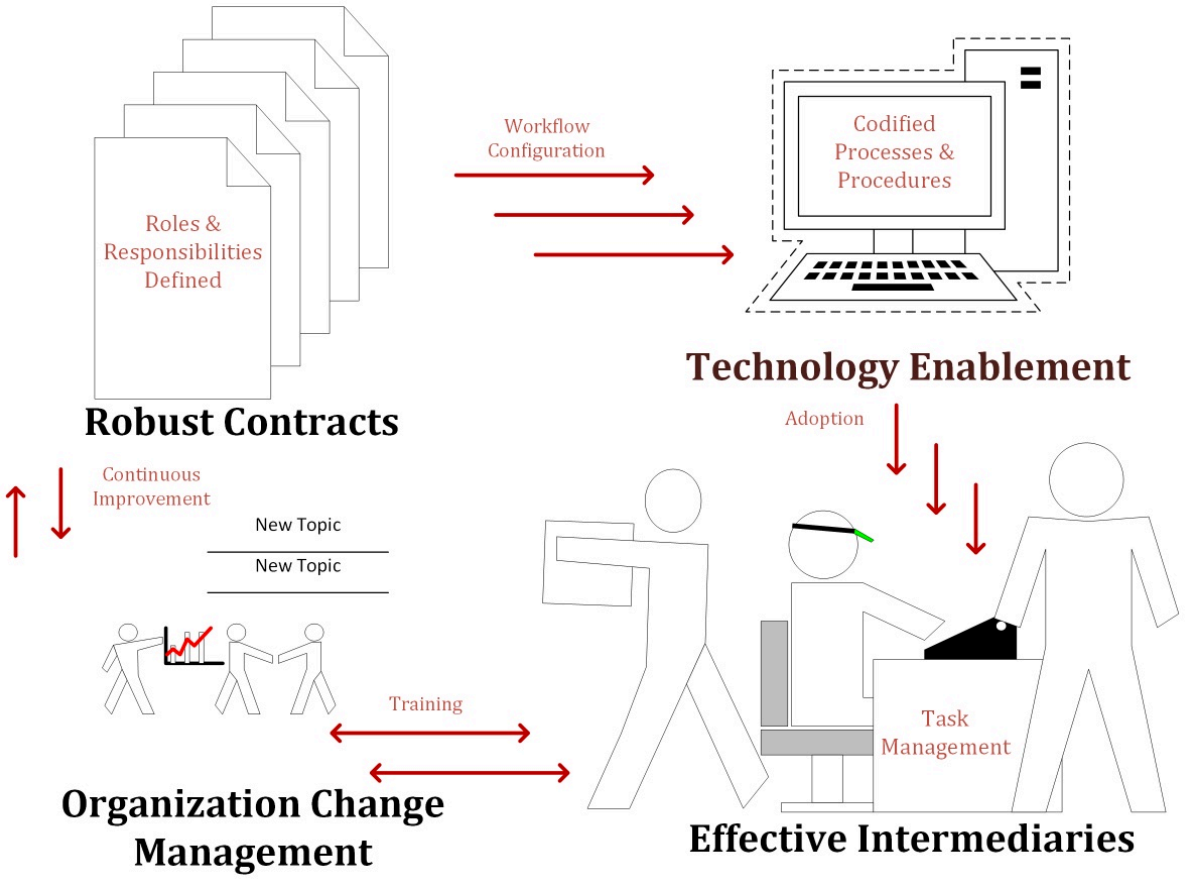


Four-Pronged Approach

The four-pronged approach to execution of the above three elements demands the following tactical components:

- **Robust contracts -** rule-based contractual requirements crafted into clear and strong contract language that mandates compliance to adopted processes, agreed terms and conditions;
- **Technology enablement** - leveraging technology (including cloud-based collaborative technologies with database functionality) to codify adopted processes, systems and responsibilities outlined in the contract;
- **Effective intermediaries** who know their roles and responsibilities and have enough expertise to understand information and prioritize action;[13] and
- **Organization Change Management** to ensure deployment of the acquired tools to monitor compliance at every stage of the project.

[13] LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.



1. ROBUST CONTRACTS

Even without the problem of information asymmetry, the complex nature of today's construction projects, makes it imperative to have sophisticated agreements with strong provisions that address all the key elements. With the additional challenges associated with inadequate information, however, contractual requirements must be robust enough to prevent the project Owner from incurring untold delays and cost overruns.

A robust contract addresses every key element of the project. Generally, the *Agreement* identifies the legal arrangement between the parties by addressing the entities, the term, the compensation, etc. The *General Conditions* identify the specific legal arrangement between the parties. The *Drawings & Specifications* identify what is to be constructed by the contracted entity and the technical requirements of the project that are to be delivered.

The most crucial component for a successful project is the often overlooked *General Requirements* (more commonly referred to as Division 1 of the Specifications). It is in the *General Requirements* that the day-to-day processes, procedures, and individual responsibilities

by job function are delineated. It contains provisions pertaining to keeping costs in check, maintaining the project schedule, and upholding quality standards. The *General Requirements* typically covers the following: project life-cycle, execution and close-out requirements, quality, price and payments, administrative requirements, product requirements and much more.[14] In short, it informs the day-to-day processes, procedures, and individual responsibilities by job function of all stakeholders in the project. For the contract to be effective, it must clearly state the specific penalties for failing to comply with outlined requirements.

However, it takes expertise to iron out the details of the document such that the Owner is well-protected. Most Owners do no have such expertise and need help. Owners need to involve credible and reputable law firms that specialize in construction, as well as construction management firms with a proven track record of aligning with the Owner's objectives to oversee the project. With the Owner actively participating (or helped by intermediaries), it assures that the Contractor is not 'blind-siding' the Owner with information or a lack there-of.

Benefits of Robust Contractual Requirements

1. Having agreed upon requirements ensures expectations on performance and delivery are detailed enough to enforce the kind of quality the Owner requires.
2. A robust contract ensures cost is kept to a minimum because estimates are made according to specifications agreed upon by both parties before the project commences.
3. It minimizes dispute and risks of legal action for the Owner.
4. It saves everyone time and money and helps the Contractor avoid disruptions, safeguarding the project's schedule.

There are numerous law firms that specialize in construction, and working in conjunction with a reputable construction management firm is one way to achieve these objectives. As contracts are neither self-enforcing nor self-monitoring, it is important to have mechanisms for achieving these goals.

2. TECHNOLOGY ENABLEMENT

In today's technology-driven world, there is no reason why technology cannot be leveraged to sustain minimal levels of asymmetric information. Construction projects can be so complex that they become cumbersome to track and monitor. They generate a massive amount of

[14] England, M. (2016). Construction Estimating - Accounting Software | The Jobsite. Jobsite.procore.com. Available at: https://jobsite.procore.com/6-general-requirements-that-can-bust-your-estimate

information and involve a large number of moving parts. Owners need to track this information in real-time in order to make decisions and monitor all the moving parts to ensure they are meeting the project's objectives.

In order to get the most out of the robust contractual requirements previously discussed, the contracts need to be effectively monitored. The provisions of the *General Requirements* can be codified in a SaaS workflow application that ensures real-time visibility into the Owner's processes and procedures. Management is then afforded the ability to hold all parties accountable to their respective responsibilities.

Leveraging technology in the management of construction projects, according to Gareth Harley, Director of Engineering and Construction at Oracle, is all about "moving something from a manual process to seeing that information in real-time,"[15] where potential problems are nipped in the bud before they materialize into full-blown money-sapping and time-consuming mistakes. "Technology" in this context is multi-faceted and could include a wide range of options including Software as a Service (SaaS), Platform as a Service (PaaS), block-chain technology, analytics, and drones.

However, the construction industry's slowness in adopting technology is well documented. Only 8% of construction firms can be classified as "cutting-edge visionary" when it comes to technology adoption, while a whopping 69% are lagging behind.[16] Compliance is still usually tracked using spreadsheets such as Excel. There are many limitations to using Excel for construction projects, including the fact that:

1. Being accessible by multiple people makes the data susceptible to human error;
2. Changes cannot be tracked in real time, and even if the spreadsheet is designed to track changes, the data cannot be trusted;
3. The spreadsheets are not suitable for collaborative work involving multiple departments – in this case, accounts, contractors, owners, quality assurance, etc. - as only one person can access the file at a time[17]; and
4. They are cumbersome for large scale projects as time is wasted reconciling data from different departments.

[15] Peiffer, E. (2017). 10 construction industry trends to watch in 2017. Construction Dive. Available at: https://www.constructiondive.com/news/construction-industry-trends-2017/433151/
[16] KPMG (2016). Global Construction Survey. Building a technology advantage. KPMG International, p.4. Available at: https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2016/09/global-construction-survey-2016.pdf
[17] Denizon. (2012). Top 10 Disadvantages of Spreadsheets. Available at: https://www.denizon.com/spreadsheets/top-10-disadvantages-of-spreadsheets/

What construction projects need is software that the *General Requirements* and all other project responsibilities can be codified (collected, arranged and ordered) into such that the process and procedural data are available in real-time. The traditional mode of deploying software is quite expensive and requires a steep learning curve for the users.[18] This has prompted a new wave of Project Management and Information Systems (PMIS) such as Software as a Service (SaaS) cloud-based technologies that allow Owners to adopt technology at relatively lower costs. A PMIS is designed to improve project planning, scheduling, monitoring and controlling, in order to raise the quality of decision making in each phase of the project life-cycle. It enables engineers and project managers to communicate project status swiftly and accurately with functional departments, while also keeping senior management up to speed on all the projects in the organization's portfolio.[19]

The result of configuring the contractual responsibilities of all parties in a system that reinforces those responsibilities via electronic workflows is that it serves to align all staff for a more effective and effcient delivery of the project.

[18] Sylos, M. (2013). Top five advantages of software as a service (SaaS) - Cloud computing news. Cloud computing news. Available at: https://www.ibm.com/blogs/cloud-computing/2013/09/top-five-advantages-of-software-as-a-service-saas/
[19] KPMG (2015). Global Construction Survey. Climbing the curve. KPMG International, p.6. Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/04/global-construction-survey-2015.pdf

It is worth noting that, in order to be effective, whatever technology is adopted must be enforced through its inclusion in the contract.

Benefits of Leveraging Technology

1. Owners can monitor progress and track project details in real-time, catching errors and issues before they get out of hand.
2. Data integrity is preserved as errors can be rolled back.
3. Its visibility makes it easier to hold all parties accountable for their assigned roles and responsibilities.
4. It facilitates collaboration and easy communication between participants ensuring timely feedback for work completed.
5. Ensures large amounts of data files are synchronized into one location, granting easy access to all with an internet-enabled device.
6. Saves tremendous costs, not only in applying value, but in the amount of errors and disputes it forestalls. A $6.5 million to $13 million investment in technology can result in cost savings of between $151 million and $171 million. [20]

Despite these advantages, however, only 50% of the industry uses PMIS workflow applications at present. And yet, their adoption offers tremendous value, epitomized by significant time and cost savings as the case study below shows.

[20] Guy, S. (2012). Shaping Urban Infrastructures. Hoboken: Taylor and Francis, p.167.

CASE STUDY: UNIFIER SOLUTION FOR MGM/MIRAGE CITY CENTER PROJECT

In 2005, MGM/Mirage, the premier hospitality service providers operating in Las Vegas, Nevada, embarked upon the $6.9 billion development of City Center, a gigantic construction project in the heart of the Las Vegas strip. With only 48-months to bring the project from concept to fruition, the MGM Mirage Design Group selected two firms to augment their 25-member in-house team of architects and engineers to deliver this massive project. One of those firms was Tishman Construction Corporation.

At the height of construction, the project employed over 10,000 workers and constructed more than $250 million of work-in-place per month. MGM Mirage Design Group recognized that the undertaking of such an enormous project in an unusually short period of time would necessitate a comprehensive approach to solidifying the diverse individuals that needed to come together to achieve such an ambitious task.

In order to organize the project around a single delivery strategy, MGM/Mirage tasked Tishman with the responsibility of establishing standard project protocols, systems and procedures that would solidify the 500-member management team into a cohesive unit. The Tishman organization brought in Mark Bodner to lead Tishman's work on the project and assume responsibility for delivering on the specified objectives. Prior to an 18-year stint with a competitor, Mark had served as the Vice President of Advanced Systems for Tishman. Following his extensive work on the City Center project, Mark successfully founded Foresee Consulting.

Tishman needed to determine the best approach to creating a unique culture for the project by identifying and utilizing the best-practices of each of the four main entities involved in the project, namely the Owner, Architect/Engineer, Construction Manager and General Contractor.

This could only have been done with an "off-the-shelf" SaaS business process workflow software platform that was easily and rapidly configurable. Such a software platform had to:

- Provide the ability to create consistency and clarity of individual roles and responsibilities across the delivery team organization;
- Break down silos of information that needed to be shared across job functions;
- Aggregate meaningful management information reporting from the reams of data the project's administrative activities produced;
- Afford the team visibility and accountability; and

- Establish itself as the single source of truth in a "real-time" objective "project record".

Additionally, the right software solution had to offer the following functional requirements:

- Flexibility in configuration to enable the team to "work" the way they chose to work (i.e. a workflow application);
- Easily configurable forms for custom definition and function of all information gathering "fields" on each step of the workflow;
- Conformance with written procedures (i.e. the project's codified *General Requirements* which defined the administrative requirements, roles and responsibilities of the individual entities and functional staff positions);
- Conformance with the project's cost accounting and reporting requirements; and
- The option to implement the system either in the "cloud" or 'self-hosted".

At the end of the solicitation, "Unifier" (an Oracle, previously Skire, PMIS solution) was selected, having stood out because of its ability to act as a self-sustaining entity. In other words, the software was configurable without custom development that would have necessitated going back to the vendor for modification of program code. It also offered the option to self-host, was competitively priced, and could be implemented in phases.

Because the project was on a fast track schedule (i.e., design and construction were proceeding simultaneously), the project administration would have been disjointed, chaotic and essentially a free-for-all with members of each of the four main entities doing things differently, if the Unifier solution had not been found and implemented in a timely manner.

Implementation of the Solution

The Unifier solution provided the tool that leveraged expert project and portfolio management knowledge with innovative state-of-the-art technology that went well beyond the original intended scope of strictly budget and cost control. Initially conceived as a tool to support 50 users performing work in 13 Business Processes on budget and cost control tasks, the application grew to over 1,300 users performing all sorts of project management tasks in over 150 Business Processes. Despite this growth throughout the project, the technical team supporting the application stayed steady with only one Technical Specialist and an Assistant Trainee. Once configured, implemented and adopted, the Unifier solution promoted MGM/Mirage's ability to be self-sufficient in many other information requirements of the project team.

Unifier brought real world benefits to the MGM/Mirage City Center project, including Cost Management, Schedule Management and Document Management. A variety of additional Business Process designs were implemented. Some of the other capabilities it provided were:

- Centralized, accurate and real-time project data in a trusted system of record;
- Streamlined and improved processes and communications;
- Owner-defined business rules for Field Reporting and Quality Control;
- Easily created and configured workflow processes via workflow designer tools for tracking retention release requests; and
- Standardized and structured approvals for subcontractors to work on the project across the entire program.

When Owners require the following project management qualities, they would be well served to consider using Unifier:

- Accessibility, accountability, and auditability;
- A highly flexible, configurable platform that facilitates team collaboration;
- A robust web-based information system with an intuitive user interface; and
- Established values and techniques that enable visibility, standardization, measurement and process improvement.

Unifier's Impact on the Project Outcome

During the contract close-out phase of City Center, Unifier provided a clearing-house of information required to close-out contracts (it was the irrefutable system of record). Unifier also presented the ability to access project-related documentation in real-time with an impeccable audit trail. This proved to be invaluable, as it allowed MGM/Mirage to always be minutes away from finding what was needed in a database of millions of documents.

The MGM/Mirage project manager's perspective was that the Unifier system provided information to track payments to subcontractors (as the trusted source of information) to enable the Owner to establish a range of values (by Subcontractor) to accurately forecast the final cost of the project.

Unifier also provided the tool that allowed the Owner to hold the Contractor accountable for fact-based failures, because it provided the required documentation to support or refute the Contractor's Change Order requests. The Ball-in-Court (BIC) and audit features of Unifier were

vital. Unifier's workflow functionality provided an irrefutable record of actions taken by the project participants. In other words, the system kept an audit trail of who initiated each record (e.g. an RFI or Change Order request), its content, and when it was initiated, reviewed, edited, and acted upon (e.g. rejected or approved). This information was extremely effective in defeating arguments floated by any of the parties that were not based upon the factual project record.

Post-construction claims resolution was supported by the Unifier system. The Unifier system provided the basis of facts for the Owner's project management and legal teams to evaluate the scope and value of the work performed by each Subcontractor.

The Unifier system was efficient in gathering information for the attorney's argument because all project information was in one place. The system eased access to project record information for disclosures during discovery. Unifier also enabled MGM/Mirage's legal counsel the ability to place the opposing counsel into the position of accepting the veracity of the system as the system of record. During the litigation discovery phase, the system was accepted as the official communication platform amongst the Owner, design team and construction team and was relied upon by all parties. As an example, it allowed a simple query of the database that enabled the Owner's counsel to easily determine, without question, that an RFI over a disputed item of work was never raised.

The legal team's perspective was that the project records were very well-organized. The Unifier system allowed the information required for litigation to be prepared in "packets" of confidential communications, which was critical to the resolution of problems. It also resulted in over $1.7 million in cost savings, saving up to 12 man-days of effort for document organization, review and compilation and deposition preparation, because the data was already organized and retrievable. This enabled MGM/Mirage and their legal counsel to focus on strategies and tactics months earlier than what would have been possible without the Unifier system's effective, efficient, and highly-advanced organization of the City Center project's data.

Applying Contractual and Technology Solutions to Key Challenges

Contracting and technology solutions can make a practical difference in the key areas in which information asymmetry leads to inefficiency. These solutions can impact the following:

a. Payment

Whereas traditional contracts obligate the Owner to pay on-time and pressure them to resolve changes and disputes in a timely manner to keep the project progressing, robust contractual requirements will define a standard form of a Change Order Request with information required by the Owner for a quick analysis and an efficient process, while the right project control technology will provide visibility into Contractor compliance to ensure accountability and enable pro-active and timely resolution of non-compliance.

b. Changes and non-conforming work

More often than not, payments are made for changed work that is in progress, while knowledge of specific "extra" work being performed out-of-contract-scope stays exclusively with the Contractor. Similarly, when it comes to non-conforming work, it is often the case that such work is already paid for before the non-conformance status is identified. When the non-conformance is identified prior to payment, the only recourse for an Owner is to withhold payment for the Contractor's work that does not meet specifications. This leads to work delays, litigation and other problems.

Robust contract terms combat such situations by making payments to the Contractor conditional upon identifying the specific work for which the payment is requested. The contract will also obligate the Contractor to submit as built documentation with their application for payment for "extra" work performed. Use of project control technology provides a further safeguard by ensuring that the project accounting record correlates to the general accounting records.

c. Acceleration costs

Tracking acceleration costs and the "slow down to speed up" process is another area with a heightened potential for disputes and delays. Ensuring coordination between the legal requirements in the contract (e.g. by stipulating that costs are to be "reasonably, necessarily and actually incurred") will bring about a tighter connection between the general accounting system

and the project record. The use of drones as part of the tracking controls on a project will make monitoring more effective, because their integration into project monitoring brings more "eyes" into the field, ensuring better oversight.

d. Quality Assurance

Sometimes non-conforming or substandard work is not a deliberate act on the Contractor's part. The Contractor's management may have no idea that the work in the field is non-conforming until it is too late. With robust contract requirements that clearly set forth the expectations of inspection responsibilities of all parties, Quality Assurance and Quality Control ("QA/QC") can be more closely monitored. The contract will require QA/QC roles to be filled and the policies strictly adhered to. The project control technology can then be used to monitor compliance to those contractual requirements.

3. EFFECTIVE INTERMEDIARIES

Unfortunately, Owners often fail to recognize the value of effective intermediaries – those who are independent and knowledgeable and can engage effectively with both the Owner and the Contractor throughout the duration of the project. An intermediary is "an in-between agent working deliberately towards achieving a goal."[21] Their expertise could be in any number of project areas, from funding management to design management. It could also include cost management, schedule management, contract management, quality management and scope management. Ideally, such intermediaries would be Owner staff with expertise to know what is important and can process project-critical information. In other words, the Owner should have access to such expertise within its own workforce.

In over forty (40) years of supporting high-value, high-impact projects, however, it has been our experience that Owners often do not have sufficient levels of staff that possess the required expertise. As a result, Owners either go into projects without effective intermediaries or establish a partnership with an organization that can play that role. Because it often takes a large amount of resources and time to first identify and select partners, and then coordinate their activities

[21] Thomas, E., Balestrin, A. and Howells, J. (2014). The Role of Intermediaries in Open Innovation: Developing a Model for Collaborative R&D. Academy of Management Proceedings, 2014(1).

together,[22] project Owners often stick to already established relationships for all projects and carry the same partnership into multiple projects, regardless of fit (or lack thereof).

At face value, this approach might seem useful for saving time and resources. For some projects, however, these established partnerships do not have the expertise to deal with the project requirements. In other words, different projects most likely require different sets of intermediaries depending on the type of expertise required.

Intermediaries process information during various stages of the project, ensuring that all stakeholders have the information required and that no party has a monopoly of the data.

To be successful in their role however, intermediaries need four critical elements:

a. Understanding the project's objective

Intermediaries – may they be architects, engineers, quantity surveyors, contractors, or other professionals – need to be clear regarding what they are working towards and their role in the overall picture. This will require a series of meetings to settle on measurable objectives premised on key performance indicators attached to all parties. When setting objectives and goals, it is important that everyone knows the why, who, what, and when of each outlined objective. These objectives should be documented and shared with all parties for the sake of accountability.

b. Healthy and collaborative interaction

Investing time and resources in facilitating collaboration and interaction between intermediaries can reduce time spent working by half. This is because ideas from one party help another party solve a pressing problem that could have otherwise held up the project. For the aforementioned to happen, the intermediaries need to have a connection – a vibe, so to speak. Such a connection needs to be intentionally nurtured. This involves integrating regular mandatory review meetings into the job function of all key stakeholders.

[22] McKinsey & Company (1997). A revolution in interaction. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/a-revolution-in-interaction.

c. Provision of adequate resources

In addition to the contract provisions that guide the performance of all entities involved in the delivery of the project, most large projects will benefit from a fully developed project *Procedures Manual* that addresses the roles and responsibilities of all entities supporting the Owner's mission during the pre-construction, construction and post-construction phases of the project. A comprehensive project *Procedures Manual* must address, at a minimum, certain key subjects in explicit detail [See sidebar].

As the extensive list of subjects in the project *Procedures Manual* and the contractual *General Requirements* shows, a variety of disciplines are required to not only engineer the processes to suit the Owner's requirements, but also to implement the execution of the project throughout delivery. Because it is highly likely that individuals with the skills and experience to enforce the specific provisions delineated in these documents may not exist within the Owner's organization, they can be seconded from a variety of professional firms with the right expertise and business model.

Content of Procedures Manual

1. Project Administration
2. Architectural Facility Program
3. Design Phase Management and Scope Control
   - A/E Selection
   - A/E Contractual Responsibilities
   - A/E Management
   - Contract Work
   - Design Phase Budgeting
   - Planning & Scheduling
4. Constructor Procurement
   - Scope of Construction Work
   - Project Controls
     - Estimating
     - Scope Control
     - Cost Management
     - Planning & Scheduling
   - Bid Process
     - Contractor pre-qualification
     - Solicitation
     - Negotiation
     - Award
5. Project Execution
   - Cost Management
     - Project Estimating
     - Value Engineering
     - Change Order Estimating
     - Cost Reporting
   - Schedule Management
     - Master Schedule
     - Progress Reporting
   - Construction Execution
     - Field Supervision
     - Management Reporting
6. Technical Support
   - Standards
   - Quality Management Goals
   - Project Team's Responsibilities

d. Effective management

Effective management is critical for three key reasons: conflict resolution, keeping Contractors in check against deviant behavior, and keeping everyone focused on the task at hand. According to Transparency International, "Third parties used as intermediaries are one of the most common channels through which bribes are made."[23] This is why Owners should not only put a strong focus on creating systems and processes that prevent nefarious acts, but also ensure that the intermediaries brought on-board are independent, tested, and maintain a strong track record.

[23] PwC, *Corruption prevention in the Engineering & Construction industry*. Available at: https://www.pwc.com/gx/en/engineering-construction/fraud-economic-crime/pdf/corruption-prevention.pdf

Benefits of Having Effective Intermediaries

1. There is equitable sharing of risk and fair incentives for intermediaries, which favors everyone including the Owner and the major Contractors.[24]
2. It promotes collaboration that has its gain in profitability and efficiency.
3. Conflicts are resolved quickly.
4. The goals and objectives of the project are disseminated to all parties - making it easy to demand accountability for execution that fails to meet requirements.

4. ORGANIZATION CHANGE MANAGEMENT

The construction industry is notorious for its apathy towards embracing change, especially when it concerns technology. For this reason, when introducing new technology and tools, as well as systems and processes that are new or uncommon, it is important to manage the disruption properly.

The fourth and final component in avoiding information asymmetry is implementing an Organizational Change Management (OCM) process. This refers to aligning the organization to utilize the technological tools which are introduced to ensure visibility into processes and monitor compliance with the rules.

The Owner must set expectations and communicate what is required of each individual. It is necessary to identify and articulate "why things are done this way" and provide feedback mechanisms in order to learn and deal with problem issues as they arise. Conducting training in required skills is paramount.[25]

Training

The best technology products accomplish nothing if users do not use or understand how to use them or what their true benefits are. A successful training program is about more than just going through the motions; it is about self-sufficiency and user adoption. It is about giving the project

[24] Out-law.com. (2017). *Construction industry must embrace collaborative working quickly or miss out on benefits.* Available at: https://www.out-law.com/en/articles/2017/october/construction-industry-must-embrace-collaborative-working-quickly-or-miss-out-on-benefits/

[25] Search CIO. (n.d.). What is organizational change management (OCM)? Available at: http://searchcio.techtarget.com/definition/organizational-change-management-OCM

team the confidence that a well-designed PMIS will empower them to do more with less. A comprehensive training program can put clients who wish to become self-sufficient on a path to supporting the change themselves. With a fully comprehensive, well-designed and professionally delivered training program, stakeholders will buy into the vision and stay true to it, in spite of the obvious challenges brought on by change.

Adoption

New technology, tools and processes are important elements of any enterprise project, but workforce adoption is the most critical component. Misalignment between the technology team and business leaders, or lack of organizational readiness within the workforce, can dramatically extend adoption, invite process work arounds and jeopardize overall project success.[26]

The main vehicle for communicating and coaching the project team throughout the phases of change is a change agent that works with the organization to create a structured, intentional program made up of multiple levels of leadership hierarchy that are responsible for cascading communications, coaching the level beneath them and gathering feedback. Initially, the purpose of messaging is awareness — "what" changes are being implemented and "why" these changes are crucial for business success. Then the team is ready to move on to more granular, role-specific information — the "when" and "how" of training.[26]

Ready: People need to understand the rationale for changes taking place in their organization. Direction must be provided from the "C-Suite". Efficiency and effectiveness comes from improvement in understanding the variety and subtle differences in agendas of silo(ed) individuals that are inter-dependent but performing discrete job functions.

Successful projects require open and unvarnished communications by utilizing a top-down, bottom-up, middle-out communication strategy[26] that:

- Helps users understand the "big picture"
- Promotes awareness of process-related integrations/changes
- Clearly identifies where users fit in the process
- Provides context for process focused training
- Reinforces alignment with project vision[26]

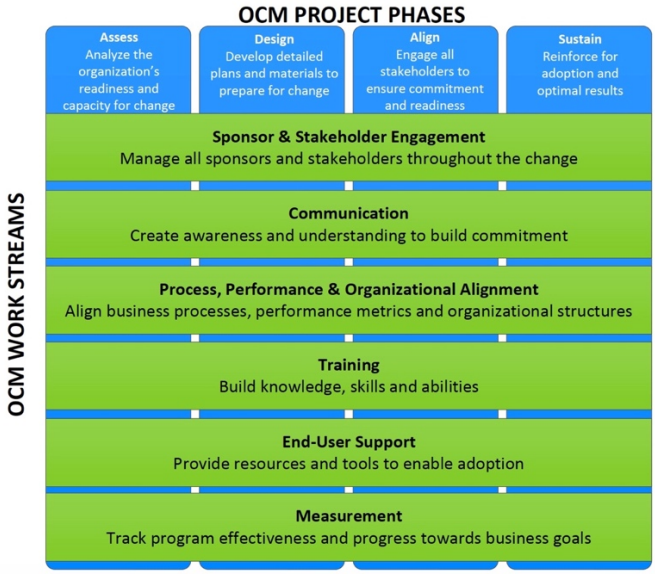
[26] The Mosaic Company, Preparing Your Workforce for Transformative Organizational Change; available at www.themosaiccompany.com

Willing: Users must allow staff some "space" in their everyday "job" to accomplish the additional work required to make the necessary changes in the way they communicate, work, monitor progress and collaborate with each other.

Able: To be embraced by all team members, including contractors, training must encompass processes, procedures and systems in a variety of settings, (i.e. team based-training, individualized role-based training as well as cross-functional training). Since all individuals have different learning preferences and styles, training must also be offered through a variety of media (e.g. streamed video, off-line recorded video, on-demand and self-directed instructional videos, conventional classroom instruction, etc.). In addition, self-help guides and user-productivity kits and quick reference guides will promote user adoption.

OCM Phases & Work streams

The following infographic identifies the phases and work streams for a successful OCM program.[27]



[27] The Mosaic Company, 2015. Available at www.themosaiccompany.com

Benefits of Change Management

- Increased speed of adoption, better utilization, and a higher degree of efficiency;
- Key business impacts identified and mitigated;
- Invites engagement between leaders and individual contributors and creates alignment for the business;
- Sustained support beyond go-live embeds to change and creates a more responsive organization[28];
- Greater ROI for investments made in the changes being implemented; and
- Reduced stress and a greater sense of control.

Change management can be a complex task. It is important that organizations have the requisite expertise to lead the process. These services can be secured from a variety of specialized professional service firms.

[28] The Mosaic Company 2015, available at www.themosaiccompany.com

Conclusion

Inefficiency and its symptoms – low productivity, delays and going over budget – are a blot on the construction industry. Although widespread, the problem is not incurable. As this paper has shown, the root cause and driver of these problems is not one without a solution: By simply embracing systems and processes that prevent asymmetric information, project owners and stakeholders can keep projects within their estimated budget and time frame.

Developing robust contract requirements, leveraging technology, bringing on board effective intermediaries, and adopting organizational change management are all critical steps that Owners need to take in order to enhance the productivity and efficiency of their projects.

About the Authors

Mark Brian Bodner is the Founder & CEO of Foresee Consulting. He has been involved in the delivery of mega-projects as an Owner Representative for more than 45 years, having worked in a variety of roles including Chief Scheduler, Auditor of Budgets and Controls, Project Manager and Project Executive on a number of high-profile projects since the 1970's, such as: EPCOT Center, Canary Wharf, MetroTech, the 1996 Atlanta Olympic Games, the Ben Gurion 2000 Airport Project and, most recently, the MGM/Mirage City Center project. Foresee Consulting, in operation since 2011, is headquartered in Las Vegas with clients across North America.

Gregory "Lance" Coburn is an expert construction attorney with more than 20 years of experience. He represents clients in domestic and international business litigation and is a member of Procopio's Construction team. He provides representation throughout the construction project process, from preconstruction strategy and contract drafting to lien and defect litigation on multi-billion dollar developments. In particular, he has extensive experience representing developers of resort hotels and casinos on the Las Vegas strip in complex construction law, intellectual property rights, and lien litigation. Lance also has counseled clients on a wide range of media law matters. His practice is based in Las Vegas.

Together, Mark and Lance were instrumental in the delivery and post project resolution of claims on the $6.9 billion City Center project.

About Foresee Consulting

Foresee Consulting is a Nevada-based construction consultancy company specializing in the deployment of Oracle Cloud Solutions. Founded in 2011 by Mark Bodner, a project executive with over forty years' international project portfolio experience, Foresee Consulting has grown to become the foremost provider of project control solutions to a wide range of projects.

As a Certified Oracle Primavera Platinum and Cloud Select Partner, Foresee specializes in the implementation, integration, support, and training for Oracle Primavera Unifier. Our team of 36 professionals comprises construction and technology professionals who have a combined 200 years of project oversight experience. The team boasts more than 100 years of combined Unifier experience, making Foresee the world's most experienced Unifier solutions provider.

By applying high performance methodologies, innovative technologies and best practices for superior and sustainable project results, Foresee has successfully defined and executed Project Controls strategies for several high-impact, high-value projects across North America. Foresee consistently deploys best-in-class industry knowledge and expertise in project control technology to help clients establish standard project protocols, systems and procedures that eliminate inefficiency and delays from projects. Foresee partners with clients from the initial planning stages of a project, through training and on-going support. Some of Foresee's current and past clients and projects include:

Energy	**Higher Education**	**Manufacturing**	**Commercial**	**Transportation**
NextEra Energy	UC Berkeley	International Paper	IKEA	MWAA
Consumers Energy	USC	Ingersoll Rand/Trane	Rudolph Libbe	SLCDA
Williams Energy	McGill		Goldman Sachs	Metrolinx
Citizens Energy	University			Sound Transit

About Procopio

Attorneys practicing construction and infrastructure law at Procopio represent all segments of the construction industry including owners, developers, public entities, general contractors, subcontractors, sureties and financial institutions. They provide guidance to clients on the legal issues that arise at all stages of public and private construction projects. In addition to speaking engagements, their construction attorneys are active with the International Bar Association – International Construction Projects Committee, the American Bar Association (ABA) Forum on the Construction Industry, the Associated General Contractors of America and other construction-related organizations. Procopio also partners with Meritas and Law Exchange International working with clients around the world.

Services

Clients trust Procopio's construction law team to solve their most complex problems. Procopio focuses their deep legal and technical knowledge in the following practice areas:

- Bid protests
- Consulting during construction
- Construction contract formation and performance
- Contractual claims
- Environmental and Land Use issues
- Mechanic's lien and Stop Notice claims
- OSHA investigations and citations
- State and federal false claims act claims
- Surety bond claims

References

1. Pmi.org. (2017). Construction Extension to the PMBOK Guide | PMI. Available at: https://www.pmi.org/pmbok-guide-standards/foundational/pmbok/construction-extension
2. United States Census Bureau Monthly Construction Spending, September 2017, Available at: https://www.census.gov/construction/c30/pdf/release.pdf
3. Economist.com. (2017). Efficiency eludes the construction industry. Available at: https://www.economist.com/news/business/21726714-american-builders-productivity-has-plunged-half-late-1960s-efficiency-eludes
4. McKinsey, The construction productivity imperative https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/the-construction-productivity-imperative. 2015.
5. KPMG (2015). Global Construction Survey. Climbing the curve. KPMG International, p.6. Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/04/global-construction-survey-2015.pdf
6. LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
7. Brook, B. (2017). Berlin's massive new $8bn airport was supposed to open in 2012. Some say it may never. Available at: http://www.news.com.au/travel/world-travel/europe/the-ongoing-multibillion-dollar-disaster-of-berlins-new-international-airport/news-story/ff684d8f7bee04c3776c381258d92f3a
8. LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
9. Maritz, T. (2017). The calculation of acceleration costs on construction projects: review article. Available at: https://www.academia.edu/800911/The_calculation_of_acceleration_costs_on_construction_projects_review_article?auto=download
10. International Project Management Association Study, September 2010
11. LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
12. Hillebrandt, P., Hughes, W., Greenwood, D. and Kwawu, W. (2006). Procurement in the Construction Industry. 1st ed. Hoboken: Taylor & Francis Ltd.
13. LePatner, B. Broken Buildings, Busted Budgets: How to Fix America's Trillion-Dollar Construction Industry. The University of Chicago Press. 2007.
14. England, M. (2016). Construction Estimating - Accounting Software | The Jobsite. Jobsite.procore.com. Available at: https://jobsite.procore.com/6-general-requirements-that-can-bust-your-estimate

15. Peiffer, E. (2017). 10 construction industry trends to watch in 2017. Construction Dive. Available at: https://www.constructiondive.com/news/construction-industry-trends-2017/433151/
16. KPMG (2016). Global Construction Survey. Building a technology advantage. KPMG International, p.4. Available at: https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2016/09/global-construction-survey-2016.pdf
17. Denizon. (2012). Top 10 Disadvantages of Spreadsheets Available at: https://www.denizon.com/spreadsheets/top-10-disadvantages-of-spreadsheets/
18. Sylos, M. (2013). Top five advantages of software as a service (SaaS) - Cloud computing news. Cloud computing news. Available at: https://www.ibm.com/blogs/cloud-computing/2013/09/top-five-advantages-of-software-as-a-service-saas/
19. KPMG (2015). Global Construction Survey. Climbing the curve. KPMG International, p.6. Available at: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/04/global-construction-survey-2015.pdf.
20. Guy, S. (2012). Shaping Urban Infrastructures. Hoboken: Taylor and Francis, p.167.
21. Thomas, E., Balestrin, A. and Howells, J. (2014). The Role of Intermediaries in Open Innovation: Developing a Model for Collaborative R&D. Academy of Management Proceedings, 2014(1).
22. McKinsey & Company (1997). A revolution in interaction. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/a-revolution-in-interaction.
23. PwC, Corruption prevention in the Engineering & Construction industry. Available at: https://www.pwc.com/gx/en/engineering-construction/fraud-economic-crime/pdf/corruption-prevention.pdf
24. Out-law.com. (2017). Construction industry must embrace collaborative working quickly or miss out on benefits. Available at: https://www.out-law.com/en/articles/2017/october/construction-industry-must-embrace-collaborative-working-quickly-or-miss-out-on-benefits/
25. Search CIO. (n.d.). What is organizational change management (OCM)? Available at: http://searchcio.techtarget.com/definition/organizational-change-management-OCM
26. The Mosaic Company 2015, available at www.themosaiccompany.com
27. The Mosaic Company 2015, available at www.themosaiccompany.com
28. The Mosaic Company, Preparing Your Workforce for Transformative Organizational Change; available at www.themosaiccompany.com