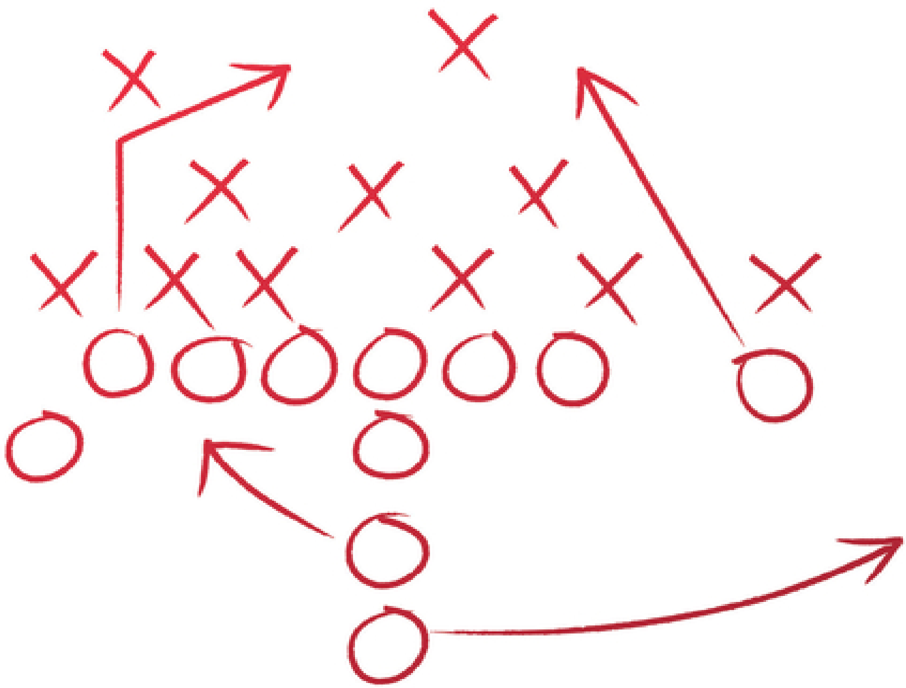
LEAN ARCHITECTURE

EXCELLENCE IN PROJECT DELIVERY

MICHAEL F. CZAP, AIA
GREGORY T. BUCHANAN, AIA



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Foreword

I had the honor of serving on the American Institute of Architects (AIA) national board from 2002 through 2004. At that time, I was an equity partner in a boutique interior design firm in Atlanta, and frankly I was a bit intimidated about joining this elite group. I imagined that everyone would be very high-powered and that I would be in the shadows. After a short time, though, I realized that these architects from big-name firms were dealing with the same problems I was: low fees, competitive pressures, and erosion of respect for the profession. I met some great people on the board, some of whom remain friends to this day, but I also realized that the profession was facing big challenges in terms of staying relevant in a rapidly changing world.

Later in my career I moved to a larger firm where the stakes were higher, designing more complex architectural and interiors projects. That is where I met Greg Buchanan. Having seen Greg and Michael deliver their Lean Architecture presentation at an AIA convention, I was very impressed with their concepts; and for several years now, I've had the pleasure of seeing Greg provide guidance and inspiration to team members and clients.

Now I will shift gears to why I believe the Lean Architecture approach espoused by Greg and Michael is so important to our profession. I have been fortunate to have a great career, better than I could have expected. Now I am near the end of my career, and what people my age do is look back and try to figure out what it all meant. So here goes.

In my 47 years of architectural practice, I have rarely seen the words *Lean* and *excellence* used together. Most architects equate excellence with bigger, fancier, more expensive buildings, which of course require more time and fee to design. The architectural profession in the US grew out of the beaux arts movement of the late eighteenth century, imported from France by people like Thomas Jefferson. Beaux arts literally means "fine arts," and, for a long time, architects identified themselves as much closer to the arts than to engineering.

That conception of architecture as a fine art worked well for a young country that was striving to catch up with Europe culturally. Building fine buildings like these took as long as it took and cost what it cost. But over the last 7 decades, the sponsorship of major buildings has increasingly become the province of large companies. Even institutional clients such as governments, schools, and cultural institutions have adopted a modern project management approach for their buildings.

We can debate the definition of *value* in buildings, but like many things in the modern world the movement has been inexorably toward driving down cost. The means to drive down cost has often been through technology. Household names like Amazon and Netflix have made goods and services more widely available at lower costs. But there have been unintended consequences to squeezing as much cost as possible out of the system. Air travel is a great example. Multitudes who were flying across the country on $300 tickets before the COVID-19 pandemic complained about crowded flights and dingy airports, not realizing that they had the air travel system they paid for. A more serious example is the healthcare industry. The pandemic has exposed that our US healthcare system is running so tight that, when unexpected needs hit, there were not enough beds, ventilators, and test kits. Resilience has been value engineered out of a critical system.

The paradox is that the architecture, engineering, and construction (AEC) industry has been remarkably stubborn in resisting the deployment of technology. We thought that adoption of parametric 3D design tools would lead to interactive models of buildings with changes automatically updating throughout the drawing set, but we found that the labor cost of building a complete 3D model of a building was prohibitive given competitive fees. So most firms model the plans in 3D but still produce the details in traditional 2D CAD. Enterprise 3D modeling software has proven to be unwieldy for quick design sketching on the front end, so many young designers bootleg simpler tools to use for ideation, further undercutting the building information modeling value proposition.

On the construction side of the equation, we have only to walk down the street and see tall buildings being built with cast-in-place concrete. Low-paid workers essentially build the structural frame in wood, pour the concrete, rip the formwork down, and then do it all over again on the next floor. Not exactly a high-tech approach, but as long as there are low-wage workers available this method works out to be less costly than steel or other methods.

But despite the fact that the AEC industry lags others in technology-driven efficiency gains, fees for architects remain stuck where they were 20 years ago. During boom times, fees may edge up a bit, but as soon as there's a downturn the race to the bottom on fees returns. Previous gains are wiped out, and we're back where we started. So, low fees, marginal profitability, boom-and-bust market, scarcity of human capital – does this sound like a profession that can invest heavily in technological innovation?

All is not lost! Architects can still succeed if we reimagine the way we work. That's why this book is so important. *Lean Architecture: Excellence in Project Delivery* lays out an approach to what we do that starts from the premise of not doing anything in the design process that doesn't add value to the finished product. Document only what's necessary, and document it one time in one place.

Although adopting a Lean Architecture approach will generate cost savings in producing the work, it would be short-sighted to see it as just a cost-cutting tool. Savings in production time and cost can be reinvested in innovation and design excellence. As a result of tight fees, many architects today bemoan the loss of time for creative wandering in the initial stages of design. Lean Architecture can help us rediscover that time, even with competitive fees. So it's really about a better design at a lower cost, and that would move the architectural profession out of the dark ages, complaining about lack of respect, and into the same kind of lower-cost, better-quality value proposition that has propelled the Amazons and Netflixes of the world to success.

For architects, this is the book we need at the moment we need it. Thank you, Greg and Michael.

Stephen Swicegood, FAIA

Acknowledgments

A few thanks. Not many people have careers that are not influenced, enabled and shaped by others. Here are some who have affected mine.

Wayne Barger, AIA, is the first person I worked with who effectively modeled what a great project manager does, providing effective leadership while staying out of the way so people could do their work. A good listener, Wayne looked for and promoted good ideas wherever they came from.

Grant A. Simpson, FAIA, combines a colorful character with intellect and keen insight into the realities of architectural practice. We met in 2004, and without asking he signed me up to speak with him at that years Texas Society of Architects annual convention. We found we had quite a lot in common; often, what I could not quite put in words Grant could well summarize while distilling the underlying principles.

My coauthor, Greg Buchanan, AIA, has become a good friend, and I am grateful for his contributions to this book. We each attended the University of Illinois at Urbana-Champaign – about 10 years apart. Greg and I both share a passion for understanding how to produce better projects and to share that with others. We have different approaches but similar ideas, and I believe that strengthens this book.

My parents, Donald and Marion Wilkins, who took in a foster kid and helped him grow up.

My wife, Lynn, loves me no matter what and knows how to put me in my place when needed. She also considers me the best architect around.

Jesus Christ, the Lord, is described in the New Testament as the architect and builder of a city with foundations. It also says that in him are hidden all the treasures of wisdom and knowledge. I have found that my best ideas and insights have often come after asking him for help.

Michael F. Czap

Almost everyone we encounter in our careers helps shape our viewpoints and approaches to problem-solving. I want to recognize several individuals who have been exceptional teachers and mentors to me and acknowledge my family for always being there when needed.

My drafting teacher at Champaign Centennial High School, Edward A. (Al) Boehm, who coached me on the rigor required to excel at technical architectural drafting - skills that are still relevant to this day even though the tools have changed.

Of all my professors at the University of Illinois at Urbana-Champaign, Michael Kyong-il Kim, PhD, AIA, NCARB, inspired a desire in me to question why things are the way they are. His teaching philosophy is of a comprehensive integrative approach that exposes students to the multiple building systems required to act together to become a singular design expression. I admire him for teaching multiple generations of professionals to think beyond the normal.

Kennedy K. (Keddy) Hutson was my first professional mentor. He took a chance on hiring me for my first position in an architect's office as an intern during graduate school. I learned many lessons from him (and others) in the short time I was employed there. After I gave notice that I was leaving to pursue an opportunity out of state, his response was one of support and encouragement to pursue what was best for my future. That lesson has stayed with me and is something I pass along to those I have mentored during my career.

My coauthor, Mike Czap, AIA, for our friendship and collaboration over the years. This book brings our shared passion to fruition, but not the end. Thanks for your insights, perspective, and most importantly the sharing of Lean Architecture.

My wife, Lori. Thanks for your love and support in writing this book. You have always encouraged my pursuits, and I could not have asked for a better person to share my life with – I love you. To our son, Samuel, and daughter, Natalie, I am proud of you both and look forward to seeing you pursue your dreams.

And my parents, George and Valerie, without whom I would not have been able to pursue my dream to be an architect, and a special thanks to my dad for his contribution to chapter 5.

Gregory T. Buchanan

Preface

The practice of architecture encompasses many things from design to drawing – and now modeling; the use of materials, the creation of places and spaces, and of course the clients who make it all possible. Somewhere amid all of these is the pursuit itself – the passion for excellence in every aspect of the work.

This book is an endeavor to bring attention to a methodology for that pursuit that can withstand the pressure of the times and facilitate the delivery of our work with excellence.

Over the years there have been many resources addressing the mechanics of project delivery such as good drafting practice, the essentials of drawing organization, and graphic standards. In the mid-1980s, as firms began to adopt computer-aided design (CAD), books proliferated on the basics of CAD and how to draw lines and ellipses or to add and name layers. What was missing, though, was a discussion of strategy on how to employ CAD effectively on small, medium, or large projects.

A recognition of the changing landscape started to happen in the mid-1990s as Grant A. Simpson, FAIA, and like-minded colleagues at HKS, Inc., a large Dallas architecture firm, began to rethink architectural documentation. They developed ideas like default scheduling, instructional systems, and working in context, ideas that enabled architects to create documents that were intuitive to prepare and more readily understood – not just to copy information but also to leverage knowledge. They also began to share these ideas at conferences and to write about them.

The design professionals' practice shifted dramatically again in the early 2000s with widespread access to the Internet, globalization, and the use of building information modeling (BIM) software. New books and online resources emerged to address the different processes and modeling techniques and the many possible uses for data-rich models. However, the challenges facing architects before and during CAD resurfaced again in slightly different ways.

Around 2001 Michael F. Czap, AIA, began using the term *Lean Architecture* to describe the thinking and underlying ideas for an approach that not only built upon the architect's tradition of craft and sufficiency but also looked at improving processes to streamline work across a firm (Figure P.1). It included developing a strategic approach that addressed the whole of project delivery and not just our use of technology or how to draw and model. He defined Lean Architecture as:

> The ongoing process of rethinking and improving architectural methodology. It is the pursuit of better work by applying Lean principles to every aspect of practice. It is about smarter information flow and understanding how we perceive and process information in order to become better communicators among ourselves and with the ultimate users of our services.
>
> Lean Architecture is not about skipping important steps, omitting necessary information, or doing less than the standard of care. To the contrary, it is identifying what adds value and reducing or eliminating what does not.

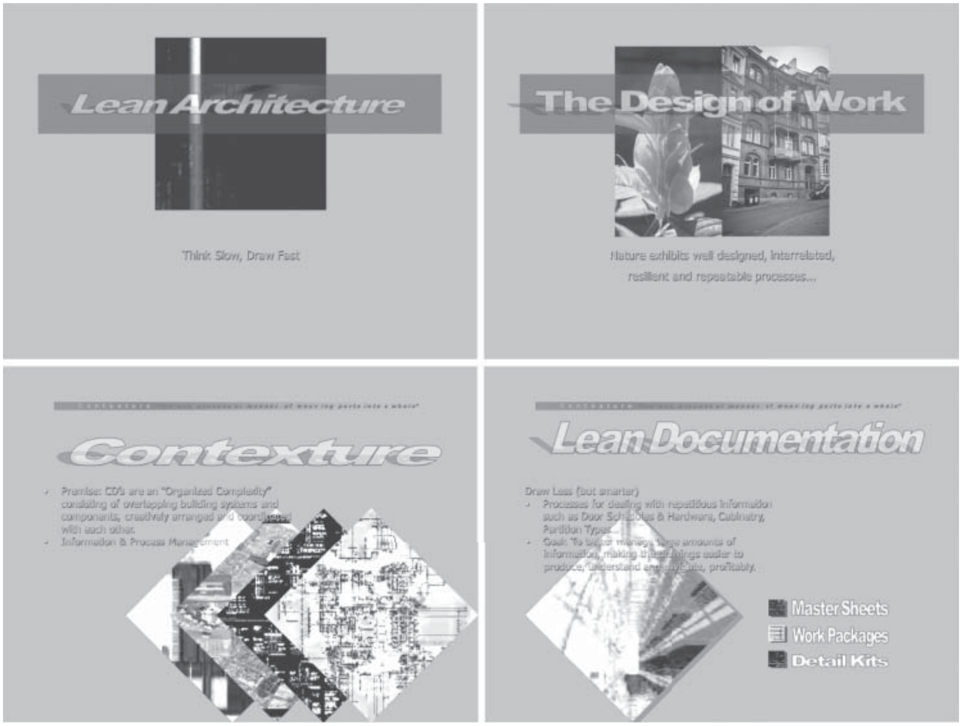

FIGURE P.1 Early presentation circa 2001.

Why Lean? It is the terminology best associated with advancing process methodology in manufacturing, software development, management, construction, and healthcare. There are other similar approaches out there, several of which we will discuss in this book.

Simpson graciously invited Czap in 2004 to speak with him at conferences, and Czap started to weave in the topic of applying Lean to architectural project delivery. He wrote several articles to support his thinking, including coauthoring with Simpson the chapter on construction drawings in *The Architect's Handbook for Professional Practice*, 15th ed. (2014), which includes a section on Lean Architecture.

In 2011, Gregory T. Buchanan, AIA, joined the effort with Czap and helped to expand the focus to address rethinking how firms work and change for the better. Brought together by a passion to effect project delivery by drawng on the influences of process improvement and Lean thinking, Czap and Buchanan began presenting their shared ideas in 2013 to a broader audience.

Many have asked what resources there are on the topic, and we are aware of none. There is a broadening interest within our profession globally on the application of Lean, and this book is a joint effort to more formally communicate ideas about improving the practice of architecture.

We will attempt to thoroughly address the topic of Lean as applied to project delivery and to intertwine them so that you no longer think of one without the other. We incorporate examples from both within and outside our profession to connect concepts and practices and to share approaches and solutions that have worked. There is no single path to excellence in project delivery, but we provide insights and share practical applications that we believe will help get you there more quickly.

It is not easy to foster change within an organization, let alone across a profession. We do believe that amid the economic and technological changes, when combined with good financial practices, a passion for client service and design excellence, Lean offers an enabling process methodology for the twenty-first century.

Michael Czap and Gregory Buchanan

Introduction

WHO IS THIS BOOK FOR?

Unless you are serious about transformation, implementing Lean across your firm may not be for you. Necessary ingredients include a commitment of time and resources and perhaps most importantly a willingness to try new ideas – to challenge and then change the ways you have worked before. Experience has shown that it is more difficult at the beginning than just doing things the old way. Yes, long-standing practices may be fine now, but are they really moving the needle to higher productivity and improving your ability to deliver projects well? We think not. Competition and fee pressure continue to force firms to do more with less, and the time is always right to become more effective and to employ commonsense approaches that question long-held assumptions and practices. It is radical only because it is different from what you are doing currently. When you experience a Lean approach, you can step back and start to see what is possible, and the concepts become clearer.

When there are profession-shaking events like the Great Recession of 2008 or the global COVID-19 pandemic, major changes occur in the economics of construction and architecture. Projects go on hold or are indefinitely delayed creating an atmosphere of uncertainty and leading to staff reductions or worse outcomes such as bankruptcy or closure. Most of you have experienced a significant change in the world in response to major events, such as the increased security screening at airports following the 9/11 attacks. Major events tend to expose structural weakness in the economy or society at large. They also tear at the fabric of a firm.

It is our observation that most companies do not operate on a level seeking to improve quality and efficiency but are instead concerned with individual project profit, winning the next commission, or earning design awards. We believe it is possible and vital to think about each of these while simultaneously bringing improvement to project delivery. This is who we are writing for.

WHY DID WE WRITE THIS BOOK?

A Lean approach to architectural or engineering practice offers value when times are good and we cannot find experienced staff to hire, and when times are not so good and we are unable to retain staff. It offers the promise of doing higher-quality work more productively.

To move from abstract concepts and obtain buy-in, Lean must be experienced firsthand by the people doing the work. They know the daily difficulties and recurring issues and are generally receptive to approaches that save them time and provide better outcomes.

We are writing this book because of a mutual commitment to working smarter and achieving better results and with the desire to share that with others. It is a passion we have in common with many design professionals: that great design must be more than just three-dimensional; it should be delivered well, and, in this increasingly complex world, the clients' and contractors' experience with us should be one where the project flows with as few interruptions as possible.

Like many reading this book, both authors here have changed jobs more than once in their careers. Each time has been an opportunity to learn how a new firm operates and the ways they do their work. While each is unique, once we get settled in and observe how things are run, it has become obvious that the techniques are essentially the same and there is little innovation occurring. Oddly enough, we find that people want to improve but do not know how to and there are few resources available. Many people have inquired where they can learn more about the subject of Lean for design professionals and request more in-depth information about our approaches. This book provides a much-needed response to these queries but is not a fix-all approach or a step-by-step manual. It is written to serve as a resource to help you understand Lean thinking and begin to see how to apply that in your firm.

ORGANIZATION

The book is broken down into four parts: (1) Building Blocks for a Lean Practice; (2) Areas of Strategic Focus with Applications; (3) Implementing Lean; and (4) Final Words and Advice.

Part I, Building Blocks for a Lean Practice, is foundational and establishes an overall framework for Lean. It explores process management theories, identifies the designer's problem, the primary goal of a design practice, and observes Lean's roots in manufacturing and how that can influence the design profession.

Part II, Areas of Strategic Focus with Applications, explores strategic areas of focus, applying Lean to project management, quality assurance, documentation, and the use of technology.

Part III, Implementing Lean shares common pitfalls and difficulties you are likely to encounter, along with approaches that we have seen work for small, medium, and large firms. We assess the use of technology in general and provide a basic program to help your efforts to rethink firm's practices.

Finally, Part IV, Final Words and Advice, summarizes where we think Lean fits within your firm and provides a number of observations for making it happen.

Throughout the book we use examples from both within and outside the profession to illustrate foundational ideas and concepts. And because they are relevant to more than one area, you will find that the principles and themes recur in multiple places in slightly different forms.

We are inviting you to join us as we learn how to think and work smarter. We concede that some of what we write about in this book will become obsolete over time; however, the principles and the thinking that underly them will not. If you will seek to understand the fundamental ideas, they can be applied to create new methodologies, as industry accepted practice and technology continue to evolve.

Lean Architecture

PART I

Building Blocks for a Lean Practice

CHAPTER 1

A Profession Ripe for Change

AN EVOLVING PROFESSION

Up through the early 1980s, most architectural firms in the United States employed a craft approach where proficiency with the tools of the day – pencils, pens, and instruments such as T-squares, triangles, parallel bars, and compasses – took time to develop. These were used with drafting media such as sheets of vellum (paper) or plastic mylar to create drawings. Along the pathway to mastering the art of drafting, with the requisite line weights and consistent lettering, one learned how buildings were put together and detailed. With some exceptions, firms were generalist in nature and worked on a variety of project types within a limited geographic area (Figure 1.1).

During that same decade, profound changes began to happen driven in large part by the emerging revolution in technology and a little later with globalization. With the ability to both communicate in real time and travel inexpensively, the consolidation of architectural and engineering firms began to occur. Fast-forwarding to the 1990s and beyond, this led to the creation of many large, multinational corporations that offered a global presence, skilled financial management, deep pools of talent, and the resources to market their services. In the United States, organizations of 30–100 people appear to have been the prime targets for acquisition. Sole proprietorships and small firms were mostly spared and to this day still comprise the majority of design practices. They continue to thrive by having the ability to deliver projects less expensively due to a lower cost structure and inherent agility. Lacking the depth of talent and other large firm advantages, many offer boutique and personalized services, while others leverage local and political relationships to compete with medium- to large-sized firms, by whom they are often engaged as local partners.

WHERE WE ARE TODAY

Professional practice today is quite different and continues to evolve at a rapid pace. Most large practices are organized into one or more specialized market sectors offering a breadth and depth of knowledge in building types such as hospitality, K–12, industrial, retail, higher education, office,

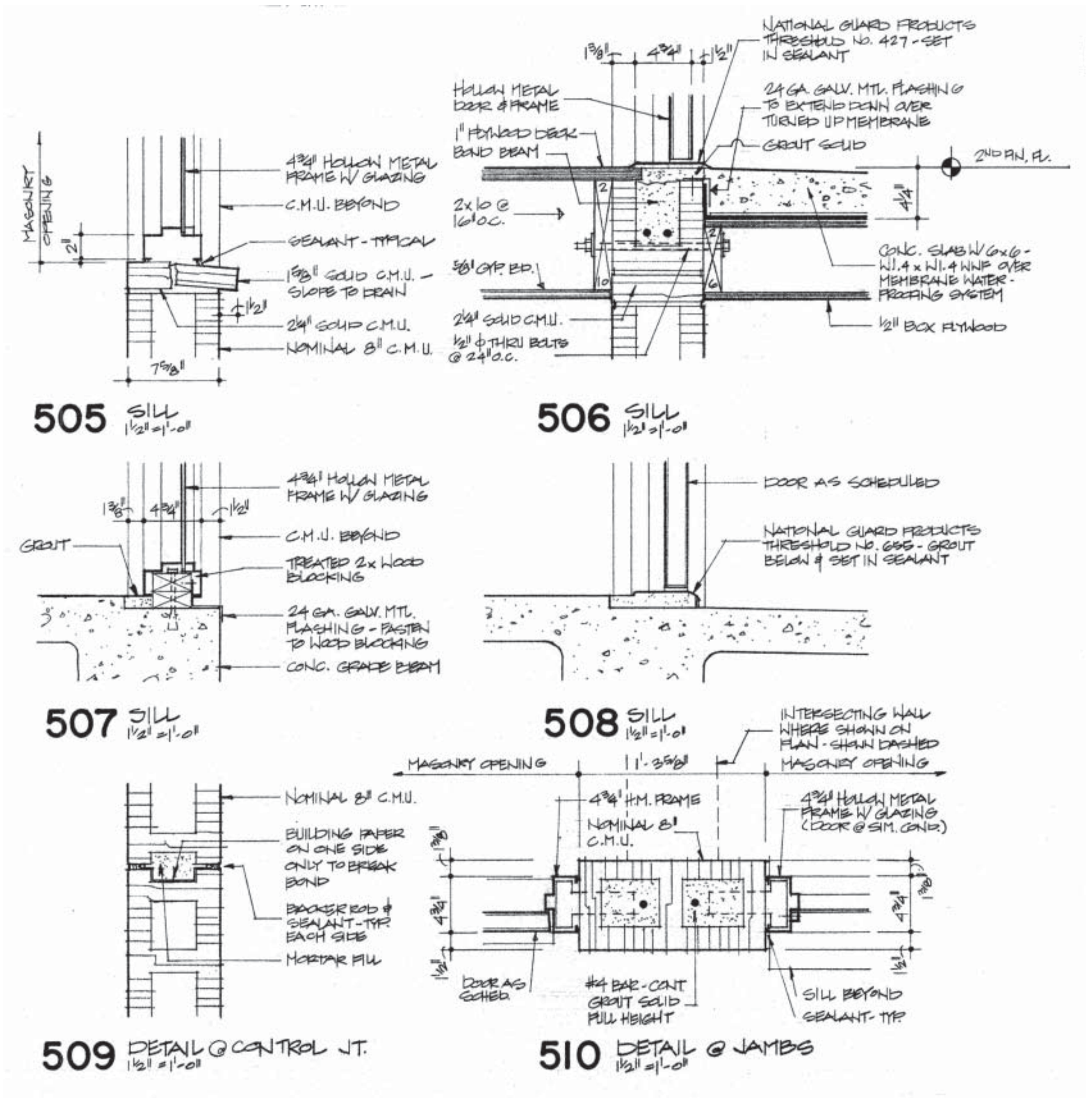

FIGURE 1.1 Hand-drafted details.

and healthcare. Great value is placed on aesthetic design for its own sake as well as the building's performance relative to its environmental impact and resiliency.

Design-side project delivery has become a more complex endeavor with multiple project stakeholders and varying options for construction. Design–bid–build is no longer the de facto method, with alternatives such as design–build, construction manager at risk, integrated project delivery (IPD), and some other variations commonplace in the United States.

In terms of architectural project delivery, the following challenges can hinder firms from consistently delivering projects with excellence:

- People: Most employees today are college graduates and arrive with a working knowledge of the software and hardware tools in use. In times past they would serve in an apprentice type role and learn the tools of productivity from seasoned professionals. The inverse is often true now where those individuals with the knowledge of building systems and constructability are not proficient with tools of design and production.
- Materials: Building systems have become proprietary and multifaceted. Traditional exterior materials such as masonry, stucco, and glazing remain in use; however, manufacturers have created significant differentiation within individual products and systems. Advances in building materials science has created new classes of products with elevated performance characteristics.
- Regulation: Building codes, accessibility standards, and other forms of regulation have increased and often overlap with each other.
- Time: The desire for return on investment and the ability to communicate information immediately have served to increase expectations for more rapid project delivery. The companion to this is an expectation for nearly concurrent decision-making.
- Environmentalism: The oil embargo of the mid-1970s and concern for the earth have brought energy efficiency to the forefront of design with a greater focus on long-term building performance as well as understanding the health effects of the materials used. The goal of carbon neutrality is now at the forefront of sustainable design.
- Litigation: For many of the reasons noted in this chapter, the design professional's risks have increased.

Each decade and generation see both dramatic and evolutionary changes that create new challenges to the profession and that can get in the way of delivery excellence. Project delivery must adapt and transform with the times we are in.

THE PRIMARY OBJECTIVE

Some would say that the American game of football has become the favorite pastime in the United States. As with most team sports, football has one objective: to score more points than the opposing side before time runs out. It is a complex game with sophisticated strategies and plays. The stakes can be high, and teams employ a formidable array of talent on and off the field to gain the slightest advantage. Football is also a simple game as the only goal is to move the ball forward on offense while the opposing defense tries to thwart that effort. Each team takes turns doing this.

In many ways, the architect's objective, like football, is both complex and simple.

The architect's primary objective, at the most basic level, is to obtain work and progress it through the firm. The movement forward of a project is the mechanism for billing, and there are few situations where the timely advancement of work is detrimental.

Many firms closely monitor their project financials to determine if they are making money, but few engage in systematic efforts to get better at delivering their work. They do not devise strategies or create different plays to move the ball forward, so to speak. By contrast, significant effort is expended by sports teams just to prepare for a single game, let alone the entire season.

Sometimes we make our work more difficult by introducing other objectives that get in the way of advancing the work. Peripheral industry initiatives, the pursuit of profit at all costs, and keeping up with changing technologies can create distraction and, if we are not careful, become a hindrance themselves. While each of these has a place, a fine line exists between distinguishing what brings ongoing benefit versus wasting time and effort on various objectives for their own sake.

SOUTHWEST AIRLINES

In an interview with *Slate* ("The Southwest Secret – How the airline manages to turn a profit, year after year after year"), an executive with Southwest Airlines discussed their ongoing growth and continued profitability (Figure 1.2). He noted that Southwest realized they only made money off their planes when they were in the air. (https://slate.com/business/2012/06/southwest-airlines-profitability-how-the-company-uses-operations-theory-to-fuel-its-success.html) They focused their operation around this idea and worked purposely to keep operations simple. Southwest flies only one series of jets, the Boeing 737, which makes aircraft training and maintenance for pilots and mechanics less complicated. Boarding procedures are streamlined by not assigning seats. This makes logistics easier when a plane is taken out of service as another 737 with a comparable seating layout can be used. "Bags fly free" reduces delays from last-minute baggage handling at the gate. Every

FIGURE 1.2 Southwest Airlines.

effort is made to facilitate rapid boarding and deplaning of the aircraft. Southwest primarily flies point to point with quick turnarounds of their aircraft.

Southwest works hard to provide great client service, and they know how to market well. Nonetheless, the goal and focus of their operation is to keep planes in the air.

If the architect's and engineer's goal is to advance projects, we want to simplify the effort to do that and eliminate everything that hinders or distracts. Yes, it would be short-sighted to think that obstacles will not arise from many places, but consider that one of your jobs is to identify and mitigate them, reducing the negative effects to the greatest extent possible.

The less complicated we make it for staff to perform their work, the more likely projects can move ahead without the wasteful iterations caused by overcomplexity and lack of clarity. Likewise, the easier it is for our clients to comprehend our ideas and recommendations, the less likely redesign will occur due to misunderstanding.

DISTRACTIONS

It would be humorous if the focus of a sports contest were to shift to the players uniforms in lieu of the strategy to win the game. The head coach's fashion sense would become more important than the team's wins and losses. Much comparison and commentary could be made with fans casting votes on which teams' uniforms are the more innovative and fashionable. Players could add embellishments reflecting their personal interests, aesthetic taste, or even current or past events. It might become important whether the uniforms were locally tailored or made in another country. They could also be evaluated on the technologies incorporated within the uniforms along with the fabric's intrinsic properties and performance data. We might also establish a formalized process and create requirements to certify uniforms for use by players. Imagine the controversy if a jersey were found to have missed a step in the certification process and one of the colors was a shade off – cancel the game!

Who does not enjoy well-designed apparel and seeing their team's attire change from game to game? Ultimately though, they are still judged on whether they bring home victories! In the same way, if the design professional's job is to deliver projects well and progressing the work is the mechanism for billing our clients, it is in our interest to become exceptionally good at moving projects ahead and to minimize distraction.

The following list highlights practical goals and ways we can begin to work differently when we look at our firms through a different lens:

- Learn how to better communicate with clients using graphics and 3D.
- Create tools and processes to guide the decision-making process.
- Understand what your consultants need to perform their work well and make sure they get it in a timely manner.
- More effectively organize geographically diverse teams.

- Devise uncomplicated ways to utilize software.
- Strategically model and draw less by understanding when and what to model and creating methods for dealing with repetitious information.
- Make deliverables and documents easier to produce, understand, and navigate by end users.
- Design and engineer projects concurrently. Too often, current practice, even with constructability reviews is a sequential process unable to prevent wasteful iterations. As much as possible, do work correctly the first time. Understand when *right* is not defined as what one thinks but what one knows.
- Raise the awareness and expectation for skillfully put-together buildings that well express the design intent. After all, is it acceptable to poorly deliver great design, or any design for that matter?

Common sense, *logical, reasonable*, and *pragmatic* are just some of the adjectives that can be used to describe approaches like these. We will examine many of them in this book and encourage you to rethink your firm, as the profession is ripe for change.

CHAPTER 2

Process Management Explained

PROCESS MANAGEMENT

Process management is the purposeful, organized effort to improve how we do something and to share that knowledge with others, integrating it into our daily practice. It presupposes that there are processes to be developed and improved. There are three primary methodologies in use today: (1) Lean thinking; (2) Six Sigma; and (3) Theory of Constraints (TOC).

Each of these has similarities with the others while maintaining a distinct focus. Our goal here is not to provide a detailed analysis of any of these but to summarize them briefly and then borrow from each for application to the practice of architecture and design. We will blur the lines between each methodology and color outside the lines. We also note that we have no interest in being Lean or Six Sigma certified, per se, so much as we just want to do better work and realize both a quantitative and qualitative benefit.

Lean	**Six Sigma**	**TOC**
Eliminate waste	***Decrease variation***	***Manage constraints***
– Identify value	– Define	– Identify the constraint
– Identify value stream	– Measure	– Exploit the constraint
– Flow	– Analyze	– Subordinate processes
– Pull	– Improve	– Elevate the constraint
– Perfection	– Control	– Repeat the process

Many of the systems and examples discussed in this book were developed well before learning of Lean or the other methodologies. Lean, Six Sigma, and the Theory of Constraints provided a framework to view what we had done and to understand why it worked well, a terminology to explain the ideas to others, and a conceptual basis from which to develop additional strategies and tactics.

LEAN

Lean, or Lean thinking, is perhaps the most recognizable term and was popularized by James P. Womack and Daniel T. Jones in their book *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. It was applied to the now-famous Toyota Production System with its relentless effort to eliminate waste, including development of innovative practices such as just-in-time (JIT) manufacturing and the Five Whys.

Based on Womack and Jones's research and that of others, manufacturers in the United States and Europe began to study and implement what the Japanese had done, learning and developing new processes themselves using these principles. The construction industry adopted Lean practices later and formalized it with the founding of the Lean Construction Institute (www.leanconstruction.org), a broad effort to increase the quality of work and raise productivity.

Lean is an approach that seeks to reduce or eliminate waste with a focus on helping the work to flow. It employs a five-step approach:

1. Identify value: Defined as what the client or customer considers important and is willing to pay for and includes the steps needed to accomplish the work correctly the first time.
2. Identify the value stream: All the activities involved in the creation of value.
3. Flow: Links the value-added activities together and optimizes them together.
4. Pull: Work that happens at the upstream request of a customer or client.
5. Perfection: The ongoing refinement of this effort.

Example in Architectural Documentation

When scheduling doors, architects typically key the head, jamb, and sill details into the door schedule. This can be time-consuming and entails a workflow like this:

Traditional Workflow

A. Model and draw.
B. For every door, identify the type of partition (e.g., drywall, masonry) and wall thickness it is installed in.
C. Draw the applicable head, jamb, and sill (HJ&S) details for each condition. Typical conditions may be predrawn and assembled on sheets in the template.
   a. Separate drawings are provided for each variation due to partition makeup and wall thickness, that is, the same size and type of door in a 3 5/8" or 6" metal stud partition warrant separate details.
D. Create drawings for specialty or atypical head, jamb, or sill details.
E. For each door, manually enter the appropriate HJ&S detail number into the door schedule.
F. Check for partitions that have been modified during the work, changing the door frame throat width.

G. Perform a quality control check of entire full door schedule prior to issuing final construction drawings.
H. During construction, monitor for any partition changes affecting the door frame throat width.
I. During construction, check the door frames submittal, repeating steps B and F.

During preparation of the door frame submittal, the subcontractor checks the floor plans to determine the appropriate door frame throat sizes (same as the architect does in Step B) – and they often find our mistakes. Knowing this will be done, we can simplify our efforts by providing the necessary guide information only and then carefully reviewing their submittal.

New Workflow

A.1 Predrawn details of *typical* door head, jamb, and sill conditions are inserted into the building information modeling (BIM) model or computer-aided design (CAD) file. They do not identify partition widths, or even the type of partition, except for concrete masonry units (CMUs). For most project types this will cover 85–95% of all doors. See Figure 2.1

B.1 Create drawings for specialty or atypical head, jamb, or sill details and key onto floor plans, reflected ceiling plans (RCPs), and section details only.

C.1 During construction, check the door frames submittal, reviewing carefully with the drawings.

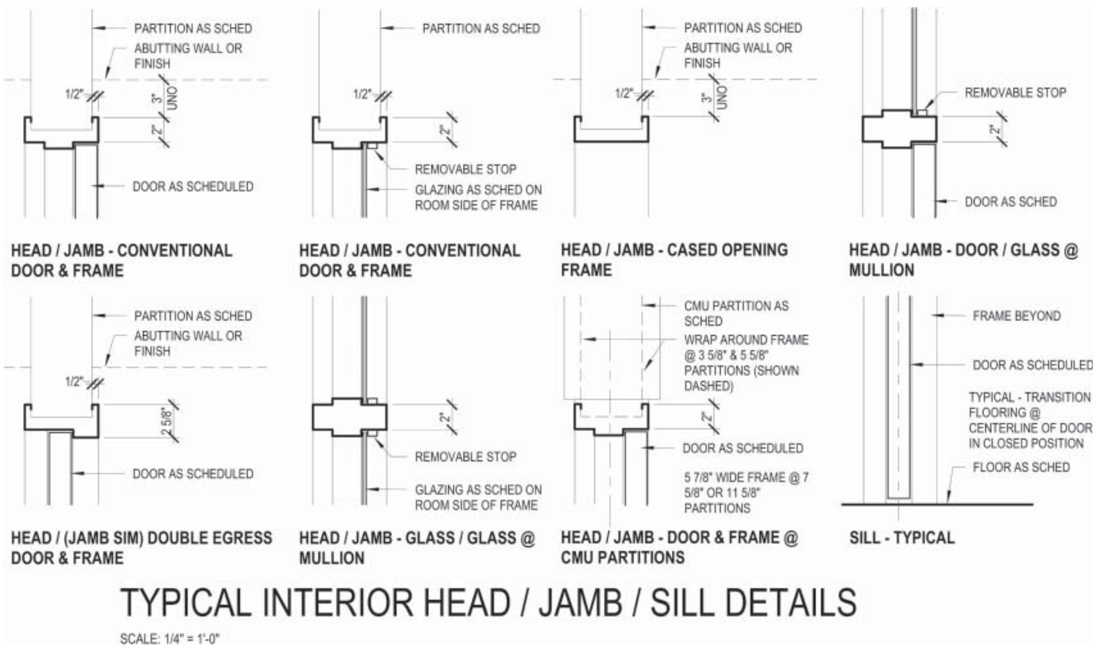

FIGURE 2.1 Typical HJ&S details.

Using this new workflow, steps B, C, E, F, and G of the traditional workflow are eliminated, a significant reduction in effort multiplied by each project in the office over time. The value for the client is that the doors are identified and priced by the contractor, with correct installation and functioning. They have little interest in how this is accomplished. We are not advocating a particular way of documenting but illustrating how a common approach can be condensed to become simpler, with no loss of accuracy or insufficiency of information.

Further development may result in BIM or similar software recognizing the type and thickness of the partition a door is in, automatically tracking the relationship, and eliminating the need for architects to check or to transcribe any information. The goal remains to provide the contractor with accurate data for bidding and, later, the development of submittals.

CONCEPTS, SYSTEMS, AND METHODS

Within Lean itself, several methodologies have been identified by observing how Japanese automotive firms, especially Toyota, are organized to perform work more effectively. Six Sigma and the Theory of Constraints are similar.

Kaizen = continuous improvement; Kaizen events are an intensive effort to examine and improve a process in a limited time period
5S = a workplace organization methodology
Kanban = a visual scheduling or signaling system
Value-stream mapping = identifying all the steps in a process that add value
Just-in-time = creating efficiency in inventory and workflow by having the needed material or components available only when needed

While this book does not use these terms and expressions broadly, we certainly do not discourage readers from further research or their use if they help with understanding the concepts and application better. Perceptive readers will find many applications to their work as design professionals. There are many excellent resources addressing them in detail, and a list of current publications and articles that address these is provided in the Appendix.

SIX SIGMA

Six Sigma was developed by Motorola in the 1980s as a means of reducing variation among processes and improving quality. The acronym DMAIC summarizes the five-step approach:

D: Define a process or processes
M: Measure the processes current performance
A: Analyze the performance
I: Improve the process if possible
C: Control implementation of the desired changes

Example in the Service Industry

We would think it odd if a banking system allowed the use of different forms at their branch locations for making a loan application. In this case, each loan officer might have their own preferred version that varies in length and in the amount and types of information requested. The review-and-approval process becomes unnecessarily cumbersome, and a qualitative assessment of the applicant is more difficult. Instead we expect the bank leadership to develop a common form with limited variation that is available on their website. Many other aspects of the loan process can now be automated, and evaluating individual loan applications is streamlined.

You may have noticed that we have not referenced or examined the five steps of DMAIC. Rather, just by understanding the benefit of reducing variation and increasing flow, observation and personal experience enable us to see the right thing to do here.

THEORY OF CONSTRAINTS

In 1984 Eliyahu Goldratt introduced the Theory of Constraints through publication of his fictional book *The Goal*. The theory postulates an approach that strives to optimize an entire system by the discovery and elimination (or mitigation) of constraints.

A constraint is something that prevents or hinders from achieving the goal of a system.

TOC also employs five steps:

1. Identify a constraint.
2. Exploit the constraint.
3. Subordinate processes.
4. Elevate the constraint.
5. Repeat the cycle.

TOC says that:

- The performance of a system is regulated by the major constraint that exists within it.
- If the constraint is removed, system performance is improved.
- As the system moves to higher performance, you come across another constraint.
- Continuing to remove constraints increases performance for the system.

Example in Architectural Practice

Constraints exist within every firm and project. One example is the role of the project architect (PA) within a firm. It can be difficult to find experienced technical architects with 10–15 years of experience who know how to put buildings together and can coordinate the broader team's effort.

For firms experiencing a shortage of available project architects, TOC could be applied in the following manner.

First, exploit the constraint. That is, how can we get more out of the PA? One means may be to get them a faster computer or laptop for mobile use; adjust their hours to avoid sitting in traffic or ask them to defer vacation. Be sure to exploit the constraint and not the person! Next, subordinate processes. Offload some of the PA's tasks that can be done by others; minimize their time spent doing administrative or similar types of busy work that less experienced people can do. Then elevate the issue. Hire additional project architects or those with the ability to take on minor technical tasks that allow the PA to focus on the bigger picture; accelerate the training of younger staff in this area. Once this issue is resolved or reasonably mitigated, keep repeating these steps. Look for the next constraint. It could be another staffing need, inadequate or unreliable technology, or office policies that stifle productivity. The office specification master may be out of date, requiring additional time be spent (wasted) on each separate project, with multiple teams repeatedly reviewing and updating the same sections. You can probably think of many more!

You may have noticed that technology is not mentioned in any of these process management methodologies or the examples given. That is because technology is best when viewed as a tool for doing better work and not as an end in itself.

An in-depth study of Lean in manufacturing will yield examples where both the addition of technology or its elimination is key to improving workflow and quality.

TRIZ

A lesser-known area of process management thinking that bears mention is that of studying how other types of businesses and industries work and resolve problems and making connections to your own. Genrich Altshuller (1926–1998) was an inventor and author in what was then the Soviet Union. He developed a methodology call TRIZ – the theory of inventive problem-solving – by looking at tens of thousands of patents to understand how innovation occurred. Altshuller found that (1) problems and solutions are repeated across industries and sciences; (2) patterns of technical evolution are also repeated across industries and sciences; and (3) the innovations used scientific effects outside the field in which they were developed (https://en.wikipedia.org/wiki/TRIZ).

Example from Manufacturing

Taiichi Ohno was an industrial engineer, known for his leading role in development of the Toyota Production System. Among his many innovations was the just-in-time manufacturing process where automotive parts and assemblies were brought to the assembly plant at coordinated intervals to be placed into automobiles on the assembly line as they were needed. This contrasted with other manufacturers practice of storing large quantities of parts nearby, which created logistical issues due to workplace congestion and the increased handling and sorting of parts. Moving parts around creates no value, placing them into the automobile does. Inspiration for JIT reportedly came from a visit Ohno made to the United States in the 1950s where he observed how depleted grocery store shelves were quickly restocked, corresponding with the rate that customers took items.

ILLUSTRATIONS FROM E-COMMERCE

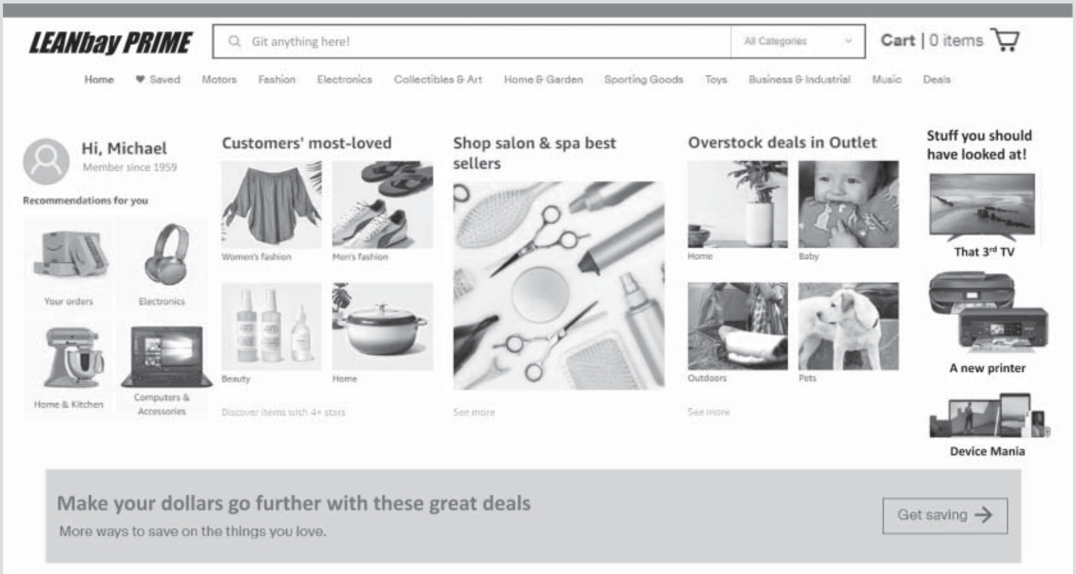

FIGURE 2.2 E-commerce website example.

E-commerce has transformed how we purchase goods and services, leaving many brick-and-mortar businesses trying to figure out how to compete (Figure 2.2). Why is this? Amazon and similarly successful e-tailers have removed most of the constraints in shopping by offering a greater variety of items with a depth of inventory, access to a global supply chain, search algorithms, and artificial intelligence that makes it easy to find what you want. This is coupled with one or two clicks to purchase and delivery to your front door, often within 24 hours.

In Figure 2.3, every aspect of the shopping experience is streamlined to quickly find the item you want with simultaneous notification of available stock or estimated availability, suggested alternatives, and selection from multiple shipping options. All of this is can be done from anywhere, at any time, and it works seamlessly, regardless of the device you use. The time spent traveling and manually looking through available inventory is eliminated.

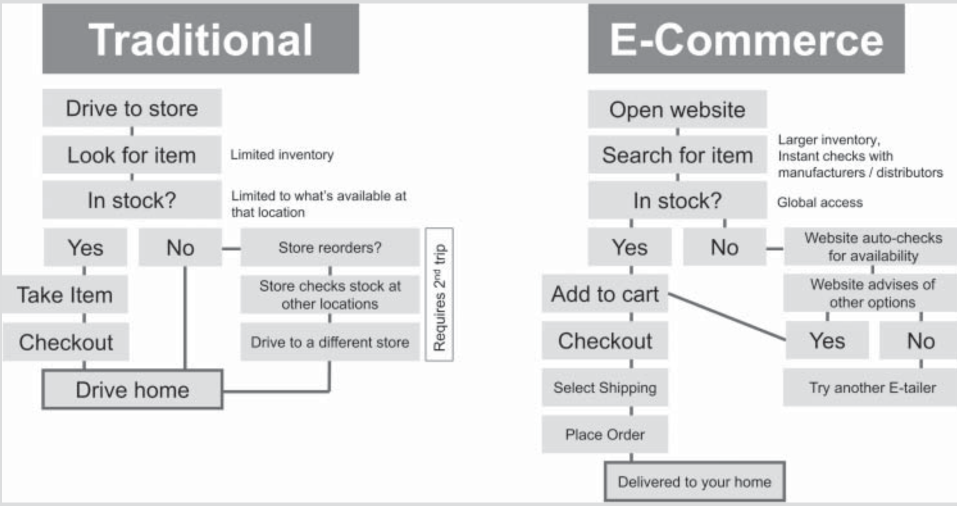

FIGURE 2.3 E-commerce comparison with traditional shopping.

SUMMARY

There is much for design professionals to learn from each of these methodologies and their tenets can be applied to every firm and team practice to bring about systematic improvement in project development and delivery.

You might say that there are as many ways of applying Lean ideas as there are types of mustard. The course you take and the ones you implement will be based on your taste and preference, but sometimes changing it up brings a new sensation to your sandwich! Whether your firm employs any or all of these is for you to determine, but be aware that Lean is not just one thing. They are a way of looking at processes and problems to bring about improvement and a means to an end that we can employ to work smarter and achieve our business purposes.

REFERENCES

Womack, J. P., and D. T. Jones. (1996). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. Simon & Schuster.

Goldratt, E. M., and J. Cox. (1984). *The Goal*. North River Press, Inc.

CHAPTER 3

The Design Firm's Problem

You may find yourself reading the title of this chapter and thinking, *What do they mean by the design firm's problem?* The world experiences myriad difficulties every day. Disease, famine, crime, and damaging storms are different kinds of problems we are made aware of by the media or perhaps experienced first hand. Some may be difficult and others impossible to solve, but by understanding the nature of the issue and its causation we are in a better position to effect a solution. Famine may have its basis in climate changes in one region, but in another it may be due to political conflict. Donating to a food bank or serving as a volunteer may provide temporary relief, but identifying the underlying issues and working to resolve those can lead to a long-term solution. The design firm's problem of course is not like any of these, but if we recognize the kind of problem that project delivery is we are in a better position to solve it.

Understanding the kind of problem one has is key to solving it well.

The application of Lean thinking since the late 1990s has significantly impacted how buildings are constructed. Jobsites are better organized, and trades work together more effectively. Surprisingly, design-side project delivery methodologies have been slow to change and have remained much the same with a few exceptions. Pull planning is increasingly used by architects and engineers to plan their work, and some projects are being developed using integrated project delivery (IPD) and IPD-ish type approaches. Others firms apply Lean Six Sigma techniques to client processes to fine-tune floor plan layouts for efficient use. These successes are overshadowed by the majority of the profession's reliance on methodologies dating from the 1960s. Why is that? Part of the answer is that contractors and design professionals deal with very different types of problems and issues.

THE KIND OF PROBLEM

Jane Jacobs, in her seminal 1961 book *The Death and Life of Great American Cities*, wrote about cities and the kind of problem they are. She described in detail the conventional urban planning approaches and the dismal results arising from the thinking of that day. Not understanding the type of problem a city was, led, in her observation, to a flawed analysis and the development of ineffective solutions. History has proven her right.

Jacobs referenced Dr. Warren Weaver's work, where he identified three capabilities that had developed in scientific thought:

1. How to deal with problems of *simplicity*: those consisting of just two variables, such as understanding the basics of how light is reflected using a mirror.
2. How to deal with problems of *disorganized complexity*: ones where multiple variables interact in a random fashion, such as how actuarial science can reasonably predict within a given area and population how many people will develop appendicitis each year or how 1000 billiard balls might behave when struck by the white ball on a (very large) pool table – solved through use of mathematics and physics.
3. How to deal with problems of *organized complexity*: those involving "dealing simultaneously with a sizable number of factors which are interrelated into an organic whole" (Jacobs 1961, p. 432). The human body exhibits dozens of complex processes that are interdependent with each other. We do not diagnose a person's illness using statistics but instead employ observation, testing, and analysis to determine what the symptoms are indicating.

The prevailing approach in the early 1960s for viewing the problems of large cities examined population density, tuberculosis rates, and crime, among other factors. The resulting solutions included large scale urban renewal projects that demolished and remade large areas of a city, redesigning and organizing them along a hierarchy of uses and with lower densities of people. Enduring ridicule by the experts of the day, Jacobs suggested cities were an *organized complexity*, developing over time with a multilayered array of relationships and reflecting an intelligent, people-driven, social, and business interconnectedness. Only by understanding the underlying links between each of these could one devise effective solutions for dealing with the problems of urban decay and the resulting blight and crime. She suggested the approach to understanding and making cities better should be more like that taken with the life sciences and biology.

BUILDINGS ARE AN ORGANIZED COMPLEXITY

A building, along with building information model (BIM) and subsequent documents that describe it, is an organized complexity. It is composed of multiple overlapping components and building systems that are logically arranged and coordinated with each other. Systems such as structural steel framing, concrete slabs, partitions, plumbing, heating, ventilating, and air-conditioning (HVAC), interior finish, exterior skin systems, elevators, and many others must be integrated together and documented. The effort to do this can be referred to as *contexture*.

Contexture: the act, process, or manner of weaving parts into a whole (www.merriam-webster.com)

In many ways, the process of developing both the design solution along with the model and documents that describe it is like setting up dominoes to topple along a particular pattern. Making changes late in the process is akin to moving one or more dominoes. To topple correctly, others may have to be reset as well. Looking at a building as an organized complexity of systems will affect the way we work:

- Where differing building systems meet, the connections between them are a primary area of focus.
- Moving or changing a single element may have ramifications on others as the building is an interconnected whole.
- When there are issues, much like diagnosing an illness, analysis may be in order to understand why a mistake or omission occurred.
- Methodologies can be developed to rapidly document individual building systems such as life safety, partitions, doors, and exterior skins with special attention to atypical conditions.
- A systems approach can be used to address building coordination and the qualitative reviews of documents.
- The contextual organization of building components can by itself reveal mistakes.

The application of Lean to construction works well because contractors deal with significant logistical issues including estimating, the procurement and staging of materials, managing and coordinating trades, and the scheduling of manpower. Those are not the types of issues facing design professionals for many aspects of their work. It is important to have a clear understanding of the nature of our work, which has implications on how Lean thinking can be applied. This can be seen in the comparison of construction and design (Figures 3.1–3.2).

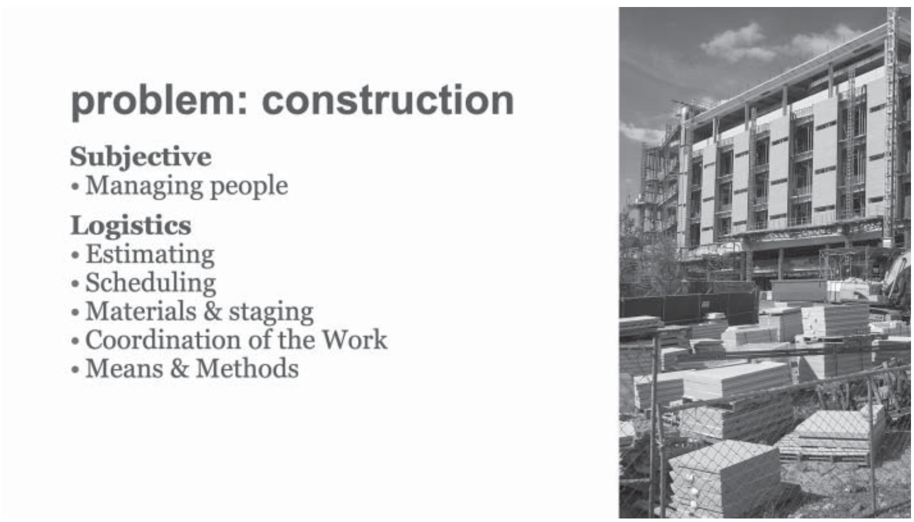

FIGURE 3.1 The problem of construction.

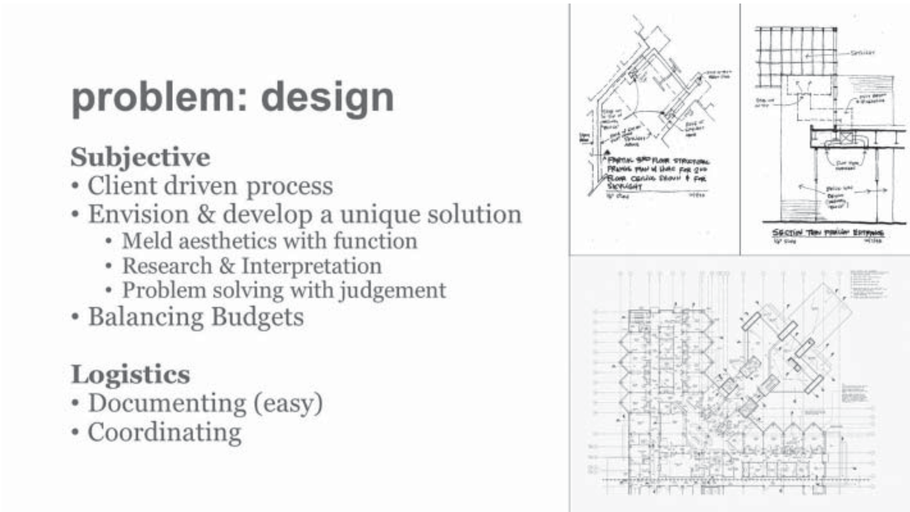

FIGURE 3.2 The problem of design.

Designers deal with very different issues than contractors. A central task of the design phases is to envision and develop a viable solution to an often changing set of parameters. This requires managing many subjective elements and communicating often complex ideas to clients in order to gain consensus. The process of design requires a degree of liberty to allow for the free flow of ideas over multiple iterations as we first imagine and then bring about order. In addition to addressing the subjective elements of design and client preferences, solving the *puzzle* of the project's design entails dealing with a sizable number of parameters – building systems, code requirements (often overlapping and conflicting) – which must be weighted, weighed, and ultimately combined together into a workable solution.

- Problems involving subjective matters such as opinion, taste, and preference or with layers of decision-makers require a more nuanced approach coupled with clear communication. It cannot be overestimated the importance of understanding how your client works and makes decisions.
- Problems dealing with issues of logistics, such as documenting or coordinating building systems or consultants, for example, are better solved by following processes and methodologies.

So by first understanding the nature of the task – is it primarily subjective or objective? – and then tailoring an approach to each, the tenets of Lean thinking and similar process management approaches can be better applied to design work.

DIVING DEEPER

Some consider project delivery to be a contractual undertaking, primarily a financial effort where money and its measurement determines how we work and what we produce. While contracts and fees are a central factor, they comprise only a part of the picture, and we can further distill the design professional's work into three basic components:

- Defining the Work
- Design or Solving the Puzzle of the project
- Delivering the Solution – documenting and construction

Many designers plunge headlong into the logistical aspects of a project or look for solutions based on aesthetics when what is needed is to first clearly identify the scope of work. We must understand the client's goals including the budgets and schedule, and our assistance is usually needed to determine these. We also want to understand the client's decision-making processes.

Ultimately we are creating a digital description of the work via a BIM model that is reasonably coordinated and constructible. If the project *puzzle* is adequately resolved, this documentation effort is the easier task and readily lends itself to Lean process management approaches. There is a more in-depth discussion of these three areas in Part II.

SUMMARY

If we fail to recognize that a building is an organized complexity, we may approach design and delivery more haphazardly, seeing the project as an assemblage of disparate elements and unconnected tasks. By understanding the design firm's problem, project issues may be solved in myriad ways. The idea is to not be reactionary but to put in place well-thought-out practices and methodologies. By first understanding the nature of the work – that is, determining whether it is primarily subjective or objective – and then adjusting your approach, the tenets of Lean thinking and similar process management systems can be better applied.

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Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Random House.

CHAPTER 4

Lean Architecture

The use of Lean, Six Sigma, and Theory of Constraints has enabled dramatic improvements across multiple industries such that training programs and certifications exist for this expertise. What Japanese manufacturers originally developed to improve their products has been recognized for its genius and the core principles distilled for others to learn and apply.

We do not believe it is as easily adaptable to the design profession but do believe that process management can and should be employed due to simple economics and the increasing complexities of doing business. We call this approach *Lean Architecture* and define it as:

> **Lean Architecture is the ongoing process of rethinking and improving architectural methodology. It is the pursuit of better work by applying Lean principles to every aspect of practice. It is about smarter information flow and understanding how we perceive and process information in order to be better communicators amongst ourselves and to the users of our services. It is identifying what adds value and reducing and eliminating what does not.**

The Lean definition for Value can be adapted for the design profession as:

- Everything our client is paying for and cares about
- Effort that progresses the project
- Work performed correctly the first time

Architecture has always been a client-focused business, and at the end of a project we are judged on their experience with us along the way as well as the final product. Clients engage design professionals for many reasons, and the buildings and improvements are a means for furthering their mission or business goals. They are generally unwilling to pay for errors or omissions in the documents or to have the same work done twice (even when they are the reason)! With the exceptions of governmental and quasi-governmental organizations where a prescribed process must be adhered to, most clients have little interest in how we do our work. Understanding value from their perspective and optimizing our firm and teams to effectively deliver this value increase the opportunity for profit and help our firms remain viable for the future. It is also an enjoyable endeavor.

Lean Architecture does not consist of a singular method of application, a set of rules to be followed or a step-by-step guidebook for success and change. It is a direction to travel and a mind-set to learn.

3 GOALS

Borrowing from Lean, Six Sigma, and the Theory of Constraints, we can establish three goals with wide application and apply them to architectural practice:

1. Structure work to flow
2. Reduce variation
3. Identify and eliminate (or mitigate) obstacles to progressing the Work

Structure Work to Flow

It is beneficial to reduce what is often referred to as project *churn*, or the back-and-forth fluctuations during the design phases and later as we document a well-thought-out solution. There is a measure of project churn and inefficiency, so to speak, that is expected and to be embraced as we develop and test ideas and resolve project issues. Creativity is rightfully difficult to manage and choreograph. The goal is to not cause ourselves harm by poorly managing during this effort or allowing unresolved project issues to build up. Depending upon the reasons, repetition of effort can be an indicator of inefficient processes or poor management and can result in wasted time and fee.

- Concurrently design, engineer and make your buildings constructible. Where possible, major design and decision making coupled with simultaneous costing and value engineering should be completed by the end of Design Development.
- Plan projects and avoid the tendency to work as hard as you can without first knowing what you intend to accomplish. Work to reduce or eliminate barriers that prevent staff and consultants from doing the work correctly the first time.
- Look for ways to eliminate activities and processes that absorb resources but do not create value. This would include working out of sequence, the delay of information that causes rework or inefficiency, going too far down the wrong paths.
- Consider the other disciplines or consultants as partners, ensuring they have the right information at the right time to do their work.
- Check as you go. Team members should be responsible for reviewing their own work as they do it, with the authority to slow up work if they see problems arise.

Reduce Variation

Design firms often employ a variety of methods to model and document projects. This is especially true at large geographically dispersed firms. Practices vary by studio, market sector, office, and personal preference. Over time, as team members work across multiple projects and with other offices, they may have to learn several different ways of doing the same thing, which provides no real benefit. Most modeling and project documentation processes can be the same or at least similar and consistent. Staff, when trained and familiar with a specific way of working, can shift more easily from one project or team to another and with minimal effort be productive. They are also less likely to make mistakes when tasks and workflows are the same or similar, and the reduction of variation serves to help work to flow more easily across the firm.

Note that we have not said to eliminate variation. Differing projects, building types, and clientele call for flexibility in the ways we manage and document.

- During design, while allowing for iterative development, ensure that relevant project information is obtained, and big picture goals are accomplished.
- Develop a documentation approach that streamlines how information is conveyed and that is easily taught to staff and new employees.

Identify and Eliminate (or Mitigate) Obstacles to Progressing the Work

Barriers exist in every office and project, and it takes a concerted effort to minimize their effects or avoid them altogether. Look ahead to identify and resolve potential problems and roadblocks before they become constraints. It is always more productive to prevent problems from happening as opposed to expending effort later to detect and correct.

- Every project has underlying constraints that we cannot change, such as the type of delivery system for construction or the client's decision-making processes. Anticipating these early and adjusting our workflow tactics can help lessen any negative effects.
- Develop methods of working that identify and resolve errors and mistakes as the work is performed rather than relying on a checker later. If there are five errors in a set of drawings with 100 items to check, all 100 items must be reviewed to find the five. Most quality assurance programs operate using this approach.
- Ensure a timely flow of information with consulting engineers by choreographing the work, enabling them to work more effectively.

The three goals provide a general direction to head toward – an objective to strive for. We are not aware of any project that has not had interruptions to the project flow or constraints that did not hinder. We are aware, however, of project teams that have put these principles into practice, continue to improve with each subsequent project, and are having fewer repeat issues as they learn to manage and produce better.

PRODUCTIVITY AND QUALITY

Two of the most overused words in business today are productivity and quality. Many design firms speak of them, but relatively few understand what they are or know how to build them into their practices and achieve them consistently.

Productivity

Checking the word *productive* in a thesaurus will yield synonyms like *creative, prolific, industrious, fruitful,* and *beneficial*. We can look at the crops on a farm, see the transformation from bare soil to an abundant harvest, and say that the field has been productive. Productivity carries with it the connotation of an amplified output or throughput.

Does being productive equate to more effort? Does the pressure to be more productive have the opposite effect and decrease over time due to employee burnout and churn? Increasing productivity must be more than simply being efficient or doing the wrong thing faster. It must contribute to the better accomplishing of a task or goal and assist in the prevention of problems. Too often, it is a term used only in relation to one's billing to a project number, with the expectation to reach a target on a weekly basis, and with little regard to being effectual. With few exceptions, no two projects are identical, and effectiveness is difficult to quantify when everyone is doing different tasks. Contrast this to a factory worker in the shipping department who, every day, is evaluated on the number of boxes packed and shipped during a shift.

Three facets of productivity that get to the heart of the matter:

- "The Avoidance of Unnecessary Work" – Doug Stoker
- "More Work in Less Time" – Barry Isakson, AIA
- "Better Work with Less Effort" – Barry Isakson, AIA

Quality

There is both an objective and subjective aspect to quality, and it can mean different things to different people. As described in the American Institute of Architects (AIA) *Handbook of Professional Practice* chapter on construction drawings:

> Quality is generally perceived and measured by comparison to a like product, standard, or service. We evaluate the quality of on automobile based on its reliability but can also appraise it by the type of materials used along with their fit and finish. Yet another comparison can be of the vehicle's performance and road handling characteristics.
>
> Similarly, quality in architectural service is reflected in design by the use of proportion, form, spatial character, and the choice of materials. It is also displayed in the technical appropriateness of building systems that "meet and greet" versus "smash and clash". It is found in the sufficiency of the architect's documents and the clients experience with us along the way. (P. 684)

Clients place value on differing aspects of our work. One may favor design while another prioritizes the speed of project delivery or depth of knowledge and experience with a project type. Some savor their own participation in the design process itself; most seem interested in getting the lowest fee.

THE USER EXPERIENCE

The way Steve Jobs led Apple was interesting in that he built a company with a reputation and culture for providing superb products along with a remarkable customer experience. Not only does Apple take great care in product development, design, manufacturing, and supply chain management, but they also equally obsess over packaging and initial presentation. Unboxing an iPhone is a delightful event itself. Removing the textured white, substantial cardboard box top that is snug but not too snug reveals a stunning device, conspicuously positioned – and not hidden within.

Have you considered what your client's experience is when working with you? The way that you listen and how you communicate ideas speak volumes about client service. When perusing your design documents, is the information that is most important to them readily found and easily understood? Is it thoughtfully laid out and organized?

How Is Quality Achieved?

It is common when illustrating a firm's approach to quality assurance to show hierarchal organization charts (Figure 4.1) with the principal-in-charge placed above the designer; the project manager and project architect in turn are shown over the job captains, staff, and consultants. A space may be reserved for a senior technical architect in the role of QA review.

Often, the senior technical architect is obligated elsewhere, and the principal-in-charge may not be engaged or knows little of the typical problems plaguing projects. What the org chart really illustrates is overall team organization and lines of responsibility, but it demonstrates nothing in the way of ensuring quality. In fact, the org charts may reveal a lack of understanding because quality is not inspected or mandated into a project but rather it is built in one step at a time.

What is missing is an understanding of the significant differences between *hierarchy of position* and *interdependent roles*. The best designer may be the worst manager or have little practical knowledge of constructability or project delivery. Likewise, good technical architects may fail to appreciate or know how to execute good design. However, all must be sympathetic to each other. Teams that deliver successful projects must be more than a collection of disparate individuals, and quality delivery is dependent on the effectual execution of roles by each person. And as is in most grand endeavors, great teams are developed over time.

PROJECT ROLES

Quality in architecture involves collaboration, and each team member has a specific role to fill. It may vary from project to project, but the employee must realize that they are integral, regardless of how mundane or unglamorous it seems at the time. Documenting the vertical circulation (stairs and elevators) may not seem exciting but is nonetheless a vital task to ensure that building occupants can egress safely and efficiently. To do this effectively, you must understand the building codes and satisfy the requirements in the design and coordinate the vertical penetrations with the other affected disciplines.

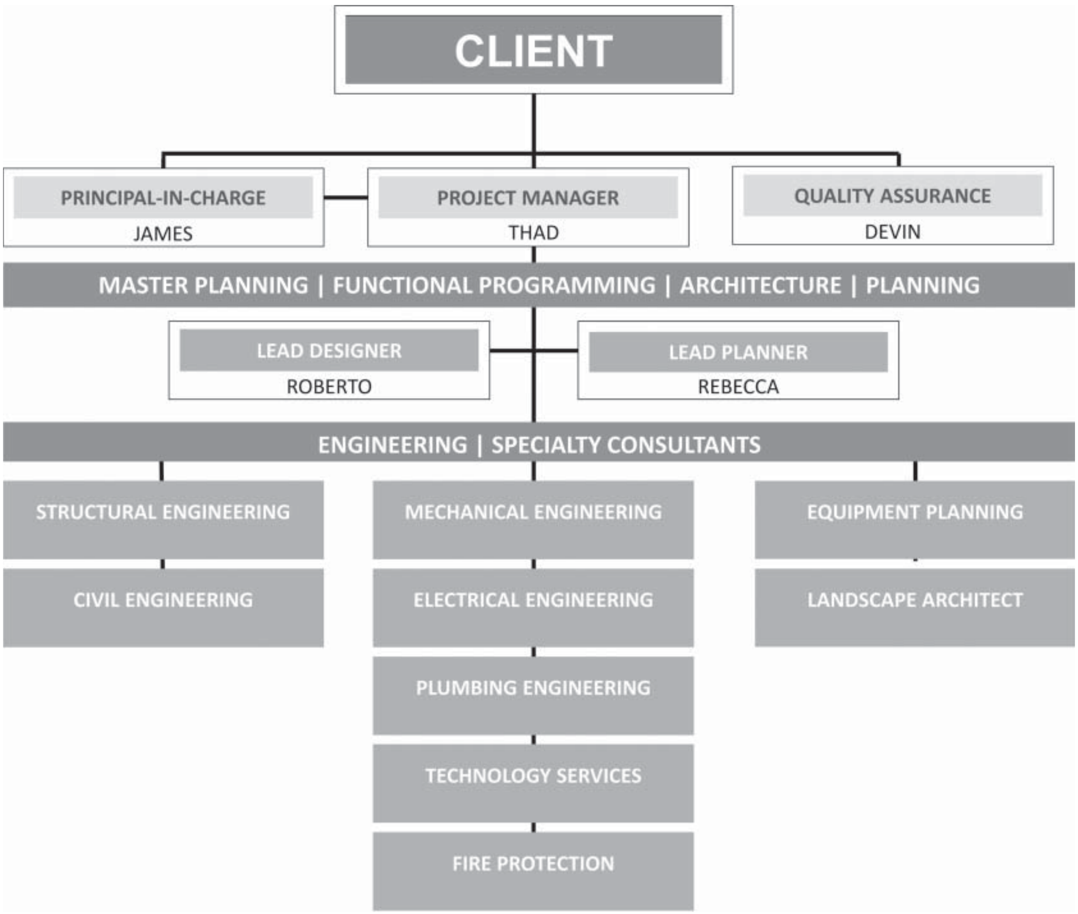

FIGURE 4.1 Traditional organization chart.

Quality Service

Our clients have a choice in their professional service provider, which is why they go to great lengths in selecting who to work with on a project. The request for qualifications (RFQ) and request for proposal (RFP) processes are in place to vet the firms. One attribute they look for is quality of service, which is much more than delivering the project on time and within budget. It also includes building a good relationship with your client such that they can trust you to make good decisions on their behalf, which some refer to as a *trusted advisor* role. A reputation for quality service is earned and is an asset in the marketplace. The opposite is also true; if you can deliver projects with lower fees than the competition but are known for poor service, you are at a disadvantage. Firms that do the absolute minimum per their contract are considered a commodity in the marketplace. To develop a more robust, long-term relationship, consider the time and effort you are willing to invest with your clients to earn their trust. It is much easier to have difficult conversations with a client if you are trusted.

Some of the qualitative and subjective aspects that clients place great value on are firm reputation, pleasing design, depth of knowledge and expertise, ability to execute, responsive architectural and engineering (AE) teams, and active listening.

Quality Delivery

The soft skills required for great quality service are nuanced, whereas the hard skills of quality project delivery are more measurable. Quantifiable aspects include issuing design documents on time and within budget that are sufficient for bidding and construction.

Quality delivery is the outcome of many small things done right. It is not easily inspected in but should be designed into the ways we work to be the inevitable result. Every aspect of our work – including contracts, planning and aesthetic design, BIM execution, technical systems, and specifications – must all be seen from a synergistic, interdependent viewpoint. What affects one affects all.

Quality control then is the job of proper execution as opposed to reliance on finding errors later through inspection or project reviews. Quality is more than the product produced; it is the approach, the direction, and the attitude that imbues itself into every aspect of what we do. It is also hard work requiring diligence and perseverance. Chapter 7 covers quality and process in greater detail.

RESOLVE

There is a place within our profession for those who are fierce in their determination and unwillingness to compromise and insist that work must be done well. They can seem intimidating to work with at times, but in reality they are the go-to leaders who tend to get the best results. Of course not all who desire to do great work are intimidating, they just share a common resolve to do it right.

A few observations:

- Individuals who will accept nothing less than a high standard of work tend to get it – and get it consistently
- Knowing what good work is provides a benchmark to be reached.
- The practice of having projects peer reviewed inculcates a sense of accountability within a team and the expectation of good work. Many architects are passionate about what they do and knowing that it will be subject to another's appraisal can be a great motivator.

CHALLENGES

The various changes near the end of design can create a difficult situation for the design team, where it becomes nearly impossible to maintain quality and ensure a coordinated set of documents. Producing construction documents is analogous to performing surgery, where a prescribed process must be reasonably followed to ensure good results. Merely adding staff or physicians does not necessarily allow you to hurry up surgery and reduce the time required. Rushing can lead to mistakes.

Project delays due to financing difficulties or client decision-making may make it necessary to reallocate design team staff to other projects with no guarantee that the original team can be placed back when the project restarts. This can put the project out of sequence from an architectural development standpoint and cause either a reevaluation of many decisions made prior to the pause or a situation where we must pick it up again where it was left off and move everything forward based on the previous teams work. Whenever there is an organizational change to the team, project history is lost, and time must be allocated to get new team members up to speed. We must advise our clients if this occurs, as there may be expectations for teams to restart quickly and keep to the original schedule. There will be times where, if not allowed to readdress scope or changes, the team has no choice but to move ahead with prior decisions, whether correct or not. This can lead to out-of-process mistakes and significant project issues.

SUMMARY

Engendering productivity and quality into our processes and products of service requires knowledge of what it means to work better and how to communicate well with clients, consultants, contractors, and code officials. We must also understand how our work products are used. To bring about improvements, we must:

- Recognize that quality is contingent and builds on work previously done.
- Try to prevent mistakes from happening versus discovering and fixing afterward.
- Design methods of working that are simpler for staff to do and that visually reveal mistakes as the work is done.
- Uncover the interdependencies between tasks and choreograph them.
- Understand the decisions and information your consultants need to do their work, when they need it – and see that they get it.
- Produce work products that are visually uncluttered, intuitive to navigate, and easy to understand.

In our experience, quality in project delivery is difficult to precisely define or measure, but we seem to know it when we see it. With pressure only increasing to meet shrinking schedules and the firm's financial goals, it is still worthwhile and a lot of fun to pursue excellence in every aspect of our work!

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CHAPTER 5

Learning from Detroit: Influences from Lean Manufacturing

WESTERN MANUFACTURING COMPARED WITH JAPANESE LEAN MANUFACTURING

In Chapter 2 we discussed the primary schools of thought for process management and only briefly addressed the theory of inventive problem-solving (TRIZ), which postulates that much can be learned by observing innovation and practices from fields other than your own. We will do that now by looking at manufacturing and the industry-wide repercussions from the pioneering efforts of the Japanese, using what is now called Lean, to see what architects and engineers might learn.

References are drawn from Dertouzos et al.'s *Made in America, Regaining the Productive Edge* (1989), which chronicles an in-depth study by the Massachusetts Institute of Technology in the 1980s on manufacturing in the United States, Western Europe, and Japan. The commission examined the production of semiconductors, computers and copiers, commercial aircraft, consumer electronics, steel, textiles, automobiles, and machine tools, along with the associated education and training.

By the 1970s and 1980s the Japanese had developed a reputation for building small cars that were reliable, fuel-efficient, and fun to drive. They had begun to win market share in the United States, especially after the oil embargo of the early 1970s, when gasoline prices soared to all-time highs and customers were increasingly looking to purchase smaller vehicles that got better gas mileage.

The Big Three American automakers from Detroit – General Motors, Ford, and Chrysler – made repeated efforts to stem the loss of market share and improve the quality of their work. General Motors boasted they would outflank the Japanese with new fuel-efficient vehicles of their own. This effort culminated with development of the X-body series of cars, among them the Chevrolet Cavalier and Buick Skylark. Released in 1980, the X-body cars were famously dismal, with failures in both quality and reliability.

So what were the Japanese doing differently? Why was it that well-resourced manufacturers from the United States – the world's largest economy – could not produce equal or better products? The answer it turns out did not lie with technology, willpower, or workers' abilities. Instead, the Japanese

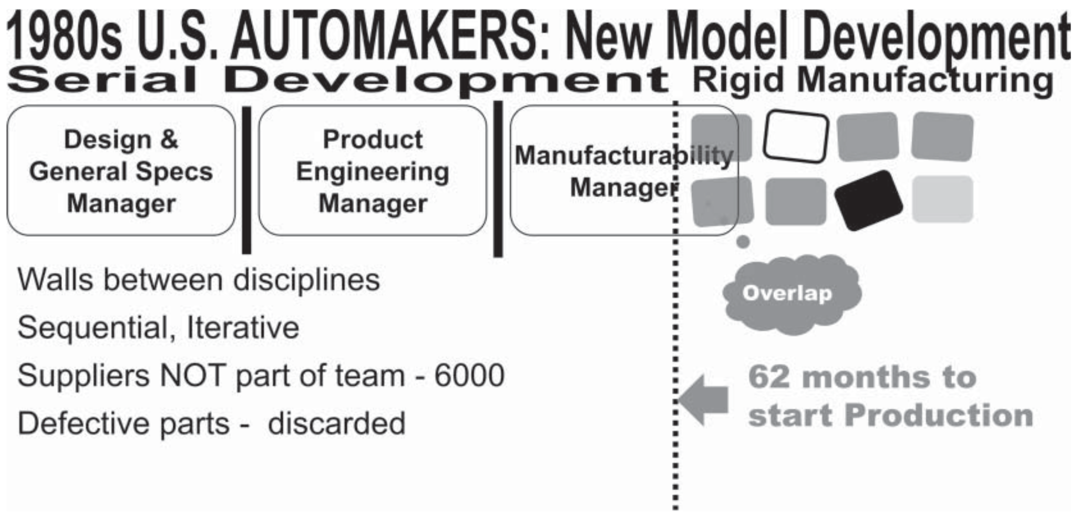

FIGURE 5.1 1980s US automakers.

had an entirely different approach to automobile development and manufacturing. American manufacturers utilized a serial development process that included three teams: design, engineering, and manufacturability (Figure 5.1). Each had a manager, and the teams worked apart from one another. The design team developed the automobile's aesthetic concept and general specifications. At a certain point, the design was handed off to engineering. This group then worked out the specifics of how the automobile would be built, developing detailed requirements for all components and systems. However, a significant amount of redesign was often necessary as what was conceived could not be realized as originally thought. Once the engineering team completed its work, the design was passed off to a manufacturability team whose task was to figure out how to build the car, including needed plant layout and equipment changes. They also found that many aspects of what design and engineering had approved could not be readily fabricated or assembled with the result that additional redesign and reengineering was needed.

The entire process was sequential and iterative, and it took American manufacturers over 5 years to bring a new car to market. This was in marked contrast to the Japanese who were able to develop a new model automobile in 19 fewer months – or just over 3 ½ years. One benefit this afforded the Japanese was the ability to respond quickly to new design trends and changes in the marketplace.

Japanese development teams were organized under a single "heavyweight" manager who presided over teams of designers, engineers, and manufacturability specialists (Figure 5.2). Rather than progressing work that might have to be undone later, they worked together from the onset to simultaneously design and engineer an automobile that could be readily built.

Another difference was that American manufacturers tended to have adversarial relationships with their suppliers (think consultants) and work was awarded based on the lowest cost. The Japanese culture placed great value on working together and long-standing relationships formed between different companies. It was common for the larger automakers to work closely with them to improve

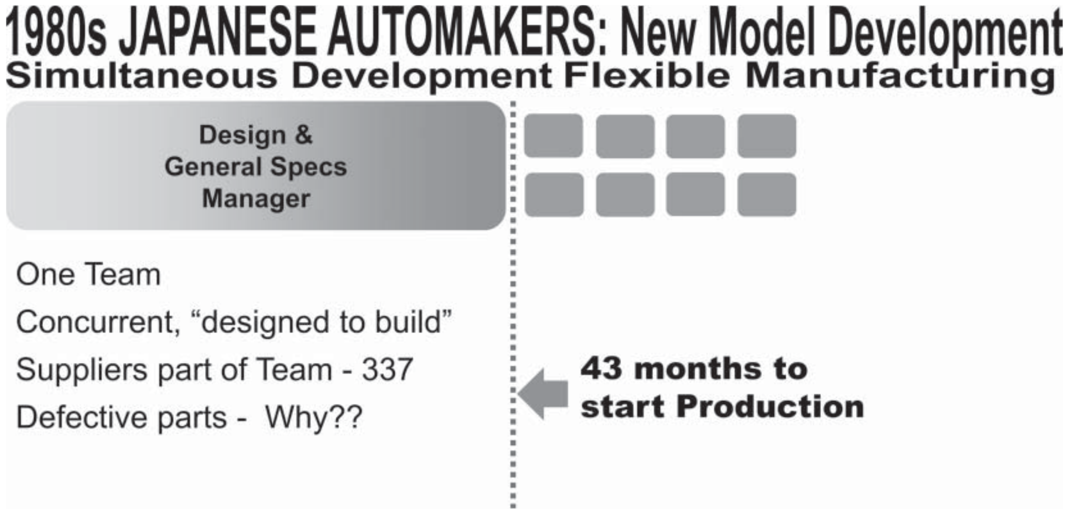

FIGURE 5.2 1980s Japanese automakers.

quality and efficiency, as opposed to the United States where quality was based around an acceptable percentage of defective parts. When problems were discovered on the assembly line, Japanese automakers investigated to find root causes and worked backward to remedy the problem. American and Western European automakers discarded defective parts and made every effort to keep the assembly line moving.

Manufacturers in the United States and Western Europe had well-established methodologies that relied on long production runs of the same or nearly identical parts. The Japanese, by contrast, were driven by a smaller, more fractured market that required they produce a larger variety of models in limited quantities. This drove them to develop flexibility in manufacturing with the capability to quickly transition from making one type of part or system to another.

The Japanese made both an art and science of manufacturing and, by the time of MIT''s publication, were being recognized as best in class. They understood how to design parts and systems for manufacturing and assembly that used fewer parts and were easier to put together. Management was viewed as more than cost control, instead focusing on how to perform work more quickly and with high-quality results. The outcome of this was significantly less time required and correspondingly lower cost to bring a new product to market that exhibited excellent performance and reliability from the onset.

The Japanese methodology sounds a lot like integrated project delivery (IPD) or the design–build process. The reality is that architectural firms are likely to encounter a variety of construction delivery methodologies as well as deal with many projects of different sizes and complexity. It makes sense to not be dependent upon the construction delivery method in order to do work well, and by understanding why some methods often yield better results than others we can seek to weave that into our current practices.

Learning about the Japanese management approaches and the design-for-manufacturing focus, it is easy to see direct application to many of the problems we encountered on design projects each day.

- Make it a priority to progress the building's design concurrently, simultaneously addressing issues of functional planning, aesthetics, life safety, and constructability – while working to ensure it is within budget.
- Develop methods of rapidly producing drawings by developing workflows for specific building systems that help the team think through the system itself and then quickly document it, while also being adaptable for unique projects and clients.
- Foster long term relationships with engineering consultants and learn how to work better with each other. This means viewing them as more than a project cost to be managed and instead understanding what they need to do their work well. It is in the architect's interest to help them manage their fee by better structuring how we work together.
- Constructability – design buildings that are simpler to build by contactors. Deliberately limit building complexity where we can to specific, high-design features and the conditions where multiple elements meet; areas where the extra effort and money spent is needed and can be appreciated. Detailing is then simplified for much of the building allowing us to focus instead on the areas of design complexity and liability. Reducing building complexity also has a positive effect on project costs. Note that this requires an understanding of how to build as well as the general sequencing of construction activities.
- Empower strong Project Managers who can direct the project's progress with authority to oversee and arbitrate the building design, interiors, consultants, and production work. We acknowledge that this requires some humility, diplomacy and a clear understanding of the firm's priorities and the project's goals.

Backgrounder 5.1 Process Management Evolution in the US Manufacturing Industry

About the Author
George F. Buchanan spent 28 years as a manufacturing executive in a variety of industries including telecommunications, consumer products, and metals. In 1996, he formed the consulting firm GFB Associates. He consulted with a number of companies throughout North America for over 20 years. During his career, he was involved in various manufacturing systems implementations and Lean manufacturing projects. He is a graduate of Auburn University.

I entered industry after graduating from college in 1968 and retired in 2017. Little did I know that I would see manufacturing processes evolve as much as they did in that time period. My first job was with General Electric (GE) – one of the largest US manufacturers at the time. The plant consisted of over 3500 employees and several hundred thousand square feet of floor space.

Our plant manufactured primarily make-to-order communications equipment for railroads, power companies, and the US government. Even though mainframe computers were common at that time for sales and finance, inventory and production planning were still manually controlled via Kardex, and blueprints were used to determine material requirements by manually calculating needs. Work orders were manually created, and follow-up was done by walking through the plant daily to determine current status. Inventory replenishment was controlled by techniques such as Reorder Point (ROP) and Economic Order Quantity (EOQ). Both of these techniques were calculations based upon historical demand for an item (i.e., past usage determined future usage). Thus, materials on hand were not based upon actual requirements. I was fortunate enough to be part of a team that helped develop our first computerized inventory and planning systems.

The first major change in the evolution of process improvements started in 1964 when Black & Decker was the first company to implement a technique known as Material Requirements Planning (MRP), which was developed by Joseph Orlicky of IBM. This technique answered three questions: (1) What is required? (2) How many are required? and (3) When are they required? Such a simple premise that changed the thought process of supply and demand. This was the first time that materials required for production were planned for based upon actual demand rather than past demand. MRP used the bill of materials and routing of the product to determine when component material orders should be placed based upon lead times.

Based upon my experiences with GE, I was recruited to implement the first MRP system in the southern US by a major manufacturer of fluorescent lighting fixtures. This implementation used the same software as Black & Decker, and I was fortunate enough to work with Orlicky. Additionally, I was able to learn from Oliver Wight and George Plossl – two of the most renowned experts in production and inventory management. The relationships I developed with these three pioneers were transformational throughout my career.

What did we gain from implementing the MRP system in 1971? When I joined the company, our inventory turnover was twice per year. We were buying shiploads of standard-width, prepainted steel coils from Taiwan and Japan and maintaining excessive carrying costs. We had various slitters – machines used to cut master coils to multiple different widths – that required multiple setups. This caused excess and obsolete inventory to rise annually. Excess inventory ties up capital, and obsolete inventory has no use and must be scrapped. Upon completion of our implementation, we increased from 2 to 52 inventory turns per year.

In these early days of transformation to computerized manufacturing control systems, IBM was the main software provider. I was involved with implementations of their first four systems – Production Information and Control System (PICS), Initial Production Information and Control System (IPICS), Communication-Oriented Production Information and Control System (COPICS), and Manufacturing, Accounting, and Production Information and Control System (MAPICS). These systems started out as MRP and evolved to Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP). The theory of MRP did not take capacity or available capacity into consideration. It assumed that there was infinite capacity available, which was not the case. MRP II added the concept of the Master Production Schedule (MPS), which allowed longer-term planning for saleable products by product families typically based upon forecasts. Rough-Cut Capacity Planning (RCCP) was developed to determine capacity constraints based upon the MPS. Capacity Requirements Planning (CRP) evolved based upon work center capabilities and product routings to determine where constraints were so that production schedules could be modified. While MRP II included typical manufacturing functions, ERP included Computer-Integrated Manufacturing (CIM), business intelligence, human resources, e-commerce, and other business functions.

After working with a few companies implementing each of the aforementioned systems, I became plant manager at a multiplant company that was planning an implementation throughout the United States. We selected ASK ManMan as the system to implement. By this time in 1981, this was the top MRP II system being implemented. We went live with this system in five manufacturing plants simultaneously within 1 year of the kickoff meeting.

As a side note, this company's product was one of the first Lean concepts used in steel making. Up until our product was developed, the control of hot steel being poured into ingots or slabs was managed by a stopper rod used to control the flow of the hot metal. Stopper rods were inserted into the bottom of the furnace and ladle to stop the flow. There was significant hot metal that ended up on the floor due to the accuracy of a person trying the insert the stopper rod from the top of the furnace or ladle. Our product used a sliding gate mechanism to automatically control the flow of the molten metal through a two-piece refractory device which was located at the bottom of the furnace or ladle. This allowed for no hot metal being lost.

One of the most beneficial improvements gained was an increase in inventory turns from 26 to over 200. Imagine the result of approaching turning inventory daily: reduced warehouse requirements, improved logistics, freed-up cash for other needs, and so forth. As a supplier to the US steel industry during this time in the 1980s, a downside was the required closure of two plants due to improvements in our processes and the closure of several US steel mills.

In the early 1990s, I joined a cable and wire manufacturer to implement an ERP system in four plants in the United States and Mexico. This was my first experience in a process manufacturing operation, which includes rubber, food, chemicals, and others where formulas are required. In our case, copper wire had various jacket formulas based upon the end use of the wire product. Very few ERP systems could help manage such manufacturing companies. We selected and implemented a system that met the unique needs such as pricing based upon the current commodity market and managed length processing (i.e., if a multistrand cable is required, the planning system must disregard some inventories as splicing is not acceptable). Being an automotive supplier, we were also implementing many just-in-time (JIT) practices (Kanban) during and after our ERP implementation. Since we were continually challenged to reduce costs by the Big Three automakers, we had to streamline production operations through Lean techniques.

We started this process by giving all employees a copy of *The Goal* by Eli Goldratt, a fictional description of the Theory of Constraints (TOC). Before any process changes were made, everyone had to read and understand the methodology. In one plant, we produced spark plug wire assemblies using traditional groupings of wire stripping machines, terminal crimping, and boot assembly machines. Our primary constraint was wire stripping.

How did we redesign workflow? We converted these unique work centers into manufacturing cells that included one of each machine into a smaller footprint of floorspace and arranged in a horseshoe. We reduced material handling, cross-trained all employees in the cell to perform each function, and staggered breaks and lunches so that there was continuous production during each shift. We saw tremendous improvements in productivity due to reduced movement of materials and changeover compared with a standard assembly line. Additionally, our production lead times were reduced, and overall product quality rose.

From a purchasing perspective, the original idea was to seek the best pricing available from as many suppliers as possible. In the 1990s, a move was made to work with vendors as partners by offering the annual demand for a group of items to only one vendor rather than splitting among several vendors. In rubber products alone, we reduced from 13 to 2 suppliers while reducing costs by at least 10%. This was one thing that American manufacturing learned from companies like Toyota, which started its JIT in the mid-1950s.

After 28 years of working in roles ranging from production planner to director of manufacturing in telecommunications, consumer products, metals, and wire and cable, I decided to begin my own consulting practice to assist various manufacturers throughout the world in streamlining processes and improving systems. For 20 years, I worked with clients in various industries including wire and cable, commercial furniture, integrated and minimill steel processors, flat-rolled metals processors, metal extrusions, titanium processors, brass ingots, rebar, angle, and steel distributors. The one common practice with each of these manufacturers was the selection and implementation of ERP systems. By this time, ERP had evolved to include all facets of the operation from sales and operations planning, supply chain management, and financial management. Other additions were quality testing and material certifications, improvements in tracking product through processes by assignment of tag numbers at various stages in the process, logic to establish selling prices based upon attributes and characteristics of the product, and the ability to have customized solutions without customizing the software by developing user tables, and many others.

One of most beneficial process improvements in the steel industry was the concept of cycle scheduling – a technique used to schedule capital equipment for which there is significant setup time involved in switching from one type of product to another. In order to minimize overall downtime due to setup and maximize machine efficiency and utilization, it is necessary to run jobs together that require the same or similar setup. Melt shops are now scheduled by metallurgical grades so that a specific number of heats can be made and cycled through to minimize costly and sometimes lengthy changeovers. Hot mills for rolling bar and angles are also using this technique based upon size and diameter.

Another huge benefit of Lean techniques in the metals industry was the improvement in logistics. In many cases, a truck can carry one coil based upon load factors. When this is the case, there can be hundreds of truckloads per day to be shipped. Scheduling of trucks by time slot along with weight scale integration upon entry and exit of the mills has reduced congestion and improved flow.

To summarize, over the last 50 years the initial impact in the evolution of manufacturing was the development of MRP, which, at its core, attempts by its logic to drive inventory to zero by balancing supply and demand. It is one tool that has dramatically changed industry through expanding its footprint to other areas of business management. Paper and pencil were replaced by high-powered computing systems. Others may not agree that MRP led the way, but I think that it paved the way for Lean manufacturing.

Things I observed to have improved over this time include (a) a dramatic decrease in required square footage for manufacturing due to layouts, inventories, and improved distribution; (b) increase in inventory turns from a few times to 300 times a year; (c) fewer employees being required to produce more product due to streamlining processes; (d) an increase in quality levels due to ISO9000 and other new quality programs; (e) less waste; (f) improved efficiencies; (g) faster data analytics due to computing power; (h) robotics; (i) radio-frequency identification; (j) 3D printing; and (k) mobile platforms for data entry.

Were there challenges with all of the evolution that I saw during my career? Of course, there were! Some people could not accept some of the changes that were made. Unfortunately, some did not remain with the company. However, this was not the norm. Resistance to change is something that most people have, but with proper education and explanation of the process it can be overcome.

How does the evolution of manufacturing improvements relate to Architecture? Both place emphasis on planning. Planning improvements in manufacturing have resulted in streamlining of the manufacturing process. For example, elimination of excess inventories has led to investment in new facilities by freeing up capital for expansion, and process improvements have led to decreasing the time from production to market.

Using similar ideas, architects can streamline the design process by improving their planning and eliminating waste. If applied strategically, manufacturing process improvement techniques can adapt to any design organization. In the same way that improvements and leveraging of technology helped with managing manufacturing inventories, technology can assist architects in managing their inventories: their projects.

END OF BACKGROUNDER

THE DESIGN AND CONSTRUCTION INDUSTRY IS NOT MASS PRODUCTION

We must be careful to not confuse the design, delivery, and construction of buildings as a mass production effort. More recently we have read with interest articles lamenting the poor productivity of construction and the need to get in step with mass production approaches used in manufacturing. This is a thought-provoking topic and would appear to be a viable observation; however, on closer inspection it is not. Building design and construction address a certain need and mass production quite a different one.

Mass production is the manufacture of nearly identical items and requires singular control over many parameters to be efficiently done. The design and construction of buildings involves managing multiple factors that often change and are out of the architect's or contractor's direct control.

The Automobile Industry

There are about 40–50 well-known companies that direct the design and manufacture of automobiles for the entire world. Many of the larger ones include multiple lines of cars and trucks branded and marketed to specific segments. Retaining overall control, they typically contract out the manufacturing (and sometimes design) of many components and subassemblies to other manufacturers, coordinating the delivery and integration of parts for final vehicle assembly.

> **The cost and effort to design a vehicle is amortized across thousands or millions of nearly identical units, unlike a building where the design is generally designed and constructed one time.**

The term *mass production* came into use in the 1920s to describe the large-scale production of standardized parts and products. As a system, it was nearly perfected by Toyota by the 1980s. It utilizes complex and tightly orchestrated processes in order to realize efficiencies. While there is much to learn from manufacturing, the architecture, engineering, and construction (AEC) industry is not in the mass production business.

Why Is There a Building Industry?

By contrast, most buildings are individually designed and constructed to meet the needs of a specific client on a unique site in a certain area or region. The client generally wants a building tailored to their needs and takes an active role in the design process. They exercise control over most aspects of the project related to the budget and schedule and retain the right to delay decision-making and to change their minds. Some clients still consider employing an architect to be a commission, not unlike engaging an artist.

Each project employs a specific combination of designers and constructors. With a few exceptions, it is unlikely that the same AEC team will work together again, missing the opportunity to collectively learn and improve together. The resulting design is typically bid competitively among multiple contractors to obtain the best value (ahem, lowest price). Alternatively, a construction manager or design–build firm may be engaged early in the process but still utilizes a similar bidding effort to select most or all subcontractors.

Applying this client-driven model of service to mass production quickly creates issues. Let us look again at the automobile industry. With this paradigm, like a building project, each prospective car owner can now change options as to the size, layout, features, and performance characteristics of their new vehicle to meet their desires. They also preserve the right to change their mind during the manufacturing process itself. It takes little imagination to see that this approach will rapidly introduce significant slowdowns to production rates with a corresponding increase in cost to produce. The benefits of mass production are lost.

Some clients still consider employing an architect and design team to be a commission, not unlike engaging an artist.

The converse is equally problematic. The variety of buildings around the world are a testimony to the creativity of people working with the limitations of available financing, building technologies, skilled labor, and materials. The unique needs of clients and their individual preferences along with many other factors all contribute to the richness of the built environment we see. We appreciate the varied buildings and urban fabric of Prague, San Francisco, and the suburban townships west of Philadelphia – especially when compared with many post–World War II American suburbs where a focus on efficiency, commoditization, and cost have led to a general blandness.

A Better Comparison

Rather than contrasting design and construction to mass production, a better comparison would be to the design and manufacture of the custom tooling used in the manufacturing plant itself. It is a capital-intensive effort, often for the development of specialized, one (or few-)-of-a-kind pieces of equipment. Design specifications for the tooling may change along the way, as it is fine-tuned for what the manufacturer will produce (e.g., automobiles, aircraft, plastic bags, food products). The design of the tooling itself is often contingent on the parts that will ultimately be produced but that themselves may be amid development.

Figure 5.3 summarizes our observations on such a comparison.

Mass Production	Design-Construction
• Product focused	• Client focused
• Production of many nearly identical items	• Unique, one of a kind projects
• Centralized control over design & production	• Distributed effort for design and construction
• Complex, tightly organized, repeating processes	• Processes are adapted to clients and projects
• Easily quantified	• Individual metrics are inexact
• Interchangeable parts & assemblies	• Unique groupings of components and proprietary building systems
• Immediate or Delayed Discovery	• Immediate or Delayed Discovery
• Retool to Fix on Next Iteration	• Learn from Prior Projects

FIGURE 5.3 Comparison.

Expanding upon this comparison, aspects that impact design and construction productivity include (1) project complexity – managing amid unrealistic expectations and conflicting goals; (2) the speed of time – needing to progress work while decisions lag or change; (3) a nonlinear design process; (4) unique (one-off) designs; (5) design fee pressure – the new constant where clients seek to reduce their costs; (6) limitations inherent in the bidding and contracting process that limit their value proposition to obtain skilled workers and delay of final building systems selection; and (7) overreliance on technology.

With these comparisons, it is possible to see the following outcomes as strategic approaches to help with productivity:

- Create standard BIM components, prototypes, and details.
- Streamline documentation of typical conditions to leave time for the unique.
- Concentrate on developing universal elements, i.e. repetitive components and systems which can be prefabricated by contractors.

Part II of the book will expand upon and provide examples based around these approaches.

LEARNING FROM DETROIT

Manufacturing gave us our first glimpse of what Lean and process management could do when rigorously applied over time. Other industries and businesses such as construction, the US military, Starbucks, and healthcare providers have subsequently built upon these ideas and principles, adapting and extending them to bring about improvement to their operations.

We are convinced there is opportunity and great value to be realized by the design profession if we likewise stand on the shoulders of giants to learn from others and adapt to our work.

Backgrounder 5.2 Constructability

There is something magical about taking the rough outline of a building and breathing life into it by crafting how materials and systems meet and greet. He may not have originated the phrase, but architect Ludwig Mies van der Rohe observed that God is in the details. The inference being that God, while orchestrator of big events beyond our comprehension, is also master of the delightful subtlety to be found in the smallest detail. Like that of other great designers, there is an enjoyment of Mies's buildings up close as well as when viewed from afar.

A key component of that effort is an understanding of the building's systems and materials themselves along with how they come together. Many project designs impose unnecessary burdens on contractors and the client's budget due to issues of unneeded complexity and poor constructability that are baked into our documents and models. Neither a clash-free nor well-coordinated building information model (BIM) ensures good constructability (Figure 5B2.1). It is also possible to model with accuracy and at the same time reflect poor construction practice.

Designing buildings that are unnecessarily complicated introduces waste through higher labor costs and potential delays as problems are worked through, first by the designers and then by the contractor. The costs are difficult to calculate up front as they are reflected not by quantitative attributes, such as yards of concrete or tons of steel, but instead in the difficulty of performing the work, the inefficient use of materials and components, or the difficult interconnections between adjoining elements.

Japanese automakers made a determined effort to design and engineer automobiles that were simpler to assemble, leading to less time and lower costs to produce.

For our purposes here, we will define *constructability* as the integration of building elements and systems together that can be reasonably fabricated and assembled and that provide reliable performance over time. Four aspects of good constructability are:

- Functional – respects the limitations of the budget, materials, and systems
- Practical – reasonable to construct
- Reliable – the design performs well over time
- Aesthetic – pleasing to the eye; it reinforces or extends the design intent

The detailing of visible elements at the exterior should be able to stand scrutiny from a subjective aesthetic viewpoint while also meeting performance criteria such as preventing or managing moisture intrusion. Designs must accommodate the capabilities and limitations of the materials and systems themselves, being worked out with some understanding of how they are fabricated and installed.

FIGURE 5B2.1 Ceiling expansion joint. Inspiring space perhaps, but routing of the expansion joint is not an elegant solution.

SPENDING MONEY WHERE YOU CAN SEE IT

A constraint we face on almost every project is the construction budget. It is always limited in some respect, and we are usually under obligation to not exceed it. There are many choices to make in the design process – and to pull off the design intent, and where we can, it is in our interest to make the building less complex to build. What do we mean? Where do we want to spend the construction dollars? Is it on unnecessarily convoluted foundations or difficult to build roof junctures that no one will see? Designing and detailing the building to generally be less complicated to construct and keeping the complexity where it is needed or can be seen and appreciated is a practical strategy with financial and aesthetic dividends.

FIGURE 5B2.2 Detailing elegance of an exterior stair at the Opel Design Center in Russelsheim, Germany.

For example, in a concrete superstructure, column grid spacings can be regularized with an arrangement that allows concrete pans to be reused on multiple bays (for pan and joist slabs). In a steel superstructure, simplifying slab and roof edge detailing saves worker labor. Coordinating with engineers could offer a way to more efficiently route heating, ventilating, and air-conditioning (HVAC) or electrical systems. In metal stud framing, using a limited number of stud sizes when detailing would simplify the work for the framing contractor – fewer piles of studs in the way, less to remember. There are also many types and sizes of metal clips as well as tricks of the trade they can employ to make things work.

This can usually be done without compromising good design; it just takes some thought and effort from a creative architect or engineer. There will be situations where we are between the proverbial rock and a hard place – just work to minimize those occurrences. Getting to know trade contractors and older field superintendents and asking their opinions and advice offers opportunities to learn better ways to build (Figure 5B2.2).

IMPACTS FROM BIM

At the 2016 BIMForum in Atlanta, Georgia, one of the more interesting presentations examined construction tolerance, camber, and deflection – with the presenter noting that they are typically not addressed by BIM. Examples were highlighted of how each of these adversely affected a project, but the incongruities were not revealed until work was being placed in the field. The takeaway was that it is possible to model with perfection what cannot be achieved in the field. A corollary that follows is that a clash-free building model or a coordinated set of construction documents does not a constructible building make. Knowledge of fabrication and installation tolerance as well as the limitations of materials and systems are essential components to good constructability.

The Big When

Constructability should be addressed early in design to avoid redesign later. Technical architects that understand how buildings are constructed are an invaluable team member and work with the designer to translate ideas into viable solutions. It is almost never too early to consider constructability if it does not get in the way of letting ideas gestate.

Speaking of BIM as a tool for constructability, an insightful project manager, Michael Hoffmeyer, AIA said, "It is advantageous to create collisions early in design to determine the most efficient layouts for structural and MEP systems and determine how they best interrelate. We will resolve conflicts as the design matures."

Constructability can be addressed too late. The design development phase is perhaps the best time to bake it into our designs and models. It can be likened to making popcorn: You turn the heat up on the stove, and when the kernels start to pop you forcefully shake the pan back and forth, causing unpopped kernels to fall to the bottom. During design development, we similarly can shake the building by working through the entire design to adjust all elements to fit together correctly and allow for construction tolerance.

- Examine key junctures and material transitions at the building exterior.
- Follow expansion joints, interior finishes, and aesthetic reveals around corners and up walls and ceilings, to ensure they transition in a logical and elegant way.

A worthwhile goal is to achieve both horizontal and vertical dimensional control by the end of this phase for the complete building, which requires working through all the critical details and major systems.

Note that we have not said that all details were modeled or drafted in final form or that we dimensioned the documents at this time. Rather, we sketched, drafted, and modeled enough to thoroughly understand the building and to determine and set relationships of materials and systems. This obviously positions the project well for the documenting phase that follows.

BIM models are useful for quantifying materials but do not convey the complexity or buildability of a design. This is not unlike the differences between data, information, knowledge, and wisdom.

FIGURE 5B2.3 Photograph is of actual field installation. *Source:* Ikerd Consulting, LLC.

An example where a fully coordinated model does not equal a constructible solution is the project highlighted in Figures 5B2.3 & 5B2.4. The graphics in Figure 5B2.4 were taken from the project's Navisworks model. The image on the left was fully coordinated but labor intensive to construct and served as the basis for the actual field installation shown in Figure 5B2.3. A difficult intersection where multiple pipes converged, 24 soldered connections were needed to route a set of three gas pipes around the fire water line. Ikerd Consulting was asked to conduct a review after construction was complete and found that, in this instance, as shown in the image on the right in Figure 5B2.4, adjusting the height of the fire water line eliminated the need to offset the gas piping with no changes in finished ceiling height. With many such conditions occurring on the project, they discovered that relatively simple adjustments could often remedy the condition. Ikerd observed that a coordinated model that is conflict-free and clash-free is not to be confused with a Lean, constructible building.

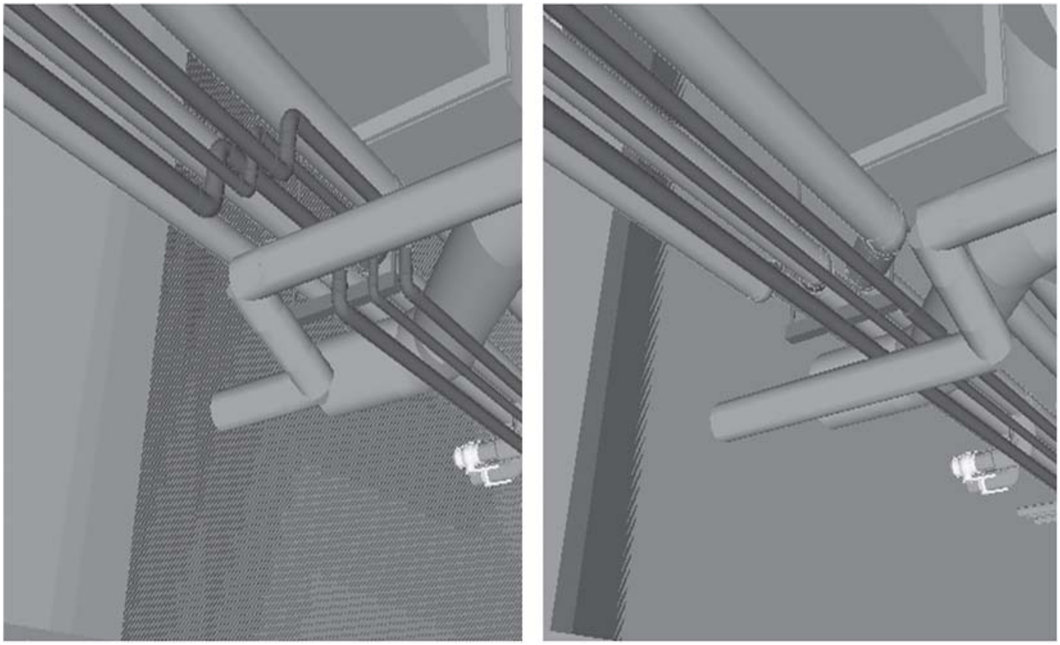

FIGURE 5B2.4 Graphics from Navisworks. *Source:* Ikerd Consulting, LLC.

END OF BACKGROUNDER

REFERENCE

Dertouzos, M., R. K. Lester, R. M. Solow, and MIT Commission on Industrial Productivity. (1989). *Made in America, Regaining the Productive Edge*. Cambridge, MA: MIT Press.

PART II

Areas of Strategic Focus with Applications

CHAPTER 6

Lean Management for Architects

In Part I we have attempted to lay a foundation for applying Lean and related process management systems to architectural practice by establishing basic goals and melding those together with examples from outside the design profession industry to provide a perspective for looking at what we do as architects and design professionals.

There are many resources available addressing project management fundamentals such as financials, scheduling, project and team setup, and how to conduct a meeting. Each of these is important, but we believe their value is best realized within the broader framework of an intentional approach to project management, one that is mission oriented, strategic, tactical, and creative. We will not be presenting a comprehensive approach here so much as building upon a Lean ideology that will drive methodologies. We will discuss project management in terms of activities furthering the project itself and not as a job description or siloed discipline. Examples and tools will be shared that may be helpful for accomplishing that effort better. To help make some of the ideas clearer, we will draw analogies to the game of American football. Much can be learned from a sport such as this where great minds prepare strategies, employ tactics, take calculated risks, and respond to challenges in real time.

Premise: Good teams develop a strategy and prepare to play the game.

Observation: Few firms have developed strategies for executing work, where all of their risk and profit lie.

THE GAME

Significant amounts of money, time, and effort are expended in preparation to play the game of football and most any other sport. Drafts are held and trades completed to assemble the best players available and to build the team's capabilities. The coaching staff employs strategic analysis to understand their team as well as the competition's strengths and how to exploit any weakness. Plays are devised, modified, and practiced extensively to hone execution and leverage each player's contribution to moving the ball downfield and then preventing the other team from doing so when they have the ball. All of this is done prior to playing the game.

> **It's not the will to win that matters; everyone has that; It's the will to prepare to win that matters.**
>
> —Coach Paul "Bear" Bryant

How many design firms invest attention and effort in devising strategies and plays for the game of project delivery? Have we learned how to effectively move the ball forward and have strategies that mitigate it being moved downfield against us? Do we assess our project team's makeup and capability to execute or simply assign people to a role or task?

Good football teams do not just show up for a game without a strategy in place beforehand for the specific opponent they will face. This contrasts with pick-up games among friends where everyone blocks someone and then goes out for a pass. Instead, each team has a playbook they use in developing a specific game plan based on the perceived strengths and weaknesses of their team and the opposition. Plays are run repeatedly in practice for each team member to learn how to execute their role and, ultimately, during the game to execute the plays effectively. The game plan is adjusted during the contest as needed, and changes are made based on the outcomes. Each game is studied afterward to analyze what worked, what did not, why, and what should be changed.

> **Definition: A playbook consists of all the plays the team will use. It includes a description of the play with a diagram of each players position on the field, illustrating what each one is to do.**

Like the game of football, much of what we do as architects is the same, project to project, and it becomes important to discern what is unique and atypical about a project or client. Understanding the challenges and constraints we are likely to face is essential for better navigating project complexity. For the routine tasks every project has, firms should develop methods for performing the work effectively and doing so in nearly the same way.

Large firms or those serving a specific market sector such as K–12 education or healthcare can develop highly specific delivery processes with minor variations only as required by the client or jurisdiction. In other words, projects can be managed and documented much in the same way. Generalist firms doing a wider variety of project types can still employ similar ways of working; they may just need to provide for a greater latitude in the application.

Field Position

Football aficionados understand well that field position is essential to achieving victory. Likewise, success in project delivery is greatly affected by how we position the project. Architects will often agree to contracts or schedules that put the team and project at an immediate disadvantage, well before design has begun or a single wall is modeled. Firms will understaff at critical junctures or move projects forward without solving essential issues, causing themselves difficulty later.

There is an unpredictable aspect during the kickoff or a punt where the receiving football team has an idea but does not know exactly where the ball will land. A judgement is made after the ball is kicked to call for a fair catch, to attempt a run back, or if in their end zone, to chose not to run it back and begin on their 25-yard line. The receiving team wants to start from the most favorable field position possible but often is not able to. Likewise, there are many times during projects where design professionals find themselves in difficult or unfavorable project situations due to factors beyond their control. Like the football team, we must begin there but work to do ourselves no harm.

Agility

It is important to look at the whole of project delivery and not see it simply as a cost management effort or series of phases. Before agreeing to a detailed timetable, first understand the interdependencies between tasks to determine if it is both realistic and achievable. Actively manage your client's expectations and keep them informed of project progress and potential issues. Let them know that you are not perfect and there will be issues but that you will work together to solve them. Identify key things that must be done and make sure they happen.

Learn to distinguish and prioritize the *hard* items that must be known and worked through now versus *soft* items where we can wait and work them out later. In an ideal situation all items would be *hard* and able to be resolved in a linear fashion; however, to flex with the client, the authorities having jurisdiction, schedule pressures, and so forth, we need to identify areas of flexibility. An example of this would be on a fast-track project where dimensional control is needed early for affixing structural elements such as floor-to-floor heights, slab edges, column grid locations, and vertical circulation shafts. We want to focus on items affecting those such as the locations of heavy mechanical equipment; the quantity, sizes, and locations of shafts, stairs, and elevators; and architectural detailing around exterior columns. We can likely defer finalizing the details and sizes of many rooms and spaces and the exact routing of MEP utilities in noncritical areas.

Make Level Paths

Among many tasks, a good project manager makes a level path for the people below them to do their work. We can view this quite simply as removing constraints by facilitating project decisions that allow the work to move ahead, seeing that their team has the proper tools (hardware and software), and not letting staff become overloaded with extra tasks that take away from their primary efforts. For example, on a given project it may be advantageous not to burden the project architect with additional responsibilities such as building information modeling (BIM) management – the constraint. The project architect must organize and coordinate all team members to complete their tasks. Consultants such as structural, MEP, and civil are at times considered a *client*, and the project architect must set all parameters affecting their work and see that this information, along with their team's work product, flows to all concerned in a timely manner. By removing the constraint of BIM management in this case, the project architect can better maintain balance and *own* the project and the work being produced.

Execute, Execute, Execute

Having a work (or game) plan is not enough – you still must do the right thing at the right time and do it well. Success in project delivery entails much more than good planning, excellence in design, or accurate modeling. A good football team works hard to learn plays and execute them properly. When mistakes are made, they try to understand why and then run the play again to get it right. Too often, architects rely on trying to dictate quality or to inspect it in, and when mistakes are made we do not

FIGURE 6.1 Define, design, and deliver.

look for the reasons why with an eye toward fostering improvement. Applying Lean principles, we would (1) develop what can be afforded and built, validating project costs as the design progresses; (2) approach project development by identifying what needs to happen at the appropriate phase and building in coordination efforts between disciplines; (3) look ahead to identify and eliminate potential roadblocks as it is more productive to prevent problems from happening as opposed to expending effort later to detect and correct; and (4) consider schedules as commitments and intentionally choreograph the interdependencies between tasks to ensure all project stakeholders have the right information at the right time. This is part art, part science, and lots of work. We will break it down into basic functional components that work with either of these views (Figure 6.1):

- Define the work
- Design or "solve the puzzle of the project"
- Deliver the solution

Note also that each of these overlaps with the others; while we are in the midst of defining aspects of the project scope of work, we may also be working through design issues and setting up the model for the delivery phase. These tasks should not be confused with the phases of schematic design (SD), design development (DD), and construction documents (CDs), which organize the work into logically ordered spheres of activity. Instead, they are broad categories that express the fundamental core of what must be done for a project and that which can be overlaid onto the design phases. It is easy to become distracted by many necessary tasks, but if we remember these three elements they can help keep us on track through the often chaotic aspects of project delivery.

Define

Through engagements, brainstorming, and interactions, define the project in every respect as early as possible. Identify potential issues that might hinder or derail the project progress including what we do not know, areas of complexity, and unrealistic expectations.

Identify the client's goals:	Determine with the client what their vision, budget, program, and so forth are. Clarify and resolve any misalignments or unrealistic expectations.
Validate the program:	Review the client's program for inconsistencies or areas that may be out of sync with the schedule or budget.
Identify the contractor delivery method:	Is the project design–bid–build, construction manager at risk (CMAR), or something else?
Validate milestone schedule:	Review and verify that the overall schedule is workable. Check the interdependencies between tasks needed to meet dates.
Identify existing conditions:	Visit the project site (or building) to observe and identify potential project issues and considerations.
Identify project parameters (e.g., site, AHJ, LEED):	What affects the project? Obtain information on the site or existing structures, the AHJ and applicable codes, sustainability objectives, and so forth.
Identify client standards:	Does the client have specific standards or criteria to follow? If so, obtain copies.
Identify building systems:	During the schematic design phase, identify in detail all building systems anticipated.
Identify major equipment:	Identify major client provided equipment and building equipment with design impacts and obtain preliminary documentation.
Identify client technologies:	What technologies will the project employ? Increasingly building owners and operators employ a variety of technologies. They affect the building infrastructure, design, and the budget. Examples include DAS, wired and wireless networking, sensor systems, cabling and fiber optic.
Design firm technology strategy:	Determine the technologies that will be employed by the design team like Revit or Newforma. Work through a BxP to identify the project's LOD and what each consultant will provide and when.
Budget optimization and reconciliation:	Create deliverables that address both the quantitative and qualitative aspects of the project. Both are necessary for effective costing by estimators and contractors. • Document areas of uncertainty including missing information and studies and tasks that are incomplete. • Perform value engineering early and often to align project scope with the budget

Notes: AHJ, Authority Having Jurisdiction. LEED, Leadership in Energy and Environmental Design. DAS, distributed antenna system. BxP, BIM execution plan. LOD, level of development.

Design

Based on a clear understanding of the client's goals and develop a design solution addressing function and aesthetics that integrates the building's systems, is constructible, and meets the budget.

Review client's or project's goals:	Revisit what the client is trying to achieve with this project.
Pull schedules:	The collaborative effort to plan the network of activities required to complete a phase or portion of work. • Work through the information handoffs between the AE team – who needs what and when. • Identify the predecessors needed to do work, that is, what does the electrical engineer need from the mechanical engineer (and they from the architect) to complete their package by a date? The architect should be responsible to make this happen.
Optimize deliverables for (SD, DD, and CD):	Cartoon and plan the deliverables for each phase to convey the project decisions clearly and simply and the scope and intent to the client and the contractor. Exercise care to minimize how many times and ways you show the same information.
Finalize life safety:	Conclude code review with the strategy to meet life safety requirements. Select UL assemblies for structure and major building elements such as roofs and walls.
Finalize building systems and finishes:	Conclude decision making on all interior and exterior building systems.
Check constructability:	Ensure the building is constructible. Finalize horizontal and vertical dimensional control, incorporating construction tolerance and good practice.
Verify technologies used by the client:	Finalize all client and project technologies.
Verify all equipment:	Finalize building equipment selections by client and AE.
Coordinate building systems:	Validate that MEP and technology spaces are sufficiently sized and vertical space is adequate for routing of MEP infrastructure.
Budget optimization and reconciliation:	Create deliverables that address both the quantitative and qualitative aspects of the project. Both are necessary for effective costing by estimators and contractors. • Document areas of uncertainty including missing information and studies and tasks that are incomplete. • Finalize value engineering early and align project scope with the budget.

Notes: SD, schematic design. DD, design development. CD, construction documents. UL, Underwriters Laboratories. AE, architects and engineers.

Deliver

This is the effort to clearly document the solution to the client's project.

Review client's and project's goals:	Confirm the project meets the original client design intent. If not, why not?
Pull schedules:	The collaborative effort to plan the network of activities required to complete a phase or portion of work. • Work through the information handoffs between the AE team – who needs what and when. • Identify the predecessors needed to do work, that is, what does the electrical engineer need from the mechanical engineer (and they from the architect) to complete their package by a date? The architect should be responsible for making this happen.
Clash resolution:	Complete building systems coordination.
Review client standards:	Double-check that the project meets the client's written standards and requirements and what they have said during design.

THE STRATEGIC PAUSE

In football, one common trait among many elite running backs is the ability to momentarily pause to let the blockers ahead open a lane to sprint through. This is considered the mark of a more seasoned player, a sign of maturity.

The same trait has broad applicability for design teams that can pause, dodge, or move sideways when decisions and schedules shift around. Every project has experienced what is called two steps forward, one step back, and it is inevitable that we will encounter obstacles and issues along the way. Seasoned teams that can pivot (or hesitate slightly) can better weather the back and forth of the work.

How do you do this? Having similar work processes allows team members to more easily shift and temporarily plug into other projects or aspects of work. Strategizing to find those areas of a project that are unaffected (or minimally so) by a pause can allow us to still push them ahead while waiting for resolution of other issues.

Applications to Project Phases

These basic tasks – define, design, and deliver – speak to everything we do in a project. While they may include subtasks and activities, they must be woven into an overall schedule amid the routine aspects of project delivery. How might this be applied to the traditional breakdown of project phases?

Schematic Design

A primary goal of schematic design is to develop initial project solutions that are viable and to set the stage for subsequent project development. Where we can, we want to push thinking and decision making to occur as early within this phase as we reasonably can.

Design Development

This is the stage of project confirmation. It builds upon the exploration of the schematic design phase to both validate and confirm the initial design intent or make the required changes so that it can in fact be realized. The implementation of all the work that confirms the assumptions of the project happens in this phase and many project teams fall flat and lose the game right here. If we are successful during this phase, it most likely means that we are well-positioned to be more productive moving into final documentation.

Construction Documents

This phase is focused on the delivery of the design already confirmed in the previous phases, and proper planning during this period is key to success. Often the documentation begins without any forethought, and a brief reset cycle to do this can be useful, allowing the team to regroup from the earlier phases. While this period sometimes bleeds over from design development, it is advantageous not to let this time be seen as an additional opportunity to redesign and change prior decisions, that is, moving the goalposts. The acronym *CDs* does not stand for continuing design. Doing so can derail team momentum, impacting profit, document coordination, and the ability to bring the work to completion. Being aware of this, make every attempt to minimize the potential impacts.

> **A longer time spent in design that resolves project issues well can result in a shorter documenting phase. Design fees should be adjusted to reflect this.**

FIND THE MONEY

Projects that move ahead without a clear understanding of where the design is in relation to the client's project budget are likely to face trouble and the potential of significant rework. This is especially important early in design where major scope related decisions such as the overall size of the building along with its major systems are determined.

Many firms are subject matter experts in the market sectors in which they operate. They understand the unique client needs, the design and planning challenges, pertinent regulations, building standards, and the competitive forces affecting specific project types. This depth of knowledge can be utilized early in design to define the work so clearly such that a construction cost estimator can create a comprehensive cost model. Many cost estimates are built around quantitative data alone, gleaned from the model directly or by doing takeoffs from hard-copy sets, PDFs, or computer-aided design (CAD) files. Subject matter expert architects and engineers can provide the *qualitative* aspects using narratives combined with 2D and 3D graphics.

It is to the design firm's benefit to help the estimator understand every aspect affecting a project, including identifying what we do not know at that point in time, as uncertainty can carry a cost. It is of great value early in design to have a realistic assessment of the project's relationship to the budget. This allows decisions to be made with confidence and can reduce unnecessary design iterations or worse yet, engaging in wasteful value engineering (VE) later on. The further along a project is when value engineering is performed, the greater the potential disruption to the design process itself with a corresponding negative effect on the schedule, and the design firm's profit.

Document issuances such as schematic design and design development serve two key purposes: (1) communicating to clients in aggregate what we have been working on for their review and approval; and (2) conveying to estimators the full scope of work for costing – what we know, anticipate, and do not know. Note that we are saying *scope* and not complete, final, or fully accurate descriptions. Precision will come later.

SCOPE DOCUMENTS

A useful and oftentimes overlooked approach to help in capturing the overall project costs in the design phases is to agree with the client (and contractor) that the early document packages are to be considered scope documents. Scope documents communicate the overall nature of the project but are not complete and coordinated documents and should not be construed as such by the estimator. The estimator must fill in the blanks based on the information provided and their experience with similar projects.

Example scope document language:

> This drawing set and associated documents (written narratives and images) issued indicates the general intent and scope of the project at the completion of this design phase. The final design documentation has not been completed; therefore, the information provided may not be completed or fully coordinated. The contractor is responsible for complete and coordinated pricing and shall include all items necessary for the proper execution and completion of the work described herein, in a successful manner, whether indicated or not.

Example: 11-Story Office Building – Schematic Design

Figure 6.2 shows a composite of several sheets from the schematic design package for an 11-story building. These project documents would be given to multiple general contractors for pricing, and the contractor with the best low price would get the job. The building design was developed using BIM and 3D modeling software. Limited traditional drawings on 30" × 42" sheets were provided, and a greater effort, using less time, was invested into an 11" × 17" design book and outline specifications using the preliminary project descriptions (PPD) format. The extensive use of color images and graphics with 3D views and narrative communicate the project scope in a way that is understandable to almost anyone.

Knowing that the pricing received from contractors will establish a budget baseline for the remainder of the project, every effort was made to identify hidden areas of cost and complexity to ensure it is included in the estimates. In the top left and right images, 3D building views and the only building

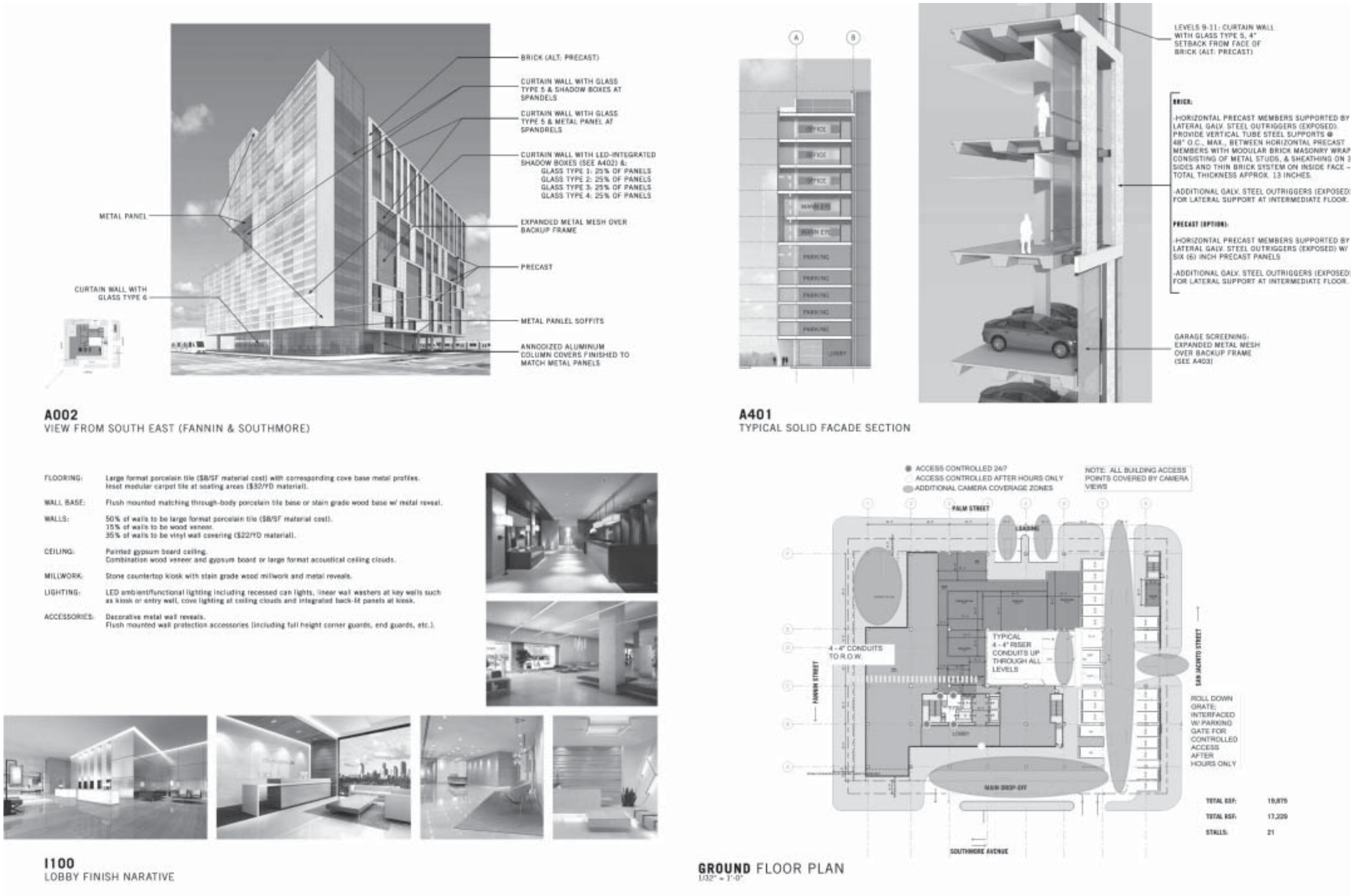

FIGURE 6.2 Schematic design phase deliverables. *Source:* Huitt-Zollars, Inc.

and wall sections provided were taken from the 3D model and imported into presentation software with annotation added there. In the bottom left, example images of higher dollar-per-square-foot areas such as lobby spaces, elevators, public restrooms, and tenant corridors from the firm's interior design portfolio were brought into the presentation software with narrative notes describing specific materials and systems such as where terrazzo and marble are used. It is advantageous to define a level of quality early rather than relying on contractors making assumptions that we may be held to later. The bottom right plan view is of the street level and addresses all low voltage systems. Using an 11 × 17 floor plan in PDF format, annotation was added to indicate security camera coverage zone coverages (colored ellipses), electronic door hardware (colored circles), as well as basic information describing conduit risers and security gate locations.

Additional sheets included photographs and graphics from various manufacturer's websites combined with portions of the project's exterior elevations that were color coded to define areas of specialty glazing, LED shadowboxes, unitized curtain wall panels, garage deck screening, anticipated signage, and other specific building systems that were being planned. The narrative included a section titled "Issues and Assumptions" to identify areas of uncertainty that might affect schedule and cost. For this project they indicated potential impacts from City landscaping requirements and light rail right-of-way improvements that might be required. Early in design, many of these were unknown and would require additional time to work through with the city and consulting engineers. A key goal of this schematic design package was to eliminate surprises and to clearly state the obvious.

Target Value Design

The schematic design approach as described is similar to target value design (TVD), where a detailed, comprehensive budget is established early in design by a collaborative effort and used throughout the project to benchmark against. Using TVD, multiple design options may be maintained concurrently for an extended period prior to final selections being made.

DON'T FIGHT THE CHAIN

Henry Ford is often credited with inventing the assembly line in the early 1900s (Figure 6.3). Prior to that, automobiles were put together in a large room or area with parts and assemblies stacked around the workers. It was terribly inefficient even for the relatively simple cars of the day. The assembly line changed that, and instead of bringing all the components to one location, the car, beginning with the chassis that was pulled by a rope, slowly traveled to where the parts and workers were located. The rope transitioned to become a chain, the speed of which governed the output of automobiles and the plants earning potential.

Design projects have at least one chain that runs through them, significantly affecting the rate at which the projects can progress. If we are not aware of this, we may find ourselves out of sync with it or worse yet, fighting the pull of the chain. The following examples illustrate where chains can exist and their effect on project efforts.

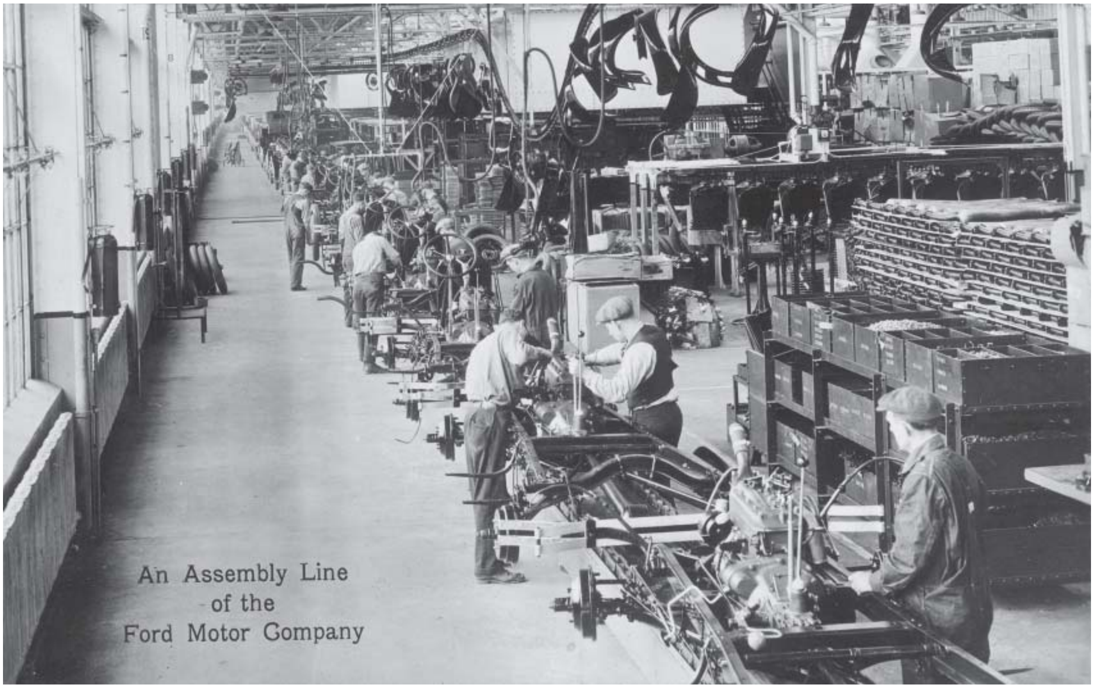

FIGURE 6.3 Automobile factory assembly line. *Source:* Adobe Stock.

Example: Client

The client for a multistory office building savored his involvement in the design process and had (great) difficulty delegating the most minor decisions. Design and project progress were hindered until one of the team members began creating decision matrices that summarized design issues and building systems choices, such as interior and exterior finishes, allowing for easy comparison and decisions. The client decision-making process was the chain.

Example: Delivery Methodology

A fast-track hospital in the Midwest forced the architecture and engineering team to work out of the normal sequence. With structural and civil packages issuing first, the design team shifted focus to get these engineers the information they needed as early as possible. This included stopping production of drawings and instead concentrating on working through design details to achieve full dimensional control, both horizontally and vertically. MEP systems were sufficiently designed and coordinated enough to determine equipment sizes and loads, along with weight, to fix the locations and sizes of required openings such as shafts and chases. One result of this was that subsequent drawing packages required little or no modification to the early ones and were relatively quick to produce. The chain regulating the project was the fast-track delivery.

Example: Regulation

A large hospital addition in the Northeast United States had a 2-year land development process to follow to gain city approval to build. The land development process was the chain about which all project and design activity was connected, and the design team's focus became to address local political concerns and facilitate the civil engineers design. In this instance, there was no advantage to making design decisions quicker or rapidly producing drawings; rather, a goal of the design team was to manage the design team effort to not exhaust fees during the 2-year design effort.

Do not fight the chain: identify it, and adjust your work as needed.

CHOREOGRAPH THE WORK

Most undertakings worth embarking on involve a schedule. Whether planning a vacation or a semester in college, schedules introduce a time frame for activities to occur and establish a date for completion. A schedule serves to set boundaries and introduce discipline to activities; it is also a benchmark to gauge progress along the way. When planning for a building, a schedule is one of the first organizational efforts to undertake.

A schedule can be referred to as a sequential list of commitments, suggesting careful study before agreement. It is important to work through and understand the interdependencies between tasks and determine if it is both realistic and achievable. This effort is best described as a type of choreography where we orchestrate the steps of the entire team to deliver a project most optimally.

Schedules exist in many forms, from high-level milestone schedules to detailed pull planning schedules. Milestone schedules set major dates and are usually worked out with the client or their project manager. The design team should review and validate the proposed milestone schedule, especially for fast-track or similar-type projects where they issue early packages or otherwise work out of order. If the milestone schedule is not workable or is unreasonable, the design team and project are at a disadvantage before the work starts.

A general note of caution: many designers are not wired to work in a linear fashion but instead operate in a manner that on the surface can appear haphazard. As such, early in the design phases, when ideas are being developed and tested, it may be more impactful to communicate the overall milestone dates and project direction and let them work toward those.

SCHEDULING CREATIVE WORK

The 3M corporation introduced Lean Six Sigma within the organization in the early 2000s. This initiative extended to obvious places such as production but was also applied to research and development (R&D), an area of the company that involves out-of-the-box thinking and creative effort.

During this time, the annual patent count noticeably decreased as innovation was stifled. To rekindle innovation, the next chief executive officer, George Buckley, subsequently adjusted the program to exclude R&D. The decision proved fruitful, and he later observed: "Invention is by its very nature a disorderly process.... You can't put a Six Sigma process into that area and say, well, I'm getting behind on invention, so I'm going to schedule myself for three good ideas on Wednesday and two on Friday. That's not how creativity works" (Peppers, 2016).

In the example shown in Figure 6.4, the design team challenged the proposed milestone schedule developed by the client's project manager. The project was a three-level, 300 000 ft^2 hospital where the schematic design package was to be given to multiple general contractors (GC) to bid. They would negotiate with the low bidder to become the construction manager. As originally setup by the owner's project manager, the GC bids would be the first pricing feedback for the design team. From a costing standpoint, the design team would be operating in the dark, so to speak, until early in the design development phase. In addition, a site, foundations, superstructure, and elevator document package would issue 1 week after the GC was selected.

The schedule shown was a working timetable with some granular information included to illustrate the necessary choreography leading to milestone dates.

The design team raised two issues they saw that could negatively impact the overall project schedule and likely lead to delays and additional design services if the project were over budget at that time (now 4 weeks into design development). This was based on two reasons. First, the easiest way to reduce project costs is to decrease the overall size of the building. With final engineering document packages issued almost immediately after receiving contractor pricing, that opportunity would be lost as the building size would have been essentially set by mid-schematic design. If more than minor changes were required, additional time and cost would be necessitated for replanning and issuing revised documents. Second, it required the design team to achieve dimensional control for many building elements within a 4-week time frame after the start of schematic design to produce coordinated engineering documents. With major pieces of the design still moving about, this was deemed unlikely.

Working with the client's desired date for occupying the building, the design team reworked the schedule backward, adjusting all interim dates to what is shown in Figure 6.4 and still allowing the project to complete on time. It was agreed for pricing to be take place during schematic design with feedback and any value engineering complete prior to achieving dimensional control for structural drawings to finalize.

Further in this chapter we will look more closely at pull planning scheduling and variants that break the design teams' efforts down to a more granular level. These types of schedules are determined best using a process that involves all project stakeholders with discussion of the information that will be exchanged along with understanding the predecessors required.

Work Planning

Work planning consists of the actualities of delivering the work – or in simpler terms, a roadmap for the overall delivery. It is much more than just taking the project fee and dividing it by the number of weeks or months to complete. A work plan is the process of figuring out what the effort to deliver the project will entail and when resources are needed to do the work. It is not a finite task. Planning the work is critical to meeting deadlines and ensuring completeness of design documentation. Unfortunately, this

Project No. 1643		**7/6/2015**
P R O J E C T S C H E D U L E - REVISED		
JULY		
✓	~~4~~	~~Begin Schematic Design (SD) Phase~~
	20	AE Team Meeting
▶	??	**Meet w/ City to clarify overall Review / Approval process** ◀
	20-21	SD Worksession 1
	22	AE/Owner Meeting - MEP Systems
AUGUST		
	13	AE Team Meeting
	17-18	SD Worksession 2
	19	Issue Schematic Floor Plan / Elevations / Utilites / Structural / Systems Description to Owner's PM team
	19	Owner's PM team begin Pricing / VE
	28	Owner's PM team to release Topo / Geotech
	31	AE Team Meeting
SEPTEMBER		
▶	??	**Set date for Review & Approvals w/ City** ◀
▶	??	**Set up meeting with State - Review** ◀
▶	??	**Set up meeting with City - Review** ◀
	10	AE Team Meeting
	15	SD Worksession 3
	15	**September 15 - Complete SD Phase**
	15	**SD Pricing / VE Complete (floor plan / Bldg Systems validated]**
	21	Issue dim control to Structural: freeze structural grid; Floor-to-Floor heights; dim control (bldg. Systems selected / elevators); prelim MEP shaft locations
	9/21/2015 - ISSUE SD PACKAGE FOR PRICING	
	24	AE Team Meeting
OCTOBER		
	12	AE Team Meeting
	12-15	DD Worksession 1
	26	AE Team Meeting
NOVEMBER		
	2	Contractor Selection / Qualification of SD Cost
	2-5	DD Worksession 2
▶	??	**Set up meeting with State - Review** ◀
▶	??	**Set up meeting with City - Review** ◀
		Final coordination comments to Structural
	9	AE Team Meeting
	11/15/2015 - ISSUE CD'S - SITE / FOUNDATIONS / SUPERSTRUCTURE / ELEVATORS	
	23	AE Team Meeting
	30-31	DD Worksession 3
DECEMBER		
	1-2	DD Worksession 3
	14-17	DD Worksession 4 (if needed)
	17	**December 15 - complete DD Phase**
	12/22/2015 - ISSUE FINAL DD PACKAGE FOR IGMP	
JANUARY		
	13	**Initial GMP**
	13	January 13, 2016 - Begin Sitework / Foundation / Structure
FEBRUARY		
MARCH		
	3/30/2016 - ISSUE CD'S - SHELL & INTERIOR FINSIH OUT	
APRIL		
	28	April 28, 2016 - Final GMP

FIGURE 6.4 Example: revised milestone project schedule.

is one of the most overlooked aspects in project delivery. We may know the deliverables due for each project phase but never develop a plan for how to get there, and it can then become a scramble at the end to finish.

Plan the work, and work the plan.

Designers are not wired to think in a linear fashion, but we have found that without some appreciation of organization many projects take on a life of their own and will fail without direction. Knowing this, we still need to plan the work and try to build these into the schedules based on our past experiences. Recognizing that there are other ways to do this, here are four successful examples we can use to plan the work:

- A simple monthly calendar with dates and milestones written on it showing the work in a universal format everyone can understand.
- A Gantt chart with tasks and resource allocation, which is more complex and time-consuming but highly effective.
- A sheet index and hours assigned to determine the number of staff needed to deliver the work.
- Experience-based planning by those with many years of delivering projects and who know what it takes.

Whichever method you subscribe to, planning has a significant impact to a project. Be sure to maintain flexibility – as things come up, priorities change as information is attained. Challenges you may face include resource allocation (staffing availability), budget challenges (both on the project and internal fees), internal and external decision-making and design changes, documentation (team experience), and misunderstandings (poor communication).

PLANNING BY WORK CYCLES

A further systematic strategy to planning is the concept of breaking down the design phases into work cycles, which *McGraw-Hill Dictionary of Scientific and Technical Terms* (2003) defines as "a sequence of tasks, operations, and processes, or a pattern of manual motions, elements, and activities that is repeated for each unit of work."

This method comes from the idea that there is an underlying logic (or sequence) of organizational effort to complete a project phase. It itemizes the production into essential component tasks. The concept is similar to Lean manufacturing processes and work breakdown structures (WBS – as defined in the *Project Management Body of Knowledge* – PMBOK Guide). Although the activities are presented as a linear workflow, where one action leads to another, the reality is that the design professionals work is not and we must anticipate some back and forth within the timeline due to the nature and iterative progression of design. The representative activities within each cycle adjust to individual project timelines. The logic of the system presents a framework for staff to follow and breaks the overall phases into smaller, more manageable pieces. Schematic design is not represented here, as the SD phase has more variability than DD or CD.

The work cycles represent the main rollup tasks of the phase and is represented in Figure 6.5.

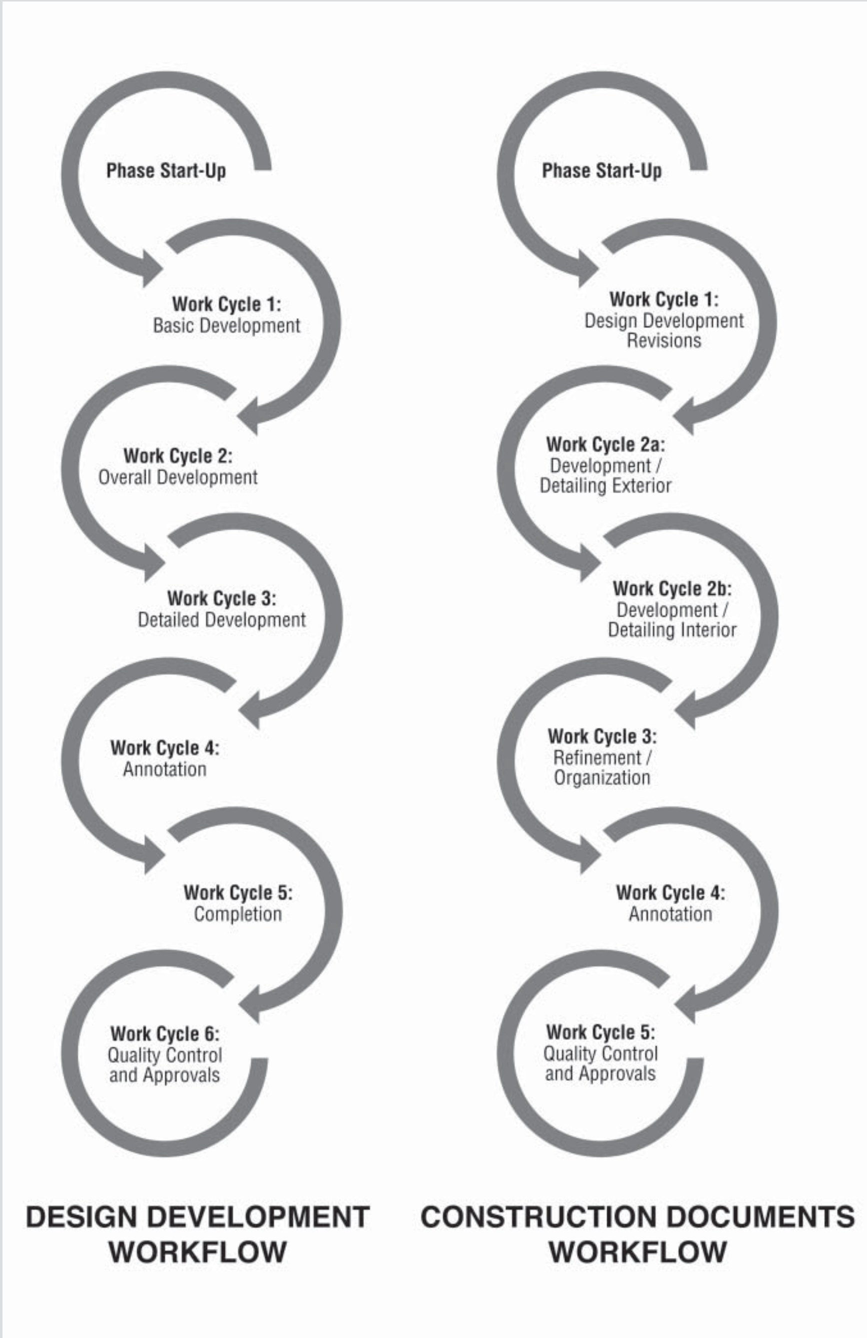

FIGURE 6.5 Work cycles diagram.

Viewing a representative cycle in a collapsed Gantt chart format (Figure 6.6), it is split into six main tasks: life safety plans, floor plans, roof plans, elevations, site plans, and quality assurance and quality control (QA/QC). In the full expanded view, each of the main tasks is further broken down into subtasks. The overall title represents what occurs within the cycle, which at this point is the minimum that must occur to begin sharing backgrounds or BIM models with consultants to progress the project forward.

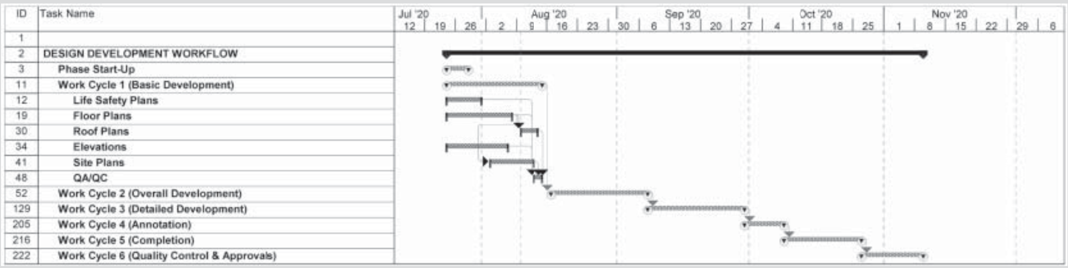

FIGURE 6.6 DD work cycle 1: main tasks.

Considering project phases in this manner offers the following advantages: (a) The process can be visualized as smaller efforts within the larger framework; (b) the duration of tasks can be monitored and assigned to staff; and (c) additional activities can be added and used in conjunction with other scheduling techniques such as pull planning.

Full-length Gantt charts showing the DD and CD workflows are located at the end of the chapter.

Critical Paths

In milestone schedules, the duration of the phases is set by the contract (SD, DD, CD) and make up the overall design time frame. A straightforward representation of this is accomplished with a Gantt chart.

Most examples of design schedules we see follow the illustration in Figure 6.7: not too detailed and not very descriptive. The example of work cycle scheduling is an expansion of the milestone Gantt chart and borrows from the contracting industry critical path method (CPM) of scheduling.

In the CPM, the critical path of a project is the sequence of dependent tasks that add up to the longest duration to get to project completion in the shortest amount of time. For example, oftentimes the installation of the elevators affects the entire construction timeline, with other tasks dependent on the elevator's completion. CPM has proven to be helpful to the contracting industry, and we cannot think of a commercial project under construction without one. So, we must ask the question, *Does design have critical paths?* The answer is yes, but not in the same way. Thinking in these terms, items such as floor plan, roof plan, and elevation development can be considered critical paths because the consultant teams must have them to progress their work. There are also additional examples in design

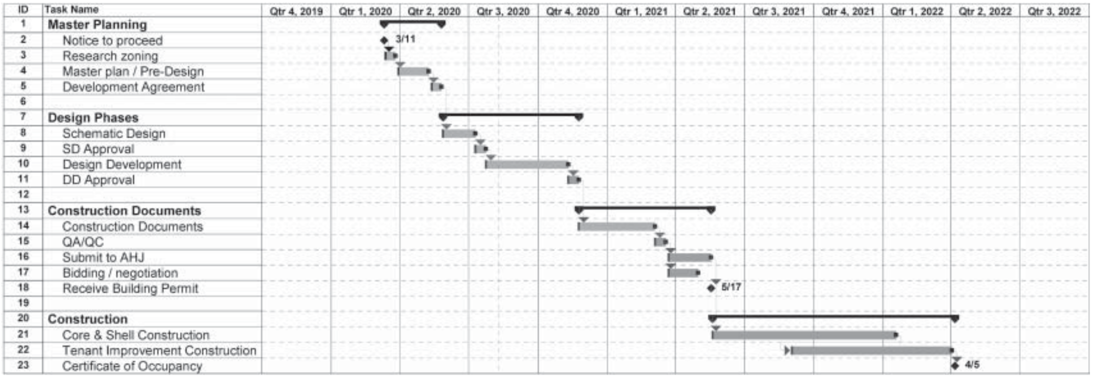

FIGURE 6.7 Representative milestone Gantt chart.

which influence schedule and may have a significant impact to deadlines, such as (a) design approvals, whether by the team or the client; (b) life safety approach, an incorrect interpretation or application of the building codes; (c) existing buildings, or discovery of unforeseen conditions; (d) building envelope, a selection of materials affecting energy code analysis; (e) scope changes, or major or minor revisions; and (f) budget, or internally designing to budget or external factors affecting budget.

The list points out that you will not be able to plan every item in; however, they do influence activity durations that are used to drive a project schedule and labor requirements. CPM scheduling can help us visualize the design process but is not essential to do so. In fact, we see few projects to which a team should schedule to this level. However, there are ways to use the ideas of CPM to aid in the overall process.

Take, for example, roll-out-type accounts such as retail stores, franchise establishments, and big box stores. These types of projects are typically site adapted with a similar scope and program and are good candidates for this method. If a studio, office, or firm doing such accounts finds their critical path and then exploits it to their advantage, scheduling the CPM way may have benefits. The takeaway here is the understanding that critical paths exist, just not in the way that construction manages them. Ultimately, the project manager should be aware and adjust their delivery plans accordingly.

Pull Planning

What if decisions were visually mapped out in a way where we know when a decision must be made or task completed? Who contributes to this, and what is affected downstream? Many design firms are borrowing a method widely used in the contracting industry and adapting it to the design side of delivery. If the entire project team is involved in setting a schedule for task completion and decisions then it is seen as more of a group effort, not just a dictated instruction. If our client's decision points were also included in such a method of project planning, then imagine the outcome: greater ability to make and stick to decisions and clear accountability.

Pull planning has been used by contractors for a number of years to plan subcontractor work as part of the implementation of the Last Planner System®[1] of Lean Construction. While not specifically targeted toward the design process, pull planning is increasingly being implemented by design firms to initially validate the milestone schedule and also to coordinate how the design team works together week by week. When also performed with the client present, it can be a powerful exercise to benignly show how their decision-making impacts the work.

[1] Last Planner System® is a registered trademark of the Lean Construction Institute (LCI) (leanconstruction.org).

Backgrounder 6.1 Collaborative Planning

CASE STUDY: PULL PLANNING FOR DESIGN FIRMS

About the Author

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CONCEPT

BRPH's branded version of pull planning, referred to as collaborative planning, was developed to enhance conventional critical path method (CPM) scheduling, typically done by a project manager or planner to establish project milestones, with more granular, task-based planning created by those who will perform the work. It is part of a more extensive BRPH Lean planning system, a hybrid approach borrowing concepts from the Lean Construction Institute's Last Planner System® and modifying them to address architecture and engineering (AE) design activities versus construction. Collaborative planning supplements traditional CPM scheduling and defines and refines interactions and information exchanges, creating conversations that produce a predictable workflow and assure that the right activity occurs at the right time. The resulting schedule is owned by the team, as its authors, rather than being dictated by others.

PROCESS

Planning is performed for only a single project phase – for example, design development – just prior to commencing the work on that phase. In this way, if the team determines they can deliver at an earlier date, future planning will work from the adjusted date forward for the next phase. Prior to participating in a collaborative planning session, discipline leads must complete project-specific homework to be ready and to derive the greatest benefit from the session.

First, determine appropriate model development specifications for your model components and systems to be provided for the milestone issue being planned. Next, develop drawing and specification deliverable lists for milestones. Guidance for content might include the AIA Project Checklist (AIA Document D200) and special submittal needs, such as those for contractor pricing or early procurement. And last, develop a work plan for deliverables, which will become the content of pull planning sticky notes, considering (a) constraints to accomplishing your work plan; and (b) precursor actions or components needed from others in to accomplish your work plan.

Session Planning Rules

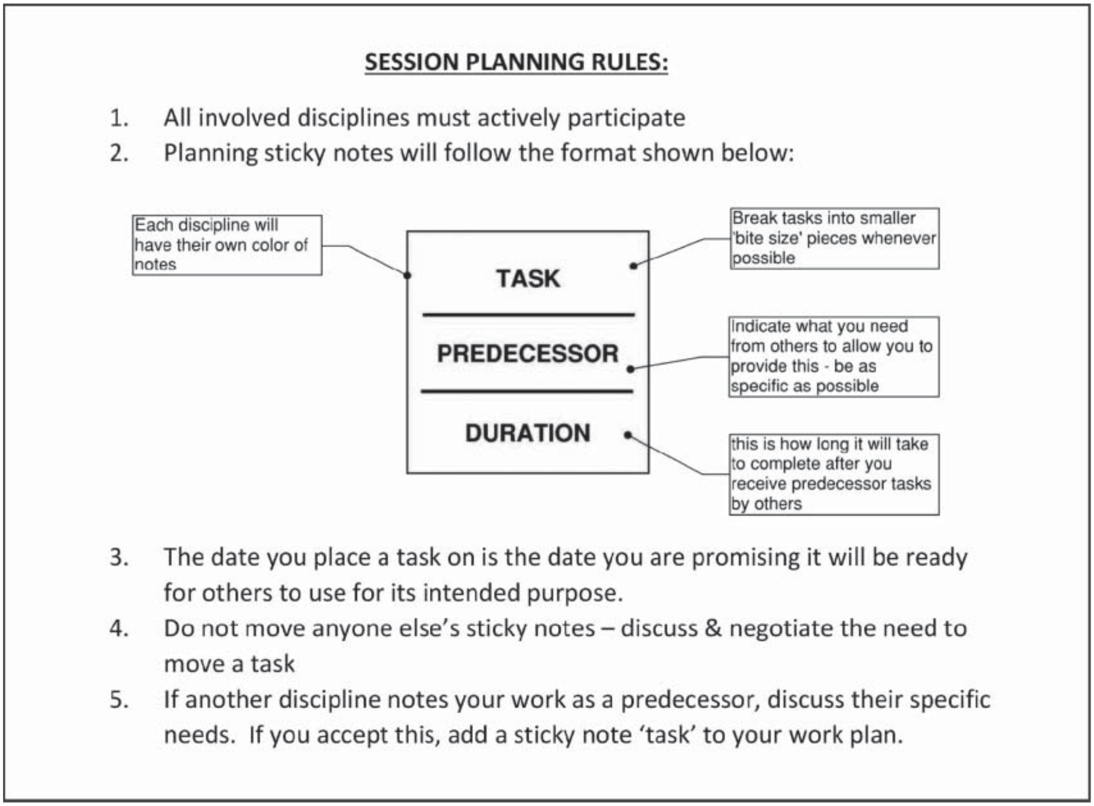
1. All involved disciplines must actively participate.
2. Planning sticky notes will follow the format illustrated in Figure 6B.1.
3. The date you place a task on is the date you are promising it will be ready for others to use for its intended purpose.
4. Do not move anyone else's sticky notes – discuss and negotiate the need to move a task.
5. If another discipline notes your work as a predecessor, discuss their specific needs. If you accept this, add a sticky note task to your work plan.

For the planning session, a planning board should be created to host the sticky notes (Figure 6B.2). The planning board consists of a series of columns, with each column representing a working day during the planning cycle. Dates or days of the week are not required at this point but can be helpful for indicating known schedule constraints such as holidays, meetings and, of course, the final delivery milestone date. We typically create our planning board on a whiteboard wall within a conference room, but it can also be done on reusable foam core boards, large paper easel pads, or a or a variety of similar materials.

Using the delivery milestone date (e.g., schematic design, design development, issue for permit) created by the CPM schedule as a target end date and working backward, the team members (under the guidance of a facilitator) use sticky notes to develop the network of activities required to complete their design tasks for the project phase, working backward from the completion date. Each task is represented by a sticky note and is filled out as described already (Figure 6B.1), detailing their work to a granular level the CPM schedule cannot provide. Sticky notes represent not only tasks but also promises made to other team members that the work described will be complete and available for use at the time indicated. After each discipline has laid out their work plan, the team reexams the flow of work they have mapped together, collaborating further to identify and mitigate bottlenecks, to shorten task durations, and to reorganize information delivery to create the smoothest workflow.

Consider using yarn or string to physically interconnect related processes (Figure 6B.3). This is a simple way to visualize critical connections in the workflow.

When the team is satisfied that they have optimized the schedule flow, with the goal of pulling tasks toward the due date to reduce the overall time required, the resulting schedule created on the planning board is transferred to project tracking software and overlaid on a calendar (Figure 6B.4). This becomes a production schedule and management tool used by the project architect to create



SESSION PLANNING RULES:

1. All involved disciplines must actively participate
2. Planning sticky notes will follow the format shown below:

3. The date you place a task on is the date you are promising it will be ready for others to use for its intended purpose.
4. Do not move anyone else's sticky notes – discuss & negotiate the need to move a task
5. If another discipline notes your work as a predecessor, discuss their specific needs. If you accept this, add a sticky note 'task' to your work plan.

FIGURE 6B.1 Collaborative planning session rules. *Source:* BRPH.

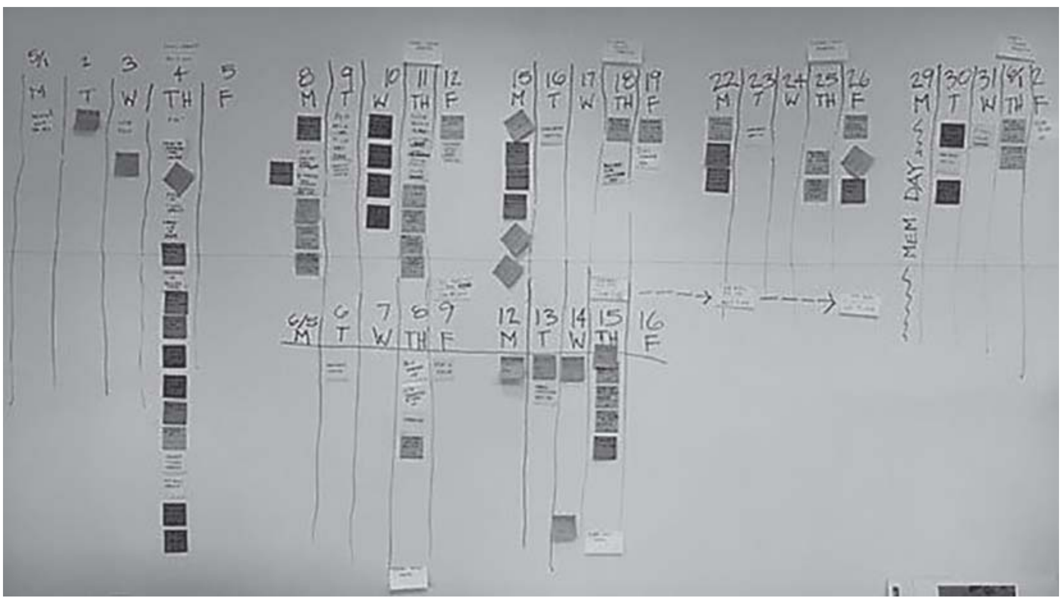


FIGURE 6B.2 Collaborative planning sticky notes on a wall. *Source:* BRPH.

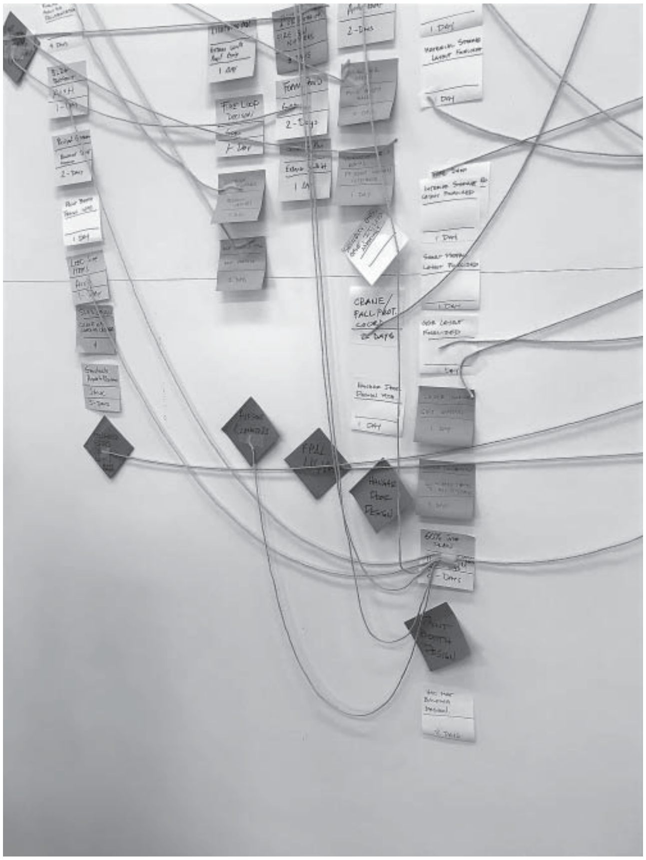


FIGURE 6B.3 Collaborative planning – interconnected processes. *Source:* BRPH.

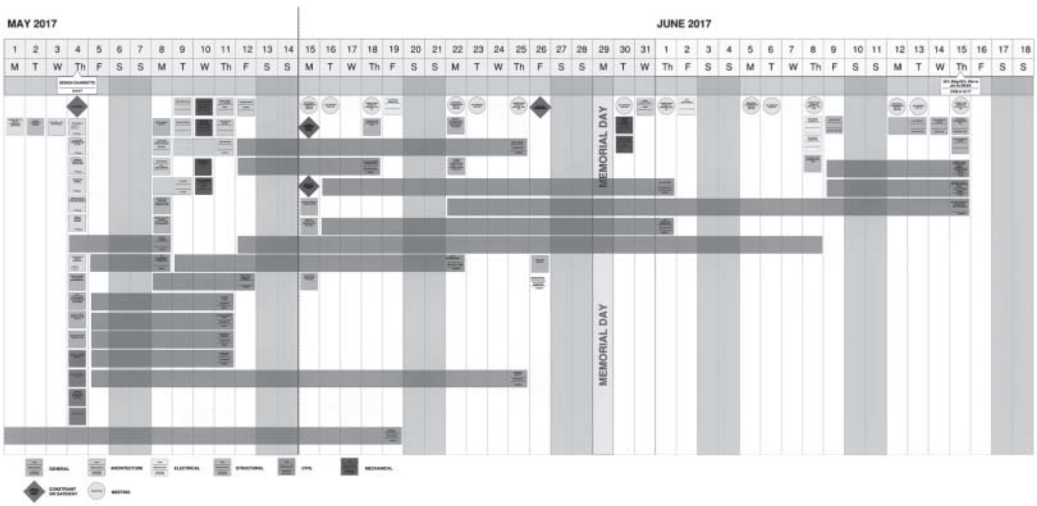


FIGURE 6B.4 Collaborative planning schedule. *Source:* BRPH.

look-ahead plans, weekly work plans, and tracking of metrics related to plan success. The resulting schedule is not static since scope changes and unforeseen circumstances and other issues always arise. Teams hold frequent, short meetings or check-ins to monitor progress against the schedule and adjust based on changing criteria or new information.

Look-ahead plans consolidate one or two weeks of the collaborative plan into a focused mini-schedule to break the performance and tracking of activities into bite-sized chunks. Weekly work plans take this a step further by using daily team check-ins to report progress during a single week of the planned schedule. These breakdowns are comparable to software development teams using a framework like Scrum to focus on a series of short-term sprints that aggregate into a larger project. The idea is that if the schedule is not meeting expectations, it is best to know as soon as possible so that impacts can be addressed by the team. In the worst-case scenario of an unrecoverable event, this would tell us that the milestone date is in jeopardy early rather than the day before it is due. It is much easier to explain to a client that their project's submittal due in 3 months may be late, with specific reasons cited versus a lengthy explanation after the deadline has passed.

The final piece of collaborative planning is performance metrics. Whether it is tracking the average reduction in delivery time versus the original CPM schedule or the ability of team members to keep their promised interdependent goals, metrics allow us to learn from our experience and carry these lessons forward to the next project phase or project. In addition to hard metrics, soft metrics such as how the team members felt about the value of the planning process can be just as meaningful and actionable.

ROLLOUT

Collaborative planning was introduced to BRPH staff in a series of presentations that defined the planning session process and its goals before applying it to a test project. For the test, a project of moderate complexity, run by a project manager and project architect who had shown a heightened interest in the earlier presentations, was selected for the first session. In addition to having leadership willing to try a new process, the project used was also ideally suited since it had completed conceptual design but not yet entered design development with a full team.

During the test project the team developed new methods for recording and maintaining the schedule they developed during planning, including weekly meetings led by the project architect that featured a reporting form that allowed each discipline leader to rate their own performance on adherence to schedule while also rating that of their teammates. This 360-degree feedback reinforced accountability and how keeping their commitments to each other was instrumental to reaching their collective goals.

As the use of collaborative planning has expanded through BRPH each subsequent planning session has yielded both variation and improvement in the process. Just as no two projects are alike, similarly no two project managers or teams are alike in their approach to the unique challenges or flow of their work. In each iteration, the underlying concepts and principles of pull planning remain intact as a foundation, but the teams are allowed, and even encouraged, to shape the mechanics of the process to suit their needs. This is the cycle of continuous improvement that is inherent in the system.

RESULTS

Beyond creating a smoother and more predictable workflow, collaborative planning has shown that the simple act of bringing teams together to discuss scheduling and the interdisciplinary interactions of how we develop design has yielded a better understanding and appreciation of how planned workflow can benefit the entire team.

Particularly for first-time participants, collaborative planning reinforces the interconnection and interdependence of design activities as a team. Consider the following example. An interiors task for planning a design development submittal might include preparing a reflected ceiling plan. In order to provide this task to a satisfactory level of completion (as defined by your homework), predecessor tasks performed by others might include (a) a lighting plan (electrical; (b) heating, ventilation, and air-conditioning (HVAC) diffuser plan (mechanical); (c) fire sprinkler layout (fire protection); (d) audiovisual appliances (communications); and (e) maintenance access panel locations. In return, for a building information modeling (BIM) production environment, each of the involved disciplines might request that interiors first provide basic ceilings within the BIM model to host their devices.

CONCLUSION

We acknowledge that this process is not a universal solution for project planning. However, the simple act of bringing teams together to discuss scheduling and the interdisciplinary interaction of how we develop work has yielded a greater appreciation for how planned workflow, as determined by those who produce the work, can benefit the entire team. Even in cases where the milestone delivery time was not reduced by planning (the ultimate goal), team members typically report that their work and interactions with their team were less stressful due to the defined expectations, predictability, and goal definition that the collaborative plan established.

Collaborative planning at BRPH continues to evolve as we learn from each planning session we perform. As with all aspects of Lean, continuous process improvement and learning are the hallmarks of every pursuit. After all, as is popularly said, Lean is not a destination; it's a journey.

END OF BACKGROUNDER

Pull Planning Project Example

Figure 6.8 is a simplified version of a pull planning schedule for a fast-track project, done to coordinate the flow of information across the design team during design development and to lead to early deliverable packages for permitting and construction to the construction manager.

Fast track: projects where early document packages such as foundations, civil, and superstructure are released, allowing the contractor to begin construction while the design is still in progress.

Beginning with the basement, the informational handoffs between disciplines were orchestrated, working through the floor plan layouts with plumbing and medical equipment items – to prepare for the foundations, elevators, landscape, and civil package. The effort continued working from the third floor down to the first in preparation for the concrete superstructure package. In this example, the MEP guaranteed maximum price (GMP) documents were for major equipment items only.

The schedule was documented using a spreadsheet only and worked out between the architects and consulting engineers. The original document was color coded for each consultant.

Beware of the tendency to become fixated on a type of software or process at the expense of what you are trying to achieve. Orchestrate the work and make it visually simple to heighten understanding.

A/E Pull Schedule - Fast Track Hospital thru GMP Issue

DATE	ACTIVITY	REMARKS
10/2	~~Arch issue Basement Plan to MEP~~	~~Includes partitions, plumbing fixtures, medical equipment locations~~
10/3	~~Meet w/ City (Arch & Contractor)~~	~~Review project schedule & City review processes~~
10/4	Equip Planner issue Basement medical equipment list (Partial)	Includes equipment dims, MEP requirements summary
10/9	~~MEP provide Basement light fixture counts for all areas w/ cutsheets~~	~~Arch to generate RCP layouts~~
10/21	~~Arch issue 1st Floor Plan to MEP~~	~~Includes partitions, plumbing fixtures, medical equipment locations~~
10/21	~~**ISSUE FINAL CIVIL TO CITY ENGINEERING DEPT FOR COMMENTS**~~	
10/23	~~Arch issue Basement Final DD to MEP~~	~~Includes elect outlet locations, med gas locations & quantities, RCP's, etc.~~
10/25	~~Equip Planner issue 1st Floor medical equipment list (Partial)~~	~~Includes equipment dims, MEP requirements summary~~
10/26	~~Equip Planner issue Basement medical equipment (Complete)~~	~~Room x Room, Crib Sheets, & cut sheets~~
10/28	~~MEP provide 1st Floor light fixture counts for all areas w/ cutsheets~~	~~Arch to generate RCP layouts~~
10/28	Arch issue 3rd Floor Plan to MEP	Includes partitions, plumbing fixtures, medical equipment locations
10/29	**ISSUE FOR PERMIT & CONSTRUCTION - FOUNDATIONS / ELEVATORS / LANDSCAPE / C**	
10/31	Equip Planner issue 3rd Floor medical equipment list (Partial)	Includes equipment dims, MEP requirements summary
11/4	MEP provide 3rd Floor light fixture counts for all areas w/ cutsheets	Arch to generate RCP layouts
11/4	Arch issue 2nd Floor Plan to MEP	Includes partitions, plumbing fixtures, medical equipment locations
11/7	Equip Planner issue 2nd Floor medical equipment list (Partial)	Includes equipment dims, MEP requirements summary
11/11	MEP provide 2nd Floor light fixture counts for all areas w/ cutsheets	Arch to generate RCP layouts
11/18	Arch issue 3rd Floor Final DD to MEP	Includes elect outlet locations, med gas locations & quantities, RCP's, etc.
11/21	Equip Planner issue 3rd Floor medical equipment (Complete)	Room x Room, Crib Sheets, & cut sheets
11/25	Arch issue 2nd Floor Final DD to MEP	Includes elect outlet locations, med gas locations & quantities, RCP's, etc.
11/28	Equip Planner issue 2nd Floor medical equipment (Complete)	Room x Room, Crib Sheets, & cut sheets
11/28	Arch issue 1st Floor Final DD to MEP	Includes elect outlet locations, med gas locations & quantities, RCP's, etc.
12/3	Equip Planner issue 1st Floor medical equipment (Complete)	Room x Room, Crib Sheets, & cut sheets
12/15	**ISSUE FINAL GMP DOCUMENTS**	**ARCH & MEP**
	– Develop Pull Schedule	
1/6	**ISSUE FOR PERMIT & CONSTRUCTION - CONCRETE SUPERSTRUCTURE**	
	– Develop Pull Schedule	
3/3	**ISSUE FOR PERMIT - ARCH & MEP (SHELL & CORE)**	
	– Develop Pull Schedule	
4/15	**ISSUE FOR CONSTRUCTION - ARCH & MEP**	

FIGURE 6B1.8 Example: Design team schedule for fast-track project.

Project Roadmap

Project schedules involve agreed upon time frames, but another aspect of project delivery is to understand what to do and when to do it. William (Bill) T. Nigro, AIA, developed the RediCheck interdisciplinary checking system in 1981. It was developed to address recurring problems and issues he had observed on projects while working with the Civil Engineer Corps of the US Navy. The RediCheck system has proved effective to significantly reduce change orders and is in use today across the United States for document checking and review by the RediCheck Firm, LLC (http://www.redicheck-review.com).

Unlike many checklists, the RediCheck approach is insightful as it examines design documents, looking at typical areas of miscoordination and where different disciplines systems interface. It introduced a sense of timing as to when specific aspects of work should be thought through and coordinated, some in design with others during construction drawings. This is an intriguing idea and can be used as a project roadmap where we identify what to work through and in what sequence. Characteristics of a project roadmap: (a) phase driven; (b) tasks to accomplish (i.e., think-through); (c) information to exchange between consultants; (d) items to coordinate; (e) things to check; (f) typical documents; and (g) project events and activities that facilitate decision-making and coordination.

Note that checklists like Figure 6.9 must be adapted to the project delivery methodology, such as fast track or those with early construction document release packages. A full copy of the Project Roadmap is included at the end of the chapter.

PROJECT ROADMAP
PRELIMINARY / SCHEMATIC DESIGN

PROJECT COORDINATION

GENERAL

- ☐ Identify scope of work - building and site
- ☐ Is the Owner's budget reasonable?
- ☐ Review the project schedule and deliverables, are they reasonable?
- ☐ Work out Schematic Design deliverables and dates w/ AEC team
- ☐ Identify GC or CM and type of delivery process - Design-Bid-Build, CMAR, etc.
- ☐ Determine general construction phasing approach
- ☐ Determine applicable codes and AHJ agencies
- ☐ Determine the overall life safety strategy (building construction type, allowable areas, height limitations, paths of egress, stairs, rated corridors, separation between new and existing additions (if required), etc...)
- ☐ Order specific code publications as required.
- ☐ Obtain copies of existing plans, specifications, if applicable; geotechnical reports, topographic surveys, etc.
- ☐ Is a Plat required?
- ☐ Verify that existing site utilities are sufficient for the project - sewer, water, electricity, gas, etc., and identify preliminary routings.
  - Review existing easements and whether new are required.
- ☐ Define LEED / Sustainability goals for project, if applicable
- ☐ Is elevator study required?
- ☐ Identify major equipment (production, kitchen, medical, elevators, dumbwaiters, etc.) These are items the contractor needs to be aware of, they impact construction x load, size, space requirements. Anything affecting layout and other disciplines.
- ☐ Determine major building systems
  - Building exterior skin systems and roof
  - Determine interior finishes along with a cost value range
  - Structural systems and preliminary layout
  - MEP systems including locations of mechanical and electrical rooms; initial equipment selections and layouts; initial routings of ductwork and major conduit runs; shaft locations and initial plumbing and electrical fixtures
  - Identify telecom and low voltage systems and MDF / IDF room locations.
- ☐ Determine an initial site grading approach.
- ☐ Identify the extents and scope of demolition.

FIGURE 6.9 Project roadmap example.

WE REALLY DO NEED EACH OTHER

Returning to a sports analogy, a team is ultimately only as good as the players on the field, and many firms experience difficulties arising from insufficient or inexperienced staff. Recruiting, training, and retaining good personnel can be an ongoing concern. In addition, many experienced architects are no longer proficient with the tools of the trade and must depend upon younger staff to do the work.

To help address these points firms can draw on the experience of senior staff to actively mentor and train younger staff; can pay close attention to the project team composition to ensure that issues of management, design, constructability, and documentation are all addressed; and can elevate the stature of production work to complement that of the design work within the firm and recruit individuals skilled in construction detailing and putting buildings together.

Roles and Responsibility

Team creation is often overlooked as a measurement of success. During a request for proposal (RFP) stage, the marketing department may work with a principal or studio leader to put the most qualified staff in the proposal to stack the team and get shortlisted for an interview. In reality, the proposed team may not be the team that will actually do the bulk of the work. The team members whose resumes appear within the RFP (Figure 4.1) are likely those with the most experience or in leadership positions. These staff are also those who may be spread thin across many projects due to their position in the firm. If the RFP is successful and the project proceeds, how does it get staffed? Each firm has their own methods of staffing, but a common method is to determine who has immediate availability and place them on the project without regard to the best fit or complementary skill sets. In some cases, the outcome can be damaging not only to the budget but also to the firm's reputation.

How do we staff projects intelligently? A good example is that a project with a versatile, technically strong project manager may be able to utilize a less experienced project architect and vice versa. Understanding project roles as opposed to hierarchy is important. Hierarchy indicates lines of authority and responsibility, but not necessarily competency or availability. Each team member is important in their respective role and subject to staffing constraints, we must assemble a team that is more than a collection of individuals. If we recognize some teams as being deficient in an area, we may be able to supplement the lacking expertise on a temporary basis to provide support. Again, it is of greater value to prevent a problem from happening than to expend effort later, at a higher cost, to remedy it.

Project roles vary between firms and may even differ within the same firm. Understanding the roles in the firm is an important aspect of knowing where the strengths and weaknesses occur and to classify employees according to their skill level. Some firms claim to be a flat organization where everyone is proclaimed to have the ability to fit in any role. This may be possible in a sole proprietorship or perhaps in a small firm, but the authors have experienced very few individuals who meet this expectation at medium to large firms. Not all architects are created the same. Some favor the design side, while others are more capable doing the delivery work, with very few who excel at both to a high level. If the premise is that anyone can perform any role, then presumably all titles can be eliminated, and everyone be paid the same salary. Of course, this is a ludicrous statement, and the premise backfires when a flat team proceeds to work on a project without the guidance of defined roles and responsibilities. If this was to occur, then in effect everyone believes they are empowered to do whatever tasks they want to do instead of focusing on the work that needs to be accomplished to move the project forward. Or think of it this way: if everyone thinks they are leading, then no one is leading. This scenario is entirely avoidable, but as good managers wanting to grow staff and trying to provide opportunities, we occasionally lose sight of the best fit for roles in a project.

In football, the head coach recruits for the best talent at each position. During training camp, the new players must earn a spot on the team and compete against each other for a coveted starting lineup position. It is extremely competitive, and there is no entitlement. Similarly, design firm employees who do not get the role they desire on a project team may have to work harder on the tasks they currently have or simply gain experience over time to prove they are ready for greater responsibility. In this case, compete for the next job but do it as a team player. Do not be disillusioned by not being the leader; serving as a role player also has its benefits and allows one to grow into a better designer, architect, and future leader. In the quest for higher position and increased responsibility, it usually starts with doing well at whatever you have to do at present.

KANBAN

Kanban is a Japanese term for visual signaling or scheduling. Figure 6.10 illustrates a simple but useful tool to assign tasks to project team members. It is a variation of a Kanban board representing tasks using a to-do, doing, and done visual format. In this example, the work items are dragged to the individuals identified at the top of the columns. When the task is completed it is dragged to the done column. A similar approach can be used to manage consulting engineers' teams.

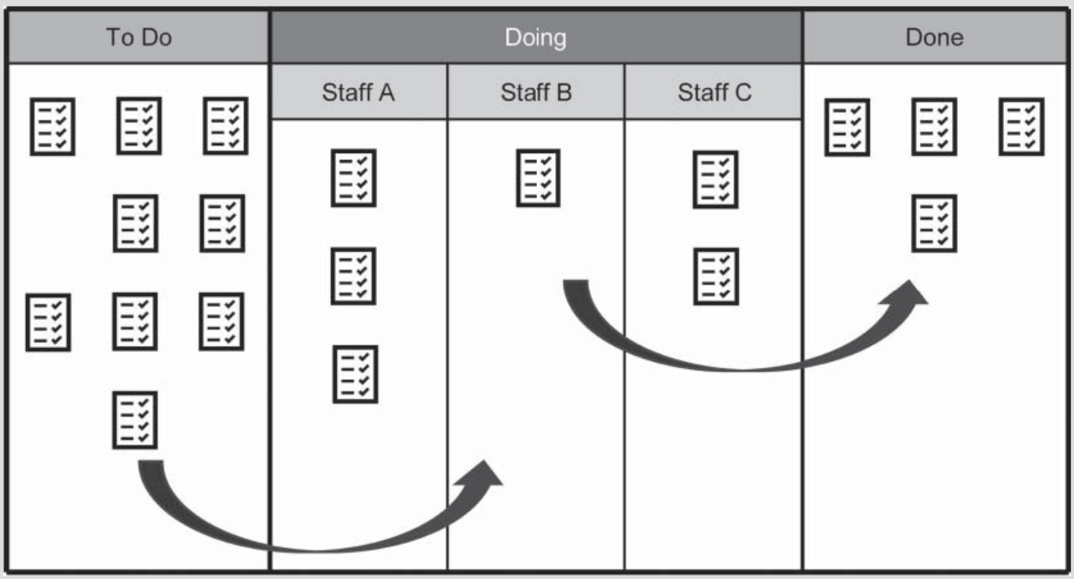


FIGURE 6.10 Kanban board.

Many web-based programs and software on the market offer a variety of board layouts. The advantage of this type of visual and real-time scheduling is that all team members can simultaneously see the progress of the work and help complete tasks as required to stay on schedule. Kanban boards offer flexibility to complete work as needed to help facilitate a more continuous flow. If assignments are not made by the project manager, however, team members choose their own tasks, and everyone is essentially on a level playing field. Allowing this approach to self-tasking minimizes project hierarchy and roles and can lead to critical items not being addressed by anyone.

Upon the successful project win and a signed contract, the real work begins. Now we have to think seriously about the effort required to deliver the project within the agreed upon schedule and budget. There are many viewpoints on what the architect does or should do. Some see our value and focus as being centered on aesthetic design; others see the work as discreet series of tasks, phases, and deliverables, as outlined in the contract.

MANAGE YOUR MONEY

In contrast with earlier times, firms today have a greater business focus with an emphasis on profitability. It is common for projects to be managed using financial metrics and their success measured solely by profit. Publicly held firms face increased pressure with quarterly statements and shareholders to answer to and are typically assessed on a short-term basis.

It is common when starting a new project for the project manager to review the fees with the project team and discuss how they are allocated by phase and discipline. We do that to know how many hours the fee equates to in order to pace ourselves and make a profit. We do not want our fees consumed in the design phases alone or, if the job goes on hold or is canceled, to have exceeded the fees we are able to bill for. And for many projects there is no issue.

Working Ahead of Billing

Oftentimes there is a tendency to progress the project at a faster rate than the agreed upon fee schedule (invoice plan) due to staff availability or other influences. This can be advantageous in some scenarios but detrimental if the project pauses or goes away completely. You must measure the risk prior to adopting this strategy as it equates to gambling with your firms' finances.

How we measure ourselves has great impact on the ways we manage and motivate people as well as our perception of value. If viewed solely through a financial lens, we will tend to evaluate every facet of work from a quantitative viewpoint consisting of dollars and cents only. We may even attempt to monetize tasks and use analytics to fine-tune every effort.

A qualitative viewpoint examines what is being accomplished and whether we are progressing the work or not. In other words, with an eye on the financials, it also seeks to make sure the project is moving ahead correctly. Meeting financial targets by themselves is no indication of whether the work is done right, and it sometimes causes us to do absurd things.

MANAGING BY THE NUMBERS

During the peer review of a large project's schematic design documents, the reviewer examined a current set of drawings looking at the overall scope of work, life safety approach, and understanding of the building systems that were anticipated. Many of the team members were young and using BIM software, a newer platform at the time for the firm.

Understanding the importance of early setup for modeling with BIM software, the reviewer asked when an experienced project architect would join the team. The project manager responded, *Our accounting plan doesn't support adding the project architect until the design development phase*. The reviewer responded that you do not wait until design development to begin thinking through the issues of how a building is put together as there are too many model implications, in particular, those of constructability. Put another way, the foundations for a good set of construction drawings are established early in the design phases. The project manager listened and continued ahead with the work.

Several weeks later the project architect joined the team full time and found the BIM model developed in such a way that they needed to scrap it entirely and start over. The good news was that the "accounting plan" then supported the project architect's involvement, and it was acceptable at that point to waste the time and fee.

The project manager's decision to allow the project development effort to be guided only by financials hindered it by allowing unresolved issues to build up – in this case an improperly modeled building – and it ultimately affected the job's and the firm's profit margin. Modern accounting software provides the ability to track a team's efforts over time and to measure against financial goals along the way. However, if the goal of the work is to complete projects in order to get paid, it is advantageous to do so with as little rework as possible.

Making Money

If the goal of the firm is to make money in the overall sense, is the best way to do that for each project to be individually profitable? Or is the whole greater than the sum of the parts? The answer has ramifications in how we staff work, reward teams, and assess success or failure. In our experience of trying to achieve individual project profitability, it becomes a weekly task to review timesheets and track down those who had put time to a job but should not have. Some do it by accident, and others just spend too much time on the job. What value is there in parsing hours? It takes time to find them, and then the accounting department must make time to contact the offender and find out what they really did – and a little more time to fix the error. Is our goal to keep perfect records no matter how long it takes? Yes, but only if it does not impede flow.

> **We should be less interested in looking for boxes to place time in and instead judge whether the effort expended contributed to moving the project forward.**

In the effort to reduce overhead costs, we sometimes eliminate accounting and similar administrative positions and shift those tasks to project managers. While there may be an immediate financial benefit, project managers can quickly get bogged down in a quagmire of everyday work – to the exclusion of tending to the client or the progress of the work. We must be mindful when balancing the firm that we may unintentionally create constraints elsewhere.

Backgrounder 6.2 Financial Metrics

About the Author
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In architectural practice today, there are no shortages of financial metrics available to senior leaders and project managers – and numerous communication channels exist to constantly disseminate that information. The key question then becomes how to focus on the most effective metrics and use them to incentivize the right behaviors? How can senior leaders resist the temptation to microanalyze their financial statements and keep their eye on broader firm-wide metrics that truly measure the health of their practices? In this section we'll address these issues and discuss some of the shortcomings of certain popular metrics.

In addition to providing detailed project-level financial information, today's accounting systems allow large enterprises to slice and dice their performance across multiple dimensions such as offices, regions, markets, and principals-in-charge. However, this ability to analyze our organizations in finite detail can create a tendency to overanalyze and focus on the wrong things – in effect, viewing the parts versus the whole. It is highly tempting in any organization to isolate as many components as possible – and measure those components for stand-alone efficiency and contribution to the larger organization. This is not an unreasonable expectation. If your firm has eight office locations and you can get all eight to perform in the black, then surely the total profit for the firm will be positive, correct? Well, certainly your firm will be profitable, but, no, you may not have maximized the firm's potential.

The first risk of this slice-and-dice approach is in getting too granular with the analysis, whereby the metrics that work at a firm-wide level no longer work well at this smaller scale. A former partner of mine once had the goal of refining the accounting system to such a degree that we could see a profit and loss statement at the individual level. Fortunately for the firm – and the mental health of each employee! – that approach was never realized. Aside from the fact that a highly functional architectural firm is successful due to its systemic structure – and not as simply a collection of individuals – drilling down to ever smaller and specific profit-and-loss statement ignores the truth that the only 100% accurate measure of profit and loss is at the enterprise or firm level. All other by-office, by-market-sector, and by-project breakdowns of profit and loss are financial abstractions to one degree or another. They all require certain assumptions of how firm-wide costs should be divided up and allocated to that particular entity. Even if you can get the allocations reasonably accurate, you consequently incentivize leaders and project managers to focus on only their piece and not the whole.

Also missed by this analysis of the parts is the interconnectedness of your entire system and where certain constraints may be holding back the firm's overall performance. Progressing schedules and meeting milestones are the most direct routes to creating value for the client and generating revenue for the firm. These processes encompass everything from the visionary rendering that secures approval for a project to a complete set of construction documents ready for bidding and a final punch list that facilities beneficial occupancy. Firm processes should be focused on always achieving key milestones on or ahead of schedule. Achieving one milestone frees up resources to meet the next one and so on. Counterintuitively, it may make sense to add staff to a project that is losing money – simply to get that project out of the way in order to free up resources to create better value on something else. Unfortunately, firms are often too obsessed with how many hours are charged to an individual project for this last concept to gain much traction. I've known many project managers who obsess over keeping principals and highly compensated staff from charging to their job. This thinking is highly flawed and demonstrates an undue emphasis on project profitability versus firm-wide optimization. Many years ago, I was managing a project that was well into the schematic design phase, and the project architect was struggling with code issues involving the main elevator configuration. The president of the firm stopped by our workstations to discuss the project, and in the space of a few minutes he suggested a floor plan change that solved the code issue and created a far more appealing aesthetic and functional solution. Had we not had that intervention by an expensive person, the entire design and documentation phase of that project would have borne the drag of that problematic layout – and ultimately delivered less value to the client. The other flaw in this aversion to senior staff charging to projects is that the cost of senior staff do not magically go away if a project manager keeps them off their project. Their costs are still with the firm regardless of where their time is charged. The talents of these experienced individuals should be highly leveraged to move projects forward and add value.

How a firm's metrics are communicated to project managers is also critically important. The challenge for senior leaders is to focus on those metrics that individuals within a firm can actually control and exert influence over. Some financial metrics are directly actionable, while others are the end result of multiple decisions and actions. It is also critical that there be a shared understanding of the rationale and fidelity behind each metric. Let's discuss some key flaws with commonly used financial metrics.

Chargeability is defined as the percentage of time an individual spends on actual, billable projects versus their total available hours. A key mind-set that still exists in the architectural profession is the billing time paradigm – similar to a lawyer or consultant billing by the hour. Labor utilization and billability measurements support this paradigm as they are used to exhort individuals to be more billable. Unfortunately, this mind-set completely overlooks the concept of *value* and whether or not the additional effort toward project time actually delivers this value. As defined by Lean principles, value is what the client is willing to pay for, and measuring staff chargeability does nothing to communicate whether or not value is being realized by the client.

Direct labor is the portion of an employee's salary in dollars that is charged to billable projects. Indirect labor would be the remaining portion spent on administrative tasks, marketing and business development, holidays, time off, and so forth. Direct labor is foundational to many other metrics and views all dollars spent as equal. Again, value is not a part of this equation.

Project profitability would seem to be the most basic of metrics. The primary goal of a firm is to grow profitably, so why not review profit rigorously at the project level? The problem is that profit is the result of many actions, not a single lever that can be pulled. This gets even more problematic when individual project profitability is how project managers are measured. With overhead factors often being larger than direct labor and not subject to a project manager's direct control, project managers shouldn't be held to a project profitability goal. Their efforts should be toward the best use of the direct labor dollars that they do control.

The better metrics that senior leaders should be focused on all center around value and driving more revenue:

- **Net Multiplier** (Net Revenue divided by Direct Labor) – while acknowledging the aforementioned shortcomings of Direct Labor, Net Multiplier captures a firm's ability to productively use that Direct Labor, negotiate good fees and capture additional services . . . all value focused, not cost focused objectives.
- **Revenue/Employee** (Net Revenue divided by total Employee count) – a broad measure that also captures how much value we as architects deliver to our clients. While we can't measure up to the revenue generating capabilities of the high tech industry (Google generates approximately $1.25 M in net revenue/employee) we can certainly improve on our current situation of roughly $150 k–$200 k per employee.
- **Revenue Factor** (Net Revenue per Total Labor dollars) – while similar to Net Multiplier, this metric eliminates the problem of distinguishing between Direct and Indirect Labor dollars. Instead of viewing Direct Labor as "good" chargeable time and Indirect Labor as "bad" overhead time, this metric illustrates how well ALL labor is creating value for clients.

CONCLUSION

To recap, senior leaders should give greater emphasis to the metrics that measure value creation versus metrics that are only cost focused. They should be mindful of how certain metrics – and subdividing the enterprise – can be driving counterproductive behaviors. While costs are important, they should not override the prime directive of the firm to move projects and processes forward and create lasting value for our clients.

END OF BACKGROUNDER

Essential Terminology

Architecture firms typically allocate over 50% of their fee between the schematic design phase and the start of construction (SD, DD, CD), and the majority of the project life (about 80%) is spent with the development and use of the construction documents (DD through the end of construction). Realizing this concentration of fee allocation, what percentage of design professionals has been exposed to the essentials of business finances and the basic notion of what it means to run a business? The answer is simple: a limited amount. The fundamentals of business are not something we are adequately taught in architecture school, yet with the number of small business owners in the profession it is something that should be necessary to understand. We will not get into the weeds of running a business, as there are books and other material available to those who want a deep dive. However, we do feel the need to cover essential terminology and show an example of how fees translate on a hypothetical project.

Gross Revenue
Total amount firms bill to clients

Direct Expenses
The consultant fees and project-specific expenses we pay

Gross Revenue
- Direct Expenses

***Net* Revenue**
What we get to keep

Net Revenue
/ Direct Labor

Net Multiplier
Measures the firm's efficiency at converting direct labor spent completing projects into revenue dollars

Metrics That Matter

Design work does not lend itself easily for comparison, and there are no baseline metrics. Unlike manufacturing where the same employees perform nearly identical tasks each day, design firms, by definition, are creating unique solutions for specific clients who retain the right to change their mind. Projects vary widely with differing requirements, contractual obligations, fees, methods of project delivery, and team makeup.

Some useful metrics for architects and engineers are as follows.

Objective: The Firm's Profitability (Versus Individual Projects)

This is a good question to ask – and perhaps the only one. If we are making more money than we are spending, that is a positive indicator. However, it is not necessarily a reliable gauge to know if we are working effectively. For any given project, we can negotiate a great fee and work wastefully, still earning a profit. Alternatively, we may have a great fee and work efficiently, making a larger profit. There are similar benefits for low-fee projects.

Subjective: The Client's Opinion of Us and Our Work

This is obtainable through informal analysis, surveys, and observation – the reduction of litigation, repeat work. After profit, this may be the next most important indicator. If they are pleased and give us additional work, our efforts may be considered worthwhile even if we lost a little on the job. A long-term client who keeps coming back for services is the best type of client.

Subjective: Requests for Information, Architect's Supplemental Instructions, and Change Orders, Grading Them by Causation

These include AE design, Authority Having Jurisdiction (AHJ) changes (gray areas of code interpretation), unknown conditions, client changes, and contractor changes due to misfit and errors. We understand that grading these by causation may cause some legal counsels to have concern; however, to improve requires a recognition of where improvement is needed. These can be an indicator of poor project management or documentation. It may also reflect a B team contractor or a client who keeps making changes. Parsing through a list of requests for information (RFIs) and change orders can be educational. Identifying the similarities of RFIs across many projects can lead to documentation improvements if there is rigor in the process of categorization.

Objective: Time Spent Performing Rework Due to Internal Design Changes and Mistakes (Not the Client or AHJ)

Rework is a form of waste, and not Lean. Also, understanding where we need to improve is valuable information, especially if we see the same problems repeating.

Objective: Number of Sheets in a Set of Construction Drawings

This is still a fairly good guide to the overall effort spent – yes, even in the BIM age. The more sheets there are, the greater amount of information there is to manage for the duration of the project. Think instead about how to lay out sheets more effectively so they are easy to follow. Use sheet white space to your advantage to save on flipping. There is an old saying about a three-finger rule when flipping through drawings: if you have to hold more than three pages as you navigate to a detail in a set, then the set is not well-thought-out.

None of these is perfect; however, trends are a valuable indicator, and we can begin to establish a general baseline using the projects already completed. In whatever way we define *success*, it must also be balanced by considering the firm's goals. A company that becomes more efficient in producing construction documents may use the time and fee saved to offset increased effort in design itself or to better address issues of sustainability – with profitability unchanged. The ability to progress work more readily and achieve the same or better work product quality in a reduced time frame or with fewer staff is a valuable competency.

Sports teams keep stats for many aspects of the teams and individual performances. They serve to provide insight and certainly make for interesting conversation. At the end of the day, though, it is the team's victories that count. Think of your own meaningful metrics against which to measure yourselves. The exercise may be enlightening. Or perhaps the better effort is to understand what adds value to our work – and relentlessly pursue that.

Challenging Assumptions

Some common assumptions that may prove incorrect are as follows.

Fees are sufficient for a given project.

RESPONSE: Not necessarily so. Firms will often take on work for a low fee to win a new client in the hopes of future work or to keep another firm out of the running. Clients can also create inefficiencies, or we may not be able to place a good team on the job. At other times we may simply need the cash flow for operations and are willing to work to break even or for a slight loss.

The fee as budgeted by phase is adequate.

RESPONSE: Again, not necessarily so. Traditional fee breakdowns by phase are still largely based on how we worked decades ago. BIM and changing project requirements sometimes require a greater effort up front, earlier in the design. When submitting proposals and working through contracts, consider shifting to billing a higher percentage for the design phases and correspondingly less for the documenting and construction administration phases later.

Each phase of work should be profitable by itself and this is an indicator of good project management.

RESPONSE: No. While it may serve as a goal for the team, the mathematics of fees can be somewhat arbitrary when applied to the realities of design and project management.

There are many reasons why there may not be enough fee in the job or a phase to support the effort and hours needed to get the work done properly. In those situations, what options do we have? We can continue to work on the project but put the additional hours on other projects and initiatives or just not report them (i.e., work overtime). We can also defer aspects of work from one phase until later when the fee allows more time. We can also use less experienced and lower-cost staff or outsource the work and can reduce the deliverables we produce and hope we can get by. We can do the work regardless, anticipating the client will make project changes we can bill for later and perhaps make up some of the difference. We can shift fees around the disciplines or ask the client for more money, which may be difficult to realize.

Regardless of staff, time, or fee, every project must meet the standard of care. It must address the client's program, resolve all functional and design issues, meet the budget (or a revised one), and issue documents on schedule that are sufficient for bidding and construction. Unresolved issues and corner cutting will necessitate additional time and money to fix later – and yes, we will remedy all project related problems. *When* we resolve project-related issues is of primary importance, and the earlier we do so, the better.

The Standard of Care

What an architect or engineer can reasonably be expected to do on a similar project in a comparable area and circumstance.

The AIA defines the architect's responsibilities in the *B101 – Standard Form of Agreement Between Owner and Architect*: The Architect shall perform its services consistent with the professional skill and care ordinarily provided by architects practicing in the same or similar locality under the same or similar circumstances. The Architect shall perform its services as expeditiously as is consistent with such professional skill and care and the orderly progress of the Project.

You may notice that the word *fee* is not included in the description.

Utilization

One method of assessing individual performance is staff utilization, or the percentage of an employee's time spent doing billable work that the firm can invoice for. This appears to be a reasonable expectation; however, an assumption is often made that high utilization is an indicator of a productive office. Utilization indicates where people are putting their time (correctly or incorrectly) but provides no qualitative insight as to whether the work is being done efficiently.

Statements you will sometimes hear:

- **If I have 5 weeks allocated to do the work, I can often do it in less, say 4 weeks – but I will not because I need to stay billable.**
- **We are over budget, and I am having the team hide its hours on other projects.**
- **I record only 40 hours to a job but keep an exact record of my time to compare the overtime worked with my annual bonus.**

Accounting is an imperfect tool to navigate by. We see this when project A team slows down temporarily, and we do not let the team work on project B because it might hurt their profitability. This is detrimental to the firm while appearing beneficial for project B.

Billable Work

Here are some all-too-typical work activities that are acceptable to bill for on most projects:

- **Making the same mistakes and fixing them**
- **Rework**

- **Redoing research of building systems**
- **Overmodeling**
- **Overdocumenting**
- **Reinventing firm standards**
- **Redesign**

If your firm is struggling with low utilization rates, this list may be helpful to get you back on track!

It can be advantageous to use profit from one project to subsidize the efforts on another regardless of the fees. Why would we do that? Decisions and issues that remain unresolved often require more time to resolve later. That is because work must often be undone and recoordinated, both of which are wasteful. It is better to get it done correctly the first time and on time.

How we measure and reward our employees directly affects how they perform.

If we increase the throughput of our firm, that is, our ability to move work through the office, we gain an immediate advantage. More can be accomplished by the same staff in the same time. Too often we resort to having people work overtime when it would be beneficial to work more effectively. With generational changes that affect a younger staff's view on the workplace, it is advantageous to be better at executing projects. When required, working overtime, but doing so more effectively, is also profitable.

$3 MILLION

When states in the northeastern US began deregulating electricity, one MEP firm sensed opportunity as energy costs were expected to significantly increase. They approached a manufacturing plant for whom they had previously engineered a central utility plant, proposing a significant savings on long-term energy costs by making major equipment changes. The estimated project cost was about $3 million with a 4-year payback, after which they would realize a $1 million cost savings annually on electricity. The manufacturer was not interested in an unsolicited construction project. Knowing the company, the MEP firm restructured their approach to say that one of the groups within the plant had an annual operating profit of about $1 million per year and what they were suggesting would save that same amount. Looking at it through that lens, the company reconsidered and proceeded with the project. Moral of the story: Many firms are interested in making money but not necessarily saving money. Operating smarter can save money.

THE COSTS OF DOING BUSINESS

By reviewing the primary components of the costs of doing business, it helps to understand the expenditures required to operate an office and how project fees can be allocated in the firm. The

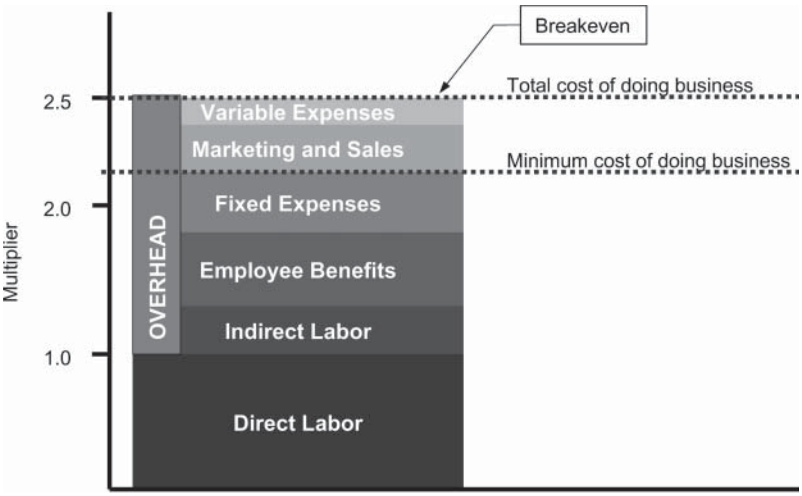


FIGURE 6.11 The costs of doing business.

following examples show the breakdown into the *total cost* and the *minimum cost* of doing business (Figure 6.11). For the objectives of this section, we are keeping the terminology simple and explaining it in as easy terms as possible.

The *total cost* of doing business is what amounts to the sum of all direct and indirect expenses required to run the business and is composed of (a) direct labor, or the portion of employee salaries assigned to billable tasks (direct project work); (b) indirect labor (administrative), or the portion of employee salaries assigned to non-billable tasks (support tasks for the office); (c) employee benefits such as vacation, health insurance, disability insurance, payroll taxes, 401(k) match; (d) fixed expenses such as office rent, information technology and communication, equipment, professional liability insurance, and other overhead costs like coffee, snacks, and supplies; (e) marketing and sales, or the costs to pursue new work; and (f) variable expenses, or the firm's costs that vary with volume or are discretionary like attending conferences, taking clients to sporting events, golfing, meals, and entertainment.

The *minimum cost* of doing business is what amounts to the least amount of money required to maintain a viable business and deliver projects. It is the point where the revenue equals the baseline expenses, or more simply the point to cover the direct salary expense and select overhead costs. This description removes marketing and sales and variable expenses from the equation, which, while important to running a business, are not always needed to be in business.

Observation: You will find in hard economic times that variable expenses are the first to be cut; in more extreme times every area will be a target for reduction.

These costs are typically thought of in terms of what is called the multiplier. Direct labor is considered a multiplier of 1.0, with overhead costs ranging anywhere from a multiplier of 1.5 to 2.0 (as a percentage of direct labor). You will find that the amount of overhead expenses to maintain a business varies greatly between firms. In the example shown in Figure 6.11, the breakeven multiplier is the sum of direct labor plus overhead expenses divided by direct labor, or a multiplier of 2.5. The lower the number, the greater the potential for profit becomes based on the net multiplier. This book primarily addresses becoming more effective with direct labor by streamlining efforts to provide high-quality services while at the same time doing so for the lowest cost. The examples in Figures 6.12 and 6.13 demonstrate this with real dollar values.

Project Example

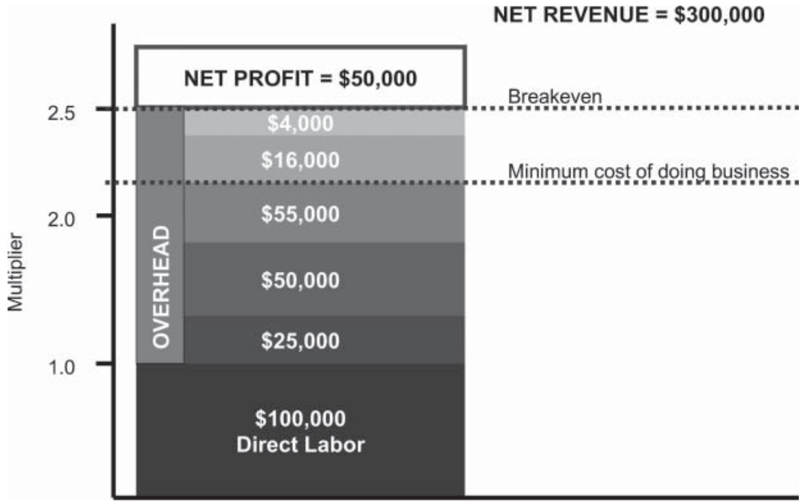


FIGURE 6.12 Project example: baseline.

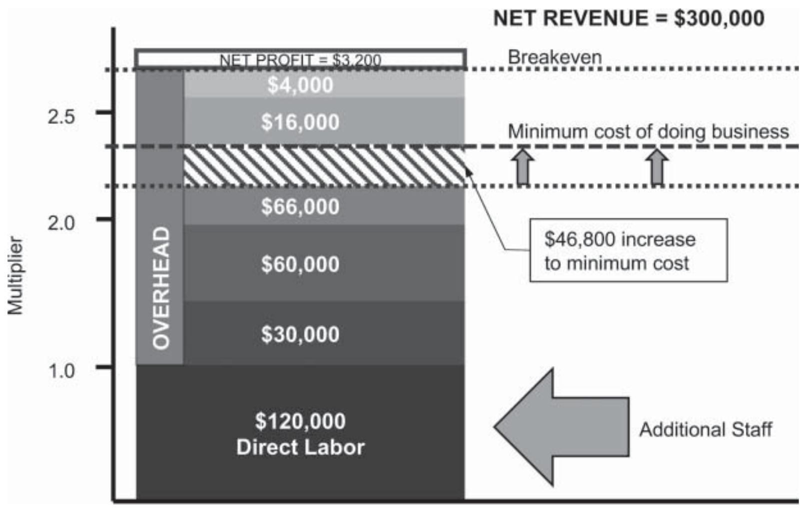


FIGURE 6.13 Project example: add staff.

In Figure 6.12, the net revenue on this project is $300 000, with $100 000 in direct labor costs, other costs distributed proportionately. The net profit is $50 000, or about 17%. The project breakeven multiplier is $250 000/$100 000 = 2.50. The net multiplier is $300 000/$100 000 = 3.00.

Now take the same project and consider having to add more staff late in the project (Figure 6.13). Our direct labor costs go up 20% from $100 000 to $120 000, along with the related overhead costs for employee benefits, indirect labor, and fixed expenses. Note that marketing and sales and variable expenses did not increase; also, the net revenue is unchanged. This pushes our minimum cost of doing business higher, which reduces net profit. The net profit is now $320 000, or about 1%. The project breakeven multiplier is now $296 800/$100 000 = 2.97. Notice the breakeven is calculated with no increase to labor cost as a direct comparison to the previous example. The net multiplier is now $300 000/$120 000 = 2.50.

You can see here that just adding staff can have a significant impact to our profit, in this case a reduction of $46 800. Looking at a project in this way makes it evident that there is great benefit to our staff being as effective as possible and value to using work plans and streamlined processes to keep our labor in check:

It is important to look at the project example in Figure 6.13 from another point of view. Our measurement of project financials is influencing how we view staff and the value they bring. In isolation, the project has a reduced profit due to adding staff. We have not provided context though, and depending upon the circumstances for adding staff the firm profitability may be unaffected.

Scenario 1: The project is poorly managed or has an inexperienced team requiring additional staff to help finish well. The project and firm have indeed incurred a reduced profit.

Scenario 2: Due to another project in the office going on hold, there are several staff with nothing to do temporarily. With the decision to retain these staff, some of them are assigned to this project.

The increase of direct labor and benefits is still applied to the project but looking at the overall impact:

- **We have not increased the firm's overhead rate, as the staff are being paid regardless of whether they help on this project or perform overhead related tasks.**
- **The additional staff may help the project by reducing risk from a deficient design or poor documentation, ensuring a happy client and repeat business.**
- **The additional staff may help complete the project more quickly freeing up the entire project team to start other work.**
- **Yes, the project financials are affected, but the firm's overall profitability is unchanged.**

How will we know we are improving? One answer is by tracking these metrics or key performance indicators (KPI) at the project and office level. Doing so may help reveal the effectiveness of the project managers and office leadership. However, care should be exercised in their pursuing, as there are often complicated stories behind the reasons for project and office performance, which has little to do with the KPIs. At their best, metrics can help inform but are an imperfect reflection of the work we do.

The Financial Game Plan

People, time, and money are primary factors affecting every project and we must know how to effectively manage them. A game plan can serve as an analogy for setting up the project financials such that we can manage the project delivery to our fee projections. Two common examples of financial game planning are by fee based upon the phases and by hours required based on the milestone phase.

The example fee-based game plan (Figure 6.14) primarily looks at overall available fee spend across the phases by duration (based on the number of weeks) with a general sense of the hours per week required to complete the work across the time frame. This method does not consider the actual effort required to produce the work but rather allocates hours to closely equal the amount of fee available. In this method, the revenue plan for monthly billing to clients typically spreads the fee equally across each phase.

Fee Based Staffing Plan | **Project Name: LATB Consulting**

PROJECT FEE WORKSHEET | **Total Fee*** | **$ 1,400,000.00**

*Net Fee - Excludes Expenses and Consultant Fees

			PD	SD	DD	CD	CA		
		Phase	PD	SD	DD	CD	CA		
		Percentage	3%	12%	25%	35%	25%	100%	
		Total Fee by Phase	**$ 42,000.00**	**$ 168,000.00**	**$ 350,000.00**	**$ 490,000.00**	**$ 350,000.00**	$ 1,400,000.00	
		Contingency per Phase	10%	10%	10%	10%	10%		
			$ 4,200.00	$ 16,800.00	$ 35,000.00	$ 49,000.00	$ 35,000.00	$ 140,000.00	
		Available Labor Fee	$ 37,800.00	$ 151,200.00	$ 315,000.00	$ 441,000.00	$ 315,000.00	$ 1,260,000.00	
		Phase Duration (weeks)	4	12	16	16	78		
Staff	Billing Rate	Role	**Hours Per Phase**					Total Hours	Labor Cost
Project Team									
Leadership	$250.00	PIC	Avg Hours/wk = 8	Avg Hours/wk = 6	Avg Hours/wk = 4	Avg Hours/wk = 2	Avg Hours/wk = 0.0		
			Total = 32	Total = 72	Total = 64	Total = 32	Total = 0	200	$ 50,000.00
Leadership	$225.00	QC	Avg Hours/wk = 0	Avg Hours/wk = 1	Avg Hours/wk = 2	Avg Hours/wk = 8	Avg Hours/wk = 0.5		
			Total = 0	Total = 12	Total = 32	Total = 128	Total = 39	211	$ 47,475.00
		Sub-Total per phase	$ 8,000.00	$ 20,700.00	$ 23,200.00	$ 36,800.00	$ 8,775.00	411	$ 97,475.00
Technical Staff	$180.00	PM	Avg Hours/wk = 20	Avg Hours/wk = 20	Avg Hours/wk = 24	Avg Hours/wk = 40	Avg Hours/wk = 2		
			Total = 80	Total = 240	Total = 384	Total = 640	Total = 156	1,500	$ 270,000.00
Technical Staff	$150.00	PA	Avg Hours/wk = 2	Avg Hours/wk = 8	Avg Hours/wk = 32	Avg Hours/wk = 40	Avg Hours/wk = 4		
			Total = 8	Total = 96	Total = 512	Total = 640	Total = 312	1,568	$ 235,200.00
Technical Staff	$120.00	Arch Staff	Avg Hours/wk = 0	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 24		
			Total = 0	Total = 480	Total = 640	Total = 640	Total = 1,872	3,632	$ 435,840.00
Technical Staff	$90.00	Arch Staff	Avg Hours/wk = 40	Avg Hours/wk = 12	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 1		
			Total = 160	Total = 144	Total = 640	Total = 640	Total = 78	1,652	$ 149,580.00
Technical Staff	$90.00	Arch Staff	Avg Hours/wk = 0	Avg Hours/wk = 0	Avg Hours/wk = 8	Avg Hours/wk = 40	Avg Hours/wk = 0		
			Total = 0	Total = 0	Total = 128	Total = 640	Total = 0	768	$ 69,120.00
		Sub-Total per phase	$ 30,000.00	$ 128,160.00	$ 291,840.00	$ 403,200.00	$ 306,540.00	9,130	$ 1,159,740.00
		TOTAL HOURS PER PHASE	280	1,044	2,400	3,360	2,457	9,541	
		LABOR SPEND PER PHASE PER PHASE	$ 38,000.00	$ 148,860.00	$ 315,040.00	$ 440,000.00	$ 315,315.00	Labor Fee Spend =	**$ 1,257,215.00**
		AVAILABLE FEE - ACTUAL FEE	$ 200.00	$ (2,340.00)	$ 40.00	$ (1,000.00)	$ 315.00	Over / (Under) =	$ (2,785.00)
		CONTINGENCY AVAILABLE	$ 4,200.00	$ 16,800.00	$ 35,000.00	$ 49,000.00	$ 35,000.00	Contingency =	$ 140,000.00
		POTENTIAL PROFIT PER PHASE	$ 4,000.00	$ 19,140.00	$ 34,960.00	$ 50,000.00	$ 34,685.00	Potential Profit =	$ 142,785.00

FIGURE 6.14 Fee-based game plan

The example milestone scheduling game plan (Figure 6.15) looks at the estimated effort required over a duration (usually by weeks) with the fee allocated to the effort to reach the phase milestone. The number of full-time employees varies based on the actual need and the fee spend adjusts concurrently. This method has more variability of revenue and depending on your accounting, months can be in the red or black if billings are fixed versus actual.

Milestone Scheduling Staffing Plan | **Project Name: LATB Consulting**

PHASE: DESIGN DEVELOPMENT — Weeks Total = 16

Phase Total Fee* =	$ 350,000.00
Contingency 10% =	$ 35,000.00
Available Labor Fee =	$ 315,000.00

*Net Fee - Excludes Expenses and Consultant Fees

Year... 2020

Staff	Billing Rate	Role	DD1	DD2	DD3	DD4	DD5	DD6	DD7	DD8	DD9	DD10	DD11	DD12	DD13	DD14	DD15	DD16		Hours per Phase	Avg /wk	Labor Cost
Week of ...			7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9				
Project Team			Planned Scheduled Hours per Week																			
Leadership	$250.00	PIC	8	8	8	8	4	4	4	4	2	2	2	2	2	2	2	2		64	4.00	$16,000.00
Leadership	$225.00	QC					4	1	1	1	1	4	1	1	1	1	1	16		33	2.06	$7,425.00
																			Sub-Total =	97		$23,425.00
Technical Staff	$180.00	PM	32	32	32	32	24	24	24	24	16	16	16	16	16	16	16	16		352	22.00	$63,360.00
Technical Staff	$150.00	PA	24	24	24	24	32	32	32	32	40	40	40	40	40	40	40	40		544	34.00	$81,600.00
Technical Staff	$120.00	Arch Staff	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		640	40.00	$76,800.00
Technical Staff	$90.00	Arch Staff					20	20	20	20	40	40	40	40	40	40	40	40		400	25.00	$36,000.00
Technical Staff	$90.00	Arch Staff									20	20	20	20	20	20	20	20		160	10.00	$14,400.00
																			Sub-Total =	2,096		$272,160.00
TOTAL HOURS / WEEK			104	104	104	104	124	121	121	121	159	162	159	159	159	159	159	174	Total =	2,193		
FTE / WEEK			2.6	2.6	2.6	2.6	3.1	3.0	3.0	3.0	4.0	4.1	4.0	4.0	4.0	4.0	4.0	4.4				

Labor Fee Spend =	$295,585.00
Over / (Under) =	$ (19,415.00)
Contingency =	$ 35,000.00
Potential Profit =	$ 54,415.00

FIGURE 6.15 Milestone scheduling game plan.

The approaches are different, but they are not mutually exclusive. At times, a combination of both methods is used to come up with the best financial game plan for the project. Does that indicate or ensure we are resolving the issues of a project well? Have we mitigated risk if we meet utilization goals for the project team? These questions are rhetorical but worth keeping in mind; the best-laid game plans do have some contradictory aspects. (Full-size versions of Figures 6.14, 6.15 are provided at the end of the chapter.)

> **Observation: A third example is the seat-of-your-pants approach where you move in a direction, keep an eye on finances, but have no plan. It is our experience that this game ends in defeat the majority of the time.**

Financial game plans are vital to delivering the work, but not all variables can be planned for in a project that can last over many months or even years. One solution to these unknowns is to hold back a percentage of fee as a contingency to cover the variables. If the game plan is so tight that there is no time to call an audible, then the game may be lost.

WHEN FEES NO LONGER MATTER

It can be a challenge to balance the needs of a client and project with the available fees and staff. However, once a contract is signed, do the fees really matter? They do in the sense that the firm must be paid for the work. If we are not able to make a profit, the firm may not remain in business for long. It does not matter in the sense that we must meet the standard of care regardless of the fee we have agreed to.

This is where it can pay to be inventive. Quite often, difficult project issues can be addressed in simple, nontraditional ways that get the job done with little effort. Trying situations can become great learning opportunities as they force us to think outside the box.

Example

Several years ago, one firm designed a new replacement hospital facility for a rural client. The construction budget and design fees were tight, and the design firm staffing was minimal. The project was fast-tracked with early packages issued. The design team was in a stressful situation, leading them to cut corners in every way they could but with the commitment to do good work regardless. They made significant reductions in the construction documentation effort by considering what was actually needed for the contractor to estimate, prepare shop drawings, and ultimately construct. Their streamlined approach worked so well that it became the firm's standard. After all, if it worked for a low-fee, fast-moving job, it could surely work for one with a better fee, too.

Moral of the story: look for the simplest, smartest way to work that meets the standard of care and make it the norm for day-to-day practice. Adjust as needed for the project's scope of work, building type, and client requirements.

Firm Math

How do we place a value on improvement? Figure 6.16 makes the point that a small improvement in a firm's ability to progress work has a company-wide benefit. Ignoring inflation for the sake of the example, it is advantageous if a 250-person firm can deliver 5% more work, in aggregate, with the same number of employees over the course of 1 year. This equates to the direct labor savings of 12.5 additional full-time equivalent employees based on 2000 hours per year. It uses a blended billing rate, eliminating the need to identify who works on which job and whether one project was as profitable as another. Adjust the numbers to fit your firm; the principle and the benefit remains the same.

We are not aware of a specific means to measure this improvement other than in an overall, firm-wide sense. Improvement can be difficult to quantify for individual projects due to the many factors influencing project flow, including how people transition between them. It is more important to improve the ability to execute work than to be able to measure it.

250 employees
$110 hour

5% improvement
$2,750,000 *value*

25,000 hours = 12.5 FTE

FIGURE 6.16 Firm math.

You may have seen the commercials that ended with the tagline, *There are some things money can't buy; for everything else there's MasterCard*. The narrator talked over the commercial, telling the price of something purchased and then contrasted the whole experience of the story in the commercial as being priceless. Well, think of the firm math example in the same way (spoken in your best commercial narrator voice):

Number of employees: 250
Average hourly billing rate: $110
Target improvement: 5%
Potential value: $2 750 000
Bottom-line savings: Priceless!

It truly would be priceless to improve just 5%. But even if 5% is out of reach, slight improvements to the most mundane tasks can become priceless to your firm. These small improvements feed the bottom line, allowing the capacity for additional work to grow without the need to hire additional staff when times are good or when we cannot retain staff in difficult economic times.

REFERENCES

American Institute of Architects. (2017). *AIA Document B101 – 2017*.

Peppers, D. (2016, May 5). *The Downside of Six Sigma*. LinkedIn.

RESOURCE MATERIAL

Figure 6.17: Fee-Based Game Plan
Figure 6.18: Milestone Scheduling Game Plan
Figures 6.19 – 6.23: Design Development Workflow
Figures 6.24 – 6.28: Construction Documents Workflow
Figures 6.29 – 6.43: Project Roadmap

Fee Based Staffing Plan			Project Name: LATB Consulting						
			PROJECT FEE WORKSHEET					Total Fee*	$ 1,400,000.00
		Phase	PD	SD	DD	CD	CA	*Net Fee - Excludes Expenses and Consultant Fees	
		Percentage	3%	12%	25%	35%	25%	100%	
		Total Fee by Phase	$ 42,000.00	$ 168,000.00	$ 350,000.00	$ 490,000.00	$ 350,000.00	$ 1,400,000.00	
		Contingency per Phase	10%	10%	10%	10%	10%		
			$ 4,200.00	$ 16,800.00	$ 35,000.00	$ 49,000.00	$ 35,000.00	$ 140,000.00	
		Available Labor Fee	$ 37,800.00	$ 151,200.00	$ 315,000.00	$ 441,000.00	$ 315,000.00	$ 1,260,000.00	
		Phase Duration (weeks)	4	12	16	16	78		
Staff	Billing Rate	Role	Hours Per Phase					Total Hours	Labor Cost
Project Team									
Leadership	$250.00	PIC	Avg Hours/wk = 8	Avg Hours/wk = 6	Avg Hours/wk = 4	Avg Hours/wk = 2	Avg Hours/wk = 0.0		
			Total = 32	Total = 72	Total = 64	Total = 32	Total = 0	200	$ 50,000.00
Leadership	$225.00	QC	Avg Hours/wk = 0	Avg Hours/wk = 1	Avg Hours/wk = 2	Avg Hours/wk = 8	Avg Hours/wk = 0.5		
			Total = 0	Total = 12	Total = 32	Total = 128	Total = 39	211	$ 47,475.00
		Sub-Total per phase	$ 8,000.00	$ 20,700.00	$ 23,200.00	$ 36,800.00	$ 8,775.00	411	$ 97,475.00
Technical Staff	$180.00	PM	Avg Hours/wk = 20	Avg Hours/wk = 20	Avg Hours/wk = 24	Avg Hours/wk = 40	Avg Hours/wk = 2		
			Total = 80	Total = 240	Total = 384	Total = 640	Total = 156	1,500	$ 270,000.00
Technical Staff	$150.00	PA	Avg Hours/wk = 2	Avg Hours/wk = 8	Avg Hours/wk = 32	Avg Hours/wk = 40	Avg Hours/wk = 4		
			Total = 8	Total = 96	Total = 512	Total = 640	Total = 312	1,568	$ 235,200.00
Technical Staff	$120.00	Arch Staff	Avg Hours/wk = 0	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 24		
			Total = 0	Total = 480	Total = 640	Total = 640	Total = 1,872	3,632	$ 435,840.00
Technical Staff	$90.00	Arch Staff	Avg Hours/wk = 40	Avg Hours/wk = 12	Avg Hours/wk = 40	Avg Hours/wk = 40	Avg Hours/wk = 1		
			Total = 160	Total = 144	Total = 640	Total = 640	Total = 78	1,662	$ 149,580.00
Technical Staff	$90.00	Arch Staff	Avg Hours/wk = 0	Avg Hours/wk = 0	Avg Hours/wk = 8	Avg Hours/wk = 40	Avg Hours/wk = 0		
			Total = 0	Total = 0	Total = 128	Total = 640	Total = 0	768	$ 69,120.00
		Sub-Total per phase	$ 30,000.00	$ 128,160.00	$ 291,840.00	$ 403,200.00	$ 306,540.00	9,130	$ 1,159,740.00
		TOTAL HOURS PER PHASE	280	1,044	2,400	3,360	2,457	9,541	
		LABOR SPEND PER PHASE PER PHASE	$ 38,000.00	$ 148,860.00	$ 315,040.00	$ 440,000.00	$ 315,315.00	Labor Fee Spend =	$ 1,257,215.00
		AVAILABLE FEE - ACTUAL FEE	$ 200.00	$ (2,340.00)	$ 40.00	$ (1,000.00)	$ 315.00	Over / (Under) =	$ (2,785.00)
		CONTINGENCY AVAILABLE	$ 4,200.00	$ 16,800.00	$ 35,000.00	$ 49,000.00	$ 35,000.00	Contingency =	$ 140,000.00
		POTENTIAL PROFIT PER PHASE	$ 4,000.00	$ 19,140.00	$ 34,960.00	$ 50,000.00	$ 34,685.00	Potential Profit =	$ 142,785.00

FIGURE 6.17 Fee-Based Game Plan.

Milestone Scheduling Staffing Plan | **Project Name: LATB Consulting**

PHASE: DESIGN DEVELOPMENT — Weeks Total = 16

Phase Total Fee* =	$ 350,000.00
Contingency 10% =	$ 35,000.00
Available Labor Fee =	$ 315,000.00

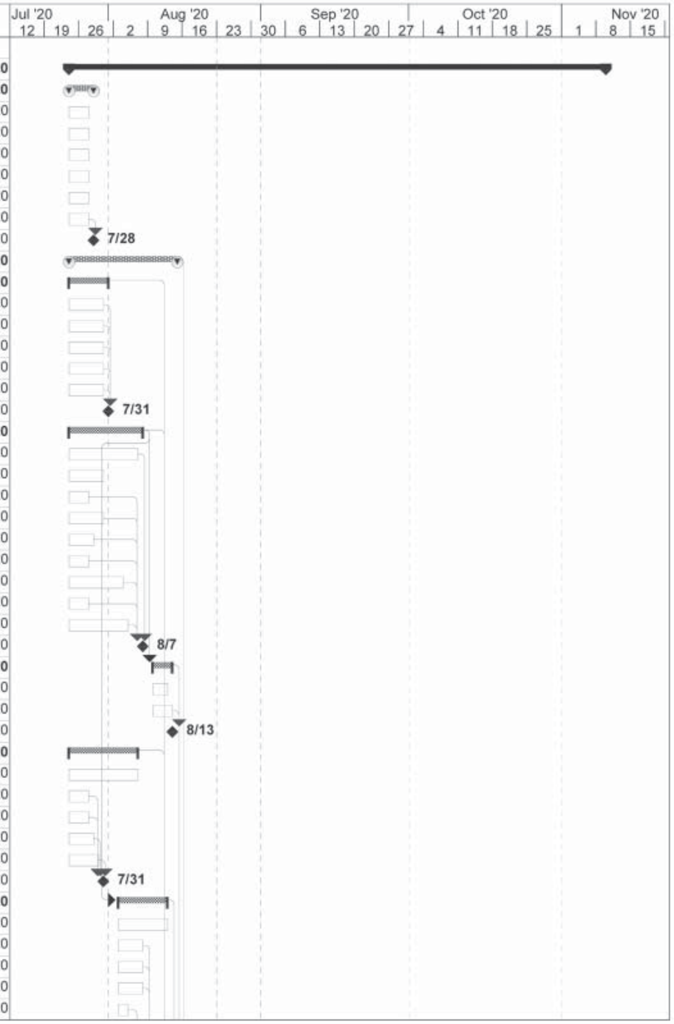
*Net Fee - Excludes Expenses and Consultant Fees

Staff	Billing Rate	Role	DD1	DD2	DD3	DD4	DD5	DD6	DD7	DD8	DD9	DD10	DD11	DD12	DD13	DD14	DD15	DD16		Hours per Phase	Avg /wk	Labor Cost
Year...			2020																			
Week of ...			7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9				
Project Team			Planned Scheduled Hours per Week																			
Leadership	$250.00	PIC	8	8	8	8	4	4	4	4	2	2	2	2	2	2	2	2		64	4.00	$16,000.00
Leadership	$225.00	QC					4	1	1	1	1	4	1	1	1	1	1	16		33	2.06	$7,425.00
																			Sub-Total =	97		$23,425.00
Technical Staff	$180.00	PM	32	32	32	32	24	24	24	24	16	16	16	16	16	16	16	16		352	22.00	$63,360.00
Technical Staff	$150.00	PA	24	24	24	24	32	32	32	32	40	40	40	40	40	40	40	40		544	34.00	$81,600.00
Technical Staff	$120.00	Arch Staff	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		640	40.00	$76,800.00
Technical Staff	$90.00	Arch Staff					20	20	20	20	40	40	40	40	40	40	40	40		400	25.00	$36,000.00
Technical Staff	$90.00	Arch Staff									20	20	20	20	20	20	20	20		160	10.00	$14,400.00
																			Sub-Total =	2,096		$272,160.00
TOTAL HOURS / WEEK			104	104	104	104	124	121	121	121	159	162	159	159	159	159	159	174	Total =	2,193		
FTE / WEEK			2.6	2.6	2.6	2.6	3.1	3.0	3.0	3.0	4.0	4.1	4.0	4.0	4.0	4.0	4.0	4.4				

Labor Fee Spend =	$295,585.00
Over / (Under) =	$ (19,415.00)
Contingency =	$ 35,000.00
Potential Profit =	$ 54,415.00

FIGURE 6.18 Milestone Scheduling Game Plan.

ID	Task Name	Duration	Start	Finish
1				
2	**DESIGN DEVELOPMENT WORKFLOW**	**77 days**	**Fri 7/24/20**	**Mon 11/9/20**
3	**Phase Start-Up**	**3 days**	**Fri 7/24/20**	**Tue 7/28/20**
4	Update Schedule	2 days	Fri 7/24/20	Mon 7/27/20
5	Adjust Work Plan	2 days	Fri 7/24/20	Mon 7/27/20
6	Review. Adjust budget, hours	2 days	Fri 7/24/20	Mon 7/27/20
7	Define Deliverables	2 days	Fri 7/24/20	Mon 7/27/20
8	Cartoon Set	2 days	Fri 7/24/20	Mon 7/27/20
9	BIM Model Health Check	2 days	Fri 7/24/20	Mon 7/27/20
10	Production Kickoff	0 days	Tue 7/28/20	Tue 7/28/20
11	**Work Cycle 1 (Basic Development)**	**16 days**	**Fri 7/24/20**	**Fri 8/14/20**
12	**Life Safety Plans**	**6 days**	**Fri 7/24/20**	**Fri 7/31/20**
13	Classifications/Occupancies	5 days	Fri 7/24/20	Thu 7/30/20
14	Egress Requirements	5 days	Fri 7/24/20	Thu 7/30/20
15	Fire Rated Elements	5 days	Fri 7/24/20	Thu 7/30/20
16	Plumbing Fixture Counts	5 days	Fri 7/24/20	Thu 7/30/20
17	General Accessibility Reqmt's	5 days	Fri 7/24/20	Thu 7/30/20
18	Provide Info. to Structural, M, P, E	0 days	Fri 7/31/20	Fri 7/31/20
19	**Floor Plans**	**11 days**	**Fri 7/24/20**	**Fri 8/7/20**
20	Refine Schematic Design Plans	2 wks	Fri 7/24/20	Thu 8/6/20
21	Input from Structural, M, P, E for Room Size Reqmt's	5 days	Fri 7/24/20	Thu 7/30/20
22	Refine Structural Frame/ Bay Sizing	2 days	Fri 7/24/20	Mon 7/27/20
23	Core/Shell Dimensional Layout	5 days	Fri 7/24/20	Thu 7/30/20
24	Identify Vertical Shaft Reqmt's	3 days	Fri 7/24/20	Tue 7/28/20
25	Floor Depressions	2 days	Fri 7/24/20	Mon 7/27/20
26	Exterior Openings	7 days	Fri 7/24/20	Mon 8/3/20
27	Shear Walls	2 days	Fri 7/24/20	Mon 7/27/20
28	External & Core Wall Materials	8 days	Fri 7/24/20	Tue 8/4/20
29	Provide Info. To All Disciplines	0 days	Fri 8/7/20	Fri 8/7/20
30	**Roof Plans**	**4 days**	**Mon 8/10/20**	**Thu 8/13/20**
31	Input from Structural, M, P, E	3 days	Mon 8/10/20	Wed 8/12/20
32	Roof Slopes/Drainage	4 days	Mon 8/10/20	Thu 8/13/20
33	Info. to Structural, M, P, E	0 days	Thu 8/13/20	Thu 8/13/20
34	**Elevations**	**10 days**	**Fri 7/24/20**	**Thu 8/6/20**
35	Refine Schematic Design Elevations	2 wks	Fri 7/24/20	Thu 8/6/20
36	Wall Materials	2 days	Fri 7/24/20	Mon 7/27/20
37	Floor to Floor Heights	2 days	Fri 7/24/20	Mon 7/27/20
38	Building/Massing Heights	3 days	Fri 7/24/20	Tue 7/28/20
39	Wall Openings	4 days	Fri 7/24/20	Wed 7/29/20
40	Info. To Structural, M, E	0 days	Fri 7/31/20	Fri 7/31/20
41	**Site Plans**	**8 days**	**Mon 8/3/20**	**Wed 8/12/20**
42	Refine Schematic Design Site Plan	8 days	Mon 8/3/20	Wed 8/12/20
43	Building Layout	5 days	Mon 8/3/20	Fri 8/7/20
44	Paving Layouts	5 days	Mon 8/3/20	Fri 8/7/20
45	Open Area Layout	5 days	Mon 8/3/20	Fri 8/7/20
46	Code Implications	2 days	Mon 8/3/20	Tue 8/4/20



Page 1

FIGURE 6.19 Design Development Workflow.

ID	Task Name	Duration	Start	Finish
47	Info. to Civil, Landscape, M, P, E	0 days	Fri 8/7/20	Fri 8/7/20
48	**QA/QC**	**2 days**	**Thu 8/13/20**	**Fri 8/14/20**
49	Team Coordination Review	2 days	Thu 8/13/20	Fri 8/14/20
50	Team Constructability Review	2 days	Thu 8/13/20	Fri 8/14/20
51	30% Design Review Meeting	0 days	Fri 8/14/20	Fri 8/14/20
52	**Work Cycle 2 (Overall Development)**	**16 days**	**Mon 8/17/20**	**Mon 9/7/20**
53	**Life Safety Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
54	Detailed Accessibility Reqmt's	5 days	Mon 8/17/20	Fri 8/21/20
55	**Floor Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
56	Further Refine Plans	5 days	Mon 8/17/20	Fri 8/21/20
57	Input from Structural, M, P, E	1 day	Mon 8/17/20	Mon 8/17/20
58	Interior Dimensional Layout	5 days	Mon 8/17/20	Fri 8/21/20
59	Interior Openings	5 days	Mon 8/17/20	Fri 8/21/20
60	Arch. Woodwork Layout	2 days	Mon 8/17/20	Tue 8/18/20
61	Info. To All Disciplines	0 days	Fri 8/21/20	Fri 8/21/20
62	**Reflected Ceiling Plans**	**5 days**	**Mon 8/24/20**	**Fri 8/28/20**
63	Input from Design, E	1 day	Mon 8/24/20	Mon 8/24/20
64	Materials	3 days	Mon 8/24/20	Wed 8/26/20
65	Ceiling grid	5 days	Mon 8/24/20	Fri 8/28/20
66	Soffits	5 days	Mon 8/24/20	Fri 8/28/20
67	Lighting Concept	5 days	Mon 8/24/20	Fri 8/28/20
68	Ceiling Heights	5 days	Mon 8/24/20	Fri 8/28/20
69	Info. to M, P, E	0 days	Fri 8/28/20	Fri 8/28/20
70	**Roof Plans**	**5 days**	**Mon 8/24/20**	**Fri 8/28/20**
71	Input from Structural, M, P, E	1 day	Mon 8/24/20	Mon 8/24/20
72	Roof Drains	2 days	Mon 8/24/20	Tue 8/25/20
73	Equipment Locations & Heights	4 days	Mon 8/24/20	Thu 8/27/20
74	Major Penetrations	4 days	Mon 8/24/20	Thu 8/27/20
75	Screen Walls	4 days	Mon 8/24/20	Thu 8/27/20
76	Penthouses Roofing Elevations	5 days	Mon 8/24/20	Fri 8/28/20
77	Define Roof System/Insulation	4 days	Mon 8/24/20	Thu 8/27/20
78	Appendages (Canopies/Grilles)	3 days	Mon 8/24/20	Wed 8/26/20
79	Info. to Civil, Structural, M, P, E	0 days	Fri 8/28/20	Fri 8/28/20
80	**Elevations**	**4 days**	**Mon 8/17/20**	**Thu 8/20/20**
81	Input from Design, Structural	4 days	Mon 8/17/20	Thu 8/20/20
82	Control joints	1 day	Mon 8/17/20	Mon 8/17/20
83	Define Grade	3 days	Mon 8/17/20	Wed 8/19/20
84	Define Foundations	3 days	Mon 8/17/20	Wed 8/19/20
85	Roof Equipment	2 days	Mon 8/17/20	Tue 8/18/20
86	Roof Screening	3 days	Mon 8/17/20	Wed 8/19/20
87	Bearing Conditions & Heights	2 days	Mon 8/17/20	Tue 8/18/20
88	Info. to Structural	0 days	Thu 8/20/20	Thu 8/20/20
89	**Building Sections**	**4 days**	**Fri 8/21/20**	**Wed 8/26/20**
90	Input from Design, Structural	1 day	Fri 8/21/20	Fri 8/21/20
91	Floor to Floor Heights	2 days	Fri 8/21/20	Mon 8/24/20
92	Level Relationships	2 days	Fri 8/21/20	Mon 8/24/20

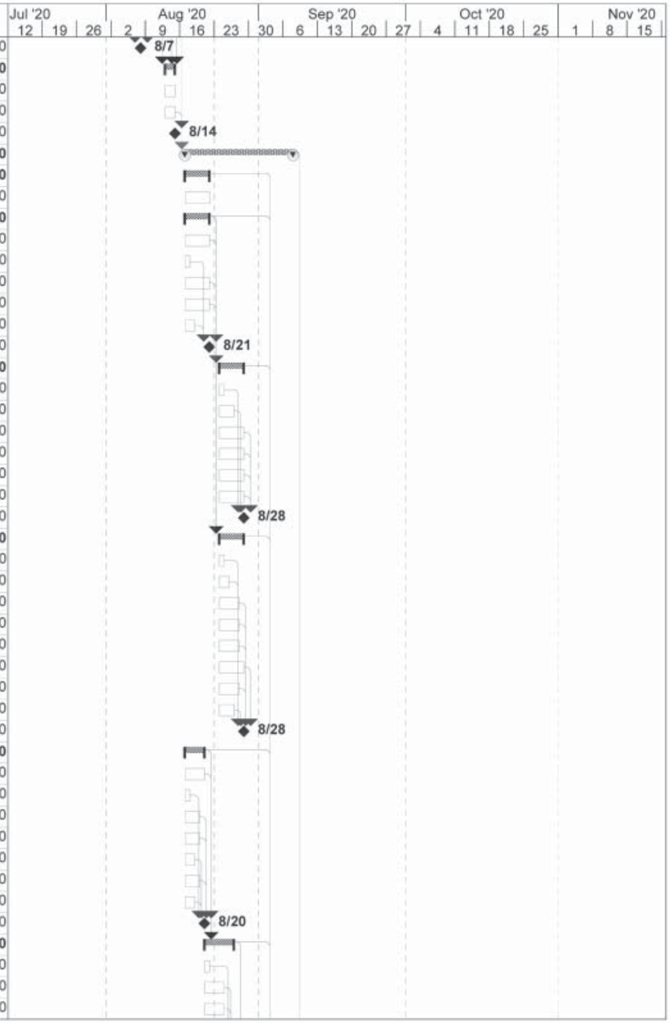


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FIGURE 6.20 Design Development Workflow.

ID	Task Name	Duration	Start	Finish
93	Ceiling Heights/Profiles	4 days	Fri 8/21/20	Wed 8/26/20
94	Structural Frame Depths	4 days	Fri 8/21/20	Wed 8/26/20
95	Info. to Structural, M, P, E	0 days	Wed 8/26/20	Wed 8/26/20
96	**Wall Sections**	**7 days**	**Thu 8/27/20**	**Fri 9/4/20**
97	Input from Structural	1 day	Thu 8/27/20	Thu 8/27/20
98	Profiles	7 days	Thu 8/27/20	Fri 9/4/20
99	Openings	3 days	Thu 8/27/20	Mon 8/31/20
100	Floor Terminations (Edge of Slab)	3 days	Thu 8/27/20	Mon 8/31/20
101	Roof terminations	3 days	Thu 8/27/20	Mon 8/31/20
102	Materials	4 days	Thu 8/27/20	Tue 9/1/20
103	Info. to Structural, M, P, E	0 days	Fri 9/4/20	Fri 9/4/20
104	**Interiors**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
105	**Finish Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
106	Material Selection	5 days	Mon 8/17/20	Fri 8/21/20
107	Layout	5 days	Mon 8/17/20	Fri 8/21/20
108	Coord. With Architectural	5 days	Mon 8/17/20	Fri 8/21/20
109	**Furniture Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
110	Furniture Layout	5 days	Mon 8/17/20	Fri 8/21/20
111	Furniture Selection	5 days	Mon 8/17/20	Fri 8/21/20
112	Coord. with Architectural, M, E	5 days	Mon 8/17/20	Fri 8/21/20
113	**Equipment Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
114	Casework Layout	5 days	Mon 8/17/20	Fri 8/21/20
115	Equipment Layout	5 days	Mon 8/17/20	Fri 8/21/20
116	Coord. with Architectural, M, P, E	5 days	Mon 8/17/20	Fri 8/21/20
117	**Site Plans**	**5 days**	**Mon 8/17/20**	**Fri 8/21/20**
118	Input from Design, Civil, M, P, E	1 day	Mon 8/17/20	Mon 8/17/20
119	Paving Materials	5 days	Mon 8/17/20	Fri 8/21/20
120	Site Walls	5 days	Mon 8/17/20	Fri 8/21/20
121	Equipment Yards	5 days	Mon 8/17/20	Fri 8/21/20
122	Fencing	5 days	Mon 8/17/20	Fri 8/21/20
123	Level Changes	5 days	Mon 8/17/20	Fri 8/21/20
124	Info. to Civil, Landscape, M, P, E	0 days	Fri 8/21/20	Fri 8/21/20
125	**Specifications**	**2 days**	**Fri 9/4/20**	**Mon 9/7/20**
126	Coordination Review	2 days	Fri 9/4/20	Mon 9/7/20
127	Constructability Review	2 days	Fri 9/4/20	Mon 9/7/20
128	Gather Product Information	2 days	Fri 9/4/20	Mon 9/7/20
129	**Work Cycle 3 (Detailed Development)**	**16 days**	**Tue 9/8/20**	**Tue 9/29/20**
130	**Life Safety Plans**	**3 days**	**Tue 9/8/20**	**Thu 9/10/20**
131	Travel Paths	3 days	Tue 9/8/20	Thu 9/10/20
132	Exit Lighting	3 days	Tue 9/8/20	Thu 9/10/20
133	Fire Extinguishers	3 days	Tue 9/8/20	Thu 9/10/20
134	Indicate Exits	3 days	Tue 9/8/20	Thu 9/10/20
135	Define Assemblies	3 days	Tue 9/8/20	Thu 9/10/20
136	Info. to M, P, E	0 days	Thu 9/10/20	Thu 9/10/20
137	**Floor Plans**	**9 days**	**Tue 9/8/20**	**Fri 9/18/20**
138	Further Refine Plans	9 days	Tue 9/8/20	Fri 9/18/20

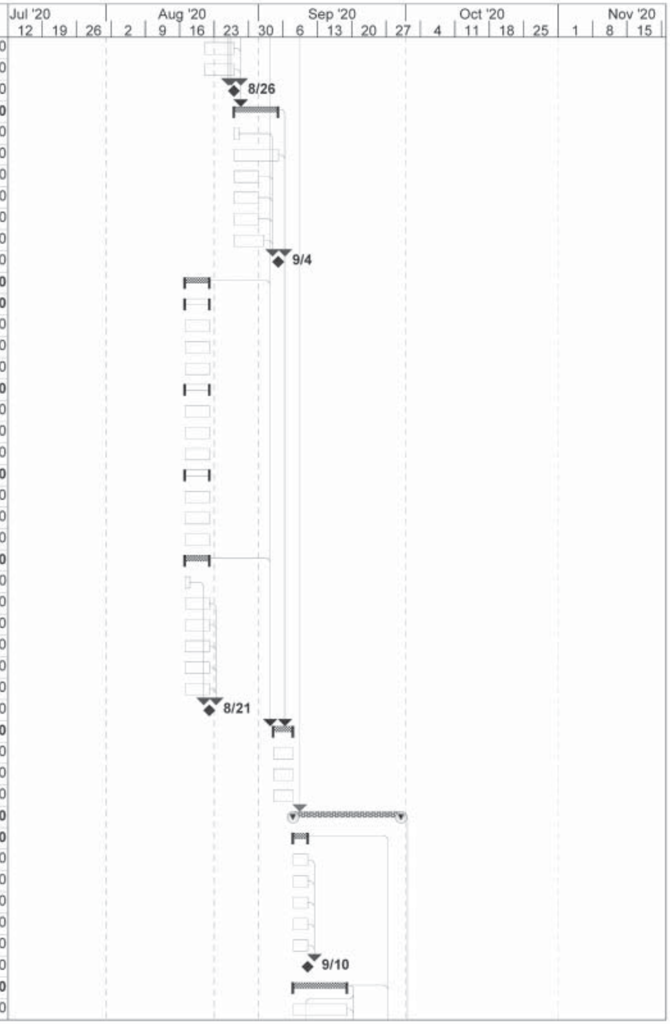

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FIGURE 6.21 Design Development Workflow.

ID	Task Name	Duration	Start	Finish
139	Input from Structural, M, P, E	1 day	Tue 9/8/20	Tue 9/8/20
140	Partition Types	4 days	Tue 9/8/20	Fri 9/11/20
141	Door/Opening Types	4 days	Tue 9/8/20	Fri 9/11/20
142	Specialties	3 days	Tue 9/8/20	Thu 9/10/20
143	Depressions for Finishes	2 days	Tue 9/8/20	Wed 9/9/20
144	Info. To All Disciplines	0 days	Fri 9/18/20	Fri 9/18/20
145	**Reflected Ceiling Plans**	**3 days**	**Tue 9/8/20**	**Thu 9/10/20**
146	Input from Design, M, E	1 day	Tue 9/8/20	Tue 9/8/20
147	Diffuser/Exhaust Layout	3 days	Tue 9/8/20	Thu 9/10/20
148	Exit Lights	3 days	Tue 9/8/20	Thu 9/10/20
149	Special Systems	3 days	Tue 9/8/20	Thu 9/10/20
150	Info. to Interiors, M, P, E	0 days	Thu 9/10/20	Thu 9/10/20
151	**Roof Plans**	**3 days**	**Tue 9/8/20**	**Thu 9/10/20**
152	Input from Structural, M, P, E	1 day	Tue 9/8/20	Tue 9/8/20
153	Roof Accessories (Skylights, Hatches)	2 days	Tue 9/8/20	Wed 9/9/20
154	Misc. Roof Mounted Equip.	3 days	Tue 9/8/20	Thu 9/10/20
155	Roof Walkways	2 days	Tue 9/8/20	Wed 9/9/20
156	Misc. Penetrations	2 days	Tue 9/8/20	Wed 9/9/20
157	Info. to Structural, M, P, E	0 days	Thu 9/10/20	Thu 9/10/20
158	**Elevations**	**10 days**	**Tue 9/8/20**	**Mon 9/21/20**
159	Input from Design, Structural, M, E	1 day	Tue 9/8/20	Tue 9/8/20
160	Window System Types	10 days	Tue 9/8/20	Mon 9/21/20
161	Material Patterns	4 days	Tue 9/8/20	Fri 9/11/20
162	Misc. Wall Mounted Equipment	4 days	Tue 9/8/20	Fri 9/11/20
163	Louvers, Downspouts & Leaders	3 days	Tue 9/8/20	Thu 9/10/20
164	**Building Sections**	**5 days**	**Tue 9/8/20**	**Mon 9/14/20**
165	Input from Structural, M, E	1 day	Tue 9/8/20	Tue 9/8/20
166	Define Insulation	3 days	Tue 9/8/20	Thu 9/10/20
167	Define Fire Proofing	3 days	Tue 9/8/20	Thu 9/10/20
168	Roof Elements	5 days	Tue 9/8/20	Mon 9/14/20
169	Refine Structural Frame Depths	4 days	Tue 9/8/20	Fri 9/11/20
170	Info. to Structural, M, P, E	0 days	Mon 9/14/20	Mon 9/14/20
171	**Wall Sections**	**12 days**	**Tue 9/8/20**	**Wed 9/23/20**
172	Input from Structural	1 day	Tue 9/8/20	Tue 9/8/20
173	Interior Profiles/Further refinement	12 days	Tue 9/8/20	Wed 9/23/20
174	Wall Insulation	3 days	Tue 9/8/20	Thu 9/10/20
175	Info. to Structural	0 days	Wed 9/23/20	Wed 9/23/20
176	**Interiors**	**5 days**	**Mon 9/14/20**	**Fri 9/18/20**
177	**Finish Plans**	**5 days**	**Mon 9/14/20**	**Fri 9/18/20**
178	Room Finish Key	5 days	Mon 9/14/20	Fri 9/18/20
179	Material Patterns	5 days	Mon 9/14/20	Fri 9/18/20
180	Coord. With Architectural	5 days	Mon 9/14/20	Fri 9/18/20
181	**Furniture Plans**	**5 days**	**Mon 9/14/20**	**Fri 9/18/20**
182	Coord. with Architectural, M, E	5 days	Mon 9/14/20	Fri 9/18/20
183	**Equipment Plans**	**5 days**	**Mon 9/14/20**	**Fri 9/18/20**
184	Interior Elevations	5 days	Mon 9/14/20	Fri 9/18/20

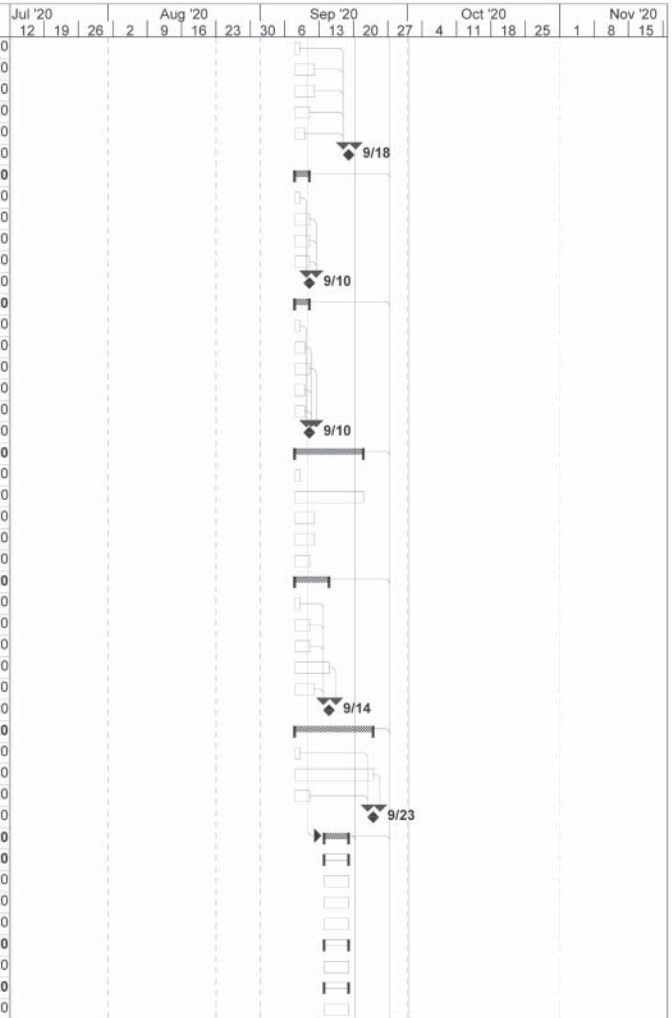

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FIGURE 6.22 Design Development Workflow.

ID	Task Name	Duration	Start	Finish
185	Equipment Schedule	5 days	Mon 9/14/20	Fri 9/18/20
186	Coord. with Architectural, M, P, E	5 days	Mon 9/14/20	Fri 9/18/20
187	**Interior Elevations**	**5 days**	**Mon 9/21/20**	**Fri 9/25/20**
188	Layout Unique Conditions	5 days	Mon 9/21/20	Fri 9/25/20
189	**Enlarged Plans**	**5 days**	**Mon 9/21/20**	**Fri 9/25/20**
190	Layout Unique Conditions	5 days	Mon 9/21/20	Fri 9/25/20
191	Clarify Dimensions & Materials	5 days	Mon 9/21/20	Fri 9/25/20
192	**Special Details**	**5 days**	**Mon 9/21/20**	**Fri 9/25/20**
193	Layout Unique Conditions	5 days	Mon 9/21/20	Fri 9/25/20
194	Clarify Dimensions & Materials	5 days	Mon 9/21/20	Fri 9/25/20
195	**Site Plans**	**5 days**	**Tue 9/8/20**	**Mon 9/14/20**
196	Input from Landscape, Civil, M, P, E	1 day	Tue 9/8/20	Tue 9/8/20
197	Signage	4 days	Tue 9/8/20	Fri 9/11/20
198	Specialties	5 days	Tue 9/8/20	Mon 9/14/20
199	Material Patterns	5 days	Tue 9/8/20	Mon 9/14/20
200	Info. to Civil, Landscape, M, P, E	0 days	Mon 9/14/20	Mon 9/14/20
201	**Specifications**	**2 days**	**Mon 9/28/20**	**Tue 9/29/20**
202	Coordination Review	2 days	Mon 9/28/20	Tue 9/29/20
203	Constructability Review	2 days	Mon 9/28/20	Tue 9/29/20
204	Gather Product Information	2 days	Mon 9/28/20	Tue 9/29/20
205	**Work Cycle 4 (Annotation)**	**7 days**	**Wed 9/30/20**	**Thu 10/8/20**
206	**All Drawings**	**5 days**	**Wed 9/30/20**	**Tue 10/6/20**
207	General Notes	3 days	Wed 9/30/20	Fri 10/2/20
208	Keynotes	3 days	Wed 9/30/20	Fri 10/2/20
209	Legends	5 days	Wed 9/30/20	Tue 10/6/20
210	Final Dimensioning	5 days	Wed 9/30/20	Tue 10/6/20
211	References	5 days	Wed 9/30/20	Tue 10/6/20
212	**Project Sheet Index**	**1 day**	**Wed 10/7/20**	**Wed 10/7/20**
213	Gather Sheet Names from Consultants	1 day	Wed 10/7/20	Wed 10/7/20
214	**Specifications**	**7 days**	**Wed 9/30/20**	**Thu 10/8/20**
215	Coordinate with Drawings	7 days	Wed 9/30/20	Thu 10/8/20
216	**Work Cycle 5 (Completion)**	**12 days**	**Fri 10/9/20**	**Mon 10/26/20**
217	**All Drawings**	**12 days**	**Fri 10/9/20**	**Mon 10/26/20**
218	Final Completion/Revisions	12 days	Fri 10/9/20	Mon 10/26/20
219	**Specifications**	**7 days**	**Fri 10/9/20**	**Mon 10/19/20**
220	Final Revisions/Coordination	7 days	Fri 10/9/20	Mon 10/19/20
221	**Print Set For Phase Check QC**	**0 days**	Mon 10/26/20	Mon 10/26/20
222	**Work Cycle 6 (Quality Control & Approvals)**	**10 days**	**Tue 10/27/20**	**Mon 11/9/20**
223	**All Drawings/Specifications**	**7 days**	**Tue 10/27/20**	**Wed 11/4/20**
224	Milestone Phase Final Checking/Coordination	7 days	Tue 10/27/20	Wed 11/4/20
225	**Design Narratives**	**5 days**	**Thu 10/29/20**	**Wed 11/4/20**
226	Revise / Update from SD Phase	5 days	Thu 10/29/20	Wed 11/4/20
227	**Internal Approval/Sign-off**	1 day	Thu 11/5/20	Thu 11/5/20
228	**Submit Drawings/Specs for Owner Approval**	0 days	Thu 11/5/20	Thu 11/5/20
229	**Presentation**	0 days	Mon 11/9/20	Mon 11/9/20

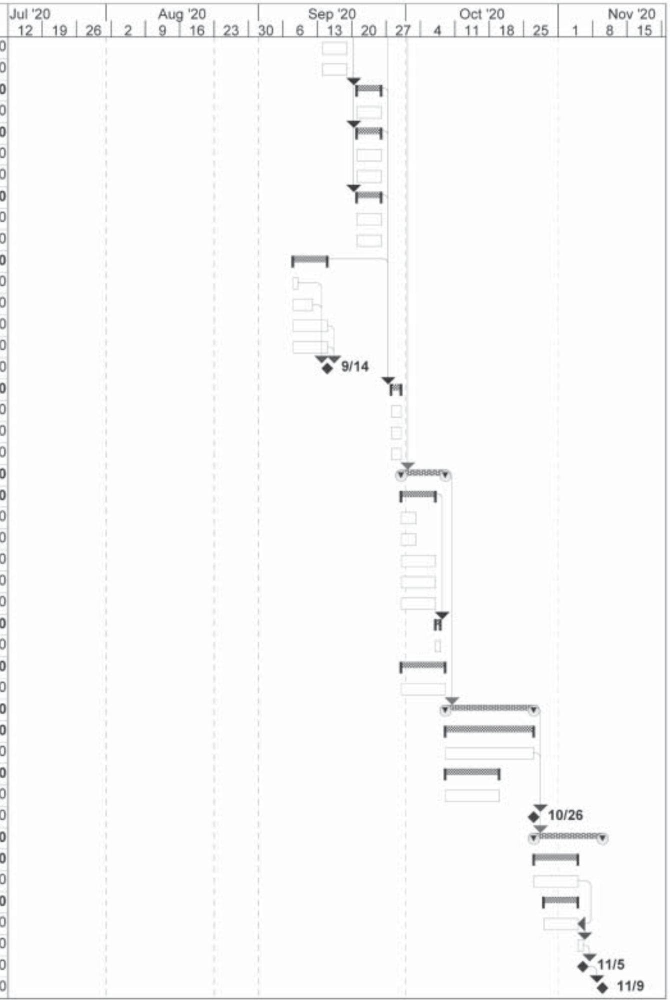

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FIGURE 6.23 Design Development Workflow.

ID	Task Name	Duration	Start	Finish
1				
2	**CONSTRUCTION DOCUMENTS WORKFLOW**	**80 days**	**Wed 11/25/20**	**Tue 3/23/21**
3	**Project Start-Up**	**2 days**	**Wed 11/25/20**	**Fri 11/27/20**
4	Update/ Revise Schedule	1 day	Wed 11/25/20	Thu 11/26/20
5	Revise Workplan	1 day	Wed 11/25/20	Thu 11/26/20
6	Review. Adjust budget, hours	1 day	Wed 11/25/20	Thu 11/26/20
7	Define Deliverables	1 day	Wed 11/25/20	Thu 11/26/20
8	Revise Cartoon Set	1 day	Thu 11/26/20	Fri 11/27/20
9	Production Kickoff	0 days	Fri 11/27/20	Fri 11/27/20
10	**Work Cycle 1 (Design Development Revisions)**	**26 days**	**Fri 11/27/20**	**Tue 1/5/21**
11	**Life Safety Plans**	**2 days**	**Fri 11/27/20**	**Tue 12/1/20**
12	Re-Review Decisions	1 day	Fri 11/27/20	Mon 11/30/20
13	Revise Drawings	2 days	Fri 11/27/20	Tue 12/1/20
14	Info. to M, P, E	0 days	Tue 12/1/20	Tue 12/1/20
15	**Floor Plans**	**10 days**	**Fri 11/27/20**	**Fri 12/11/20**
16	Review Owner Comments	1 day	Fri 11/27/20	Mon 11/30/20
17	Revise Drawings	2 wks	Fri 11/27/20	Fri 12/11/20
18	Info. To All Disciplines	0 days	Fri 12/11/20	Fri 12/11/20
19	**Reflected Ceiling Plans**	**15 days**	**Fri 12/11/20**	**Mon 1/4/21**
20	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
21	Revise Drawings	3 wks	Fri 12/11/20	Mon 1/4/21
22	Info. To All Disciplines	0 days	Mon 1/4/21	Mon 1/4/21
23	**Roof Plans**	**5 days**	**Fri 12/11/20**	**Mon 12/21/20**
24	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
25	Revise Drawings	1 wk	Fri 12/11/20	Mon 12/21/20
26	Info. to Structural, M, P, E	0 days	Fri 12/11/20	Fri 12/11/20
27	**Elevations**	**10 days**	**Fri 11/27/20**	**Fri 12/11/20**
28	Review Owner Comments	1 day	Fri 11/27/20	Mon 11/30/20
29	Revise Drawings	2 wks	Fri 11/27/20	Fri 12/11/20
30	Info. to Structural, M, P, E	0 days	Fri 11/27/20	Fri 11/27/20
31	**Building Sections**	**4 days**	**Fri 12/11/20**	**Thu 12/17/20**
32	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
33	Revise Drawings	4 days	Fri 12/11/20	Thu 12/17/20
34	Info. to Structural, M, P, E	0 days	Fri 12/11/20	Fri 12/11/20
35	**Wall Sections**	**10 days**	**Fri 12/11/20**	**Mon 12/28/20**
36	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
37	Revise Drawings	2 wks	Fri 12/11/20	Mon 12/28/20
38	Info. to Structural, M, P, E	0 days	Fri 12/11/20	Fri 12/11/20
39	**Interiors**	**10 days**	**Fri 12/11/20**	**Mon 12/28/20**
40	**Finish Plans**	**10 days**	**Fri 12/11/20**	**Mon 12/28/20**
41	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
42	Revise Drawings	2 wks	Fri 12/11/20	Mon 12/28/20
43	Coord. With Architectural	2 days	Fri 12/11/20	Tue 12/15/20
44	**Furniture Plans**	**5 days**	**Fri 12/11/20**	**Mon 12/21/20**
45	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20
46	Revise Drawings	1 wk	Fri 12/11/20	Mon 12/21/20
47	Coord. with Architectural, M, E	2 days	Fri 12/11/20	Tue 12/15/20
48	**Equipment Plans**	**5 days**	**Fri 12/11/20**	**Mon 12/21/20**
49	Review Owner Comments	1 day	Fri 12/11/20	Mon 12/14/20

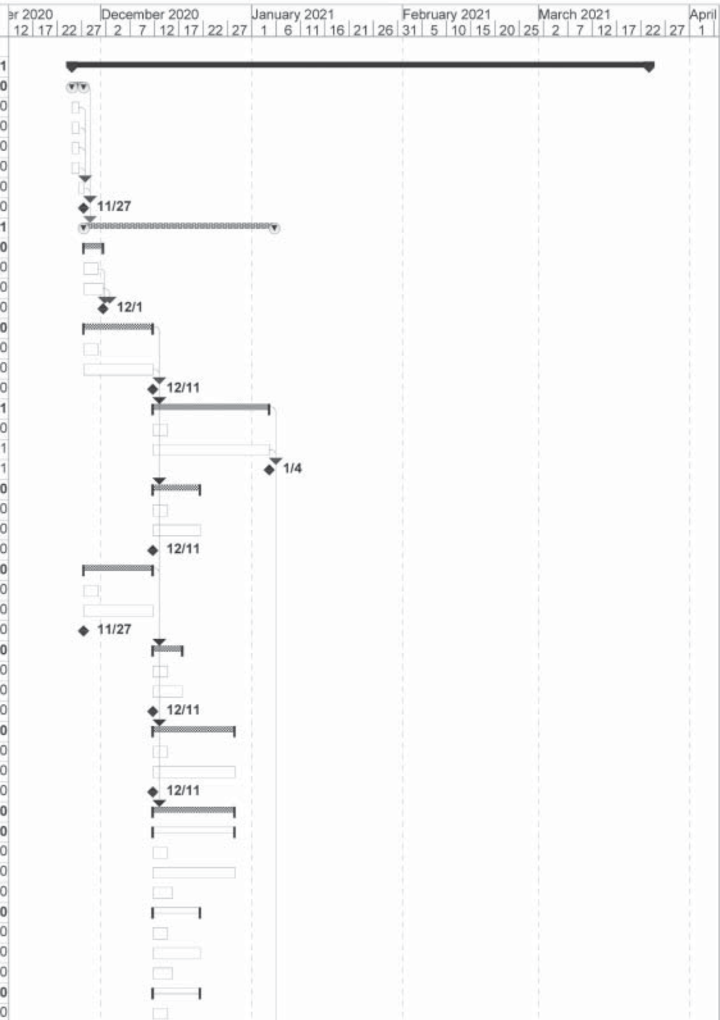

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FIGURE 6.24 Construction Documents Workflow.

ID	Task Name	Duration	Start	Finish
50	Revise Drawings	1 wk	Fri 12/11/20	Mon 12/21/20
51	Coord. with Architectural, M, P, E	2 days	Fri 12/11/20	Tue 12/15/20
52	**Site Plans**	**10 days**	**Fri 11/27/20**	**Fri 12/11/20**
53	Review Owner Comments	1 day	Fri 11/27/20	Mon 11/30/20
54	Revise Drawings	2 wks	Fri 11/27/20	Fri 12/11/20
55	Info. to Civil, Landscape, M, P, E	2 days	Fri 11/27/20	Tue 12/1/20
56	**60% Design Review**	0 days	Tue 1/5/21	Tue 1/5/21
57	**Work Cycle 2a (Development/Detailing Exterior)**	**25 days**	**Tue 1/5/21**	**Thu 2/11/21**
58	**Floor Plans (Plan Details)**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
59	Input from Structural	1 day	Tue 1/5/21	Wed 1/6/21
60	Opening Details	1 wk	Tue 1/5/21	Wed 1/13/21
61	Corner Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
62	Material Intersections	2 days	Tue 1/5/21	Thu 1/7/21
63	Columns at Exterior Walls	2 days	Tue 1/5/21	Thu 1/7/21
64	Misc. Plan Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
65	Expansion/Control Joints	1 day	Tue 1/5/21	Wed 1/6/21
66	Info. To All Disciplines	0 days	Wed 1/13/21	Wed 1/13/21
67	**Roof Plans (Roof Details)**	**15 days**	**Wed 1/13/21**	**Wed 2/3/21**
68	Input from Structural, M, P, E	1 day	Wed 1/13/21	Thu 1/14/21
69	Roof Drains	2 days	Wed 1/13/21	Fri 1/15/21
70	Screen Walls	1 wk	Wed 1/13/21	Wed 1/20/21
71	Curb Details	3 days	Wed 1/13/21	Mon 1/18/21
72	Hatch Details	1 day	Wed 1/13/21	Thu 1/14/21
73	Coping/Flashing Details	1 wk	Wed 1/13/21	Wed 1/20/21
74	Roof Terminations/Flashing	2 wks	Wed 1/13/21	Wed 1/27/21
75	Skylights	1 day	Wed 1/13/21	Thu 1/14/21
76	Equipment Curbs	3 days	Wed 1/13/21	Mon 1/18/21
77	Penthouses	1 wk	Wed 1/20/21	Wed 1/27/21
78	Appendages (Canopies/Grilles)	1 wk	Wed 1/27/21	Wed 2/3/21
79	Info. to Civil, Structural, M, P, E	0 days	Wed 2/3/21	Wed 2/3/21
80	**Wall Sections (Wall System Details)**	**24 days**	**Tue 1/5/21**	**Wed 2/10/21**
81	Input from Structural	1 day	Tue 1/5/21	Wed 1/6/21
82	Below Grade Conditions	1 day	Tue 1/5/21	Wed 1/6/21
83	Foundation Conditions	3 days	Tue 1/5/21	Fri 1/8/21
84	Opening (Head/Sill) Conditions	1 wk	Fri 1/8/21	Mon 1/18/21
85	Floor Termination Conditions	1 wk	Mon 1/18/21	Mon 1/25/21
86	Lintel Conditions	1 wk	Mon 1/25/21	Mon 2/1/21
87	Roof termination Conditions	3 days	Mon 2/1/21	Fri 2/5/21
88	Parapet Conditions	3 days	Fri 2/5/21	Wed 2/10/21
89	Expansion/Control Joints	1 day	Tue 1/5/21	Wed 1/6/21
90	Info. to Structural	0 days	Wed 2/10/21	Wed 2/10/21
91	**Site Plans**	**25 days**	**Tue 1/5/21**	**Thu 2/11/21**
92	**Enlarged Site Plans**	**20 days**	**Tue 1/5/21**	**Wed 2/3/21**
93	Input from Civil	1 day	Tue 1/5/21	Wed 1/6/21
94	Paving Materials/Textures	1 wk	Tue 1/5/21	Wed 1/13/21
95	Site Walls	1 wk	Wed 1/13/21	Wed 1/20/21
96	Site Amenities	1 wk	Wed 1/20/21	Wed 1/27/21
97	Stairs/Ramps	1 wk	Wed 1/27/21	Wed 2/3/21
98	Misc. Conditions	1 wk	Tue 1/5/21	Wed 1/13/21

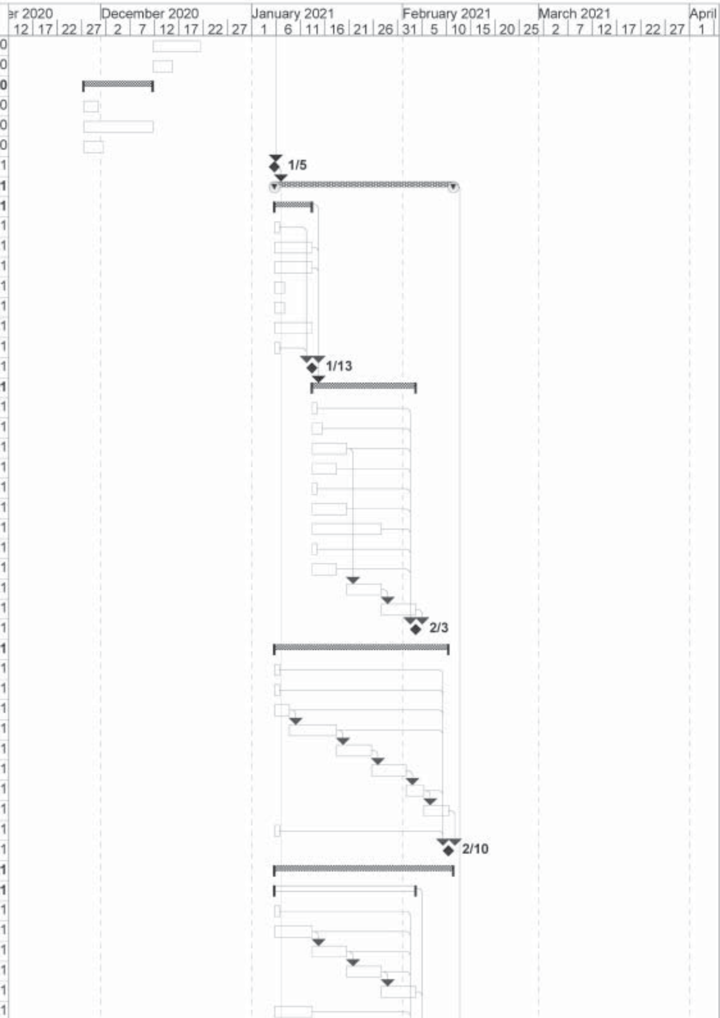

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FIGURE 6.25 Construction Documents Workflow.

ID	Task Name	Duration	Start	Finish
99	Info. to Civil, Landscape	0 days	Wed 2/3/21	Wed 2/3/21
100	**Site Details**	**5 days**	**Thu 2/4/21**	**Thu 2/11/21**
101	Site Wall Details	3 days	Thu 2/4/21	Tue 2/9/21
102	Waterproof Deck Conditions	1 day	Thu 2/4/21	Fri 2/5/21
103	Stair/Ramp Details	3 days	Thu 2/4/21	Tue 2/9/21
104	Misc. Specialty Conditions	1 wk	Thu 2/4/21	Thu 2/11/21
105	Signage Details	2 days	Thu 2/4/21	Mon 2/8/21
106	Info. to Civil, Landscape	0 days	Thu 2/11/21	Thu 2/11/21
107	**Work Cycle 2b (Development/Detailing Interior)**	**22 days**	**Tue 1/5/21**	**Mon 2/8/21**
108	**Life Safety Plans**	**3 days**	**Tue 1/5/21**	**Fri 1/8/21**
109	UL Assemblies	3 days	Tue 1/5/21	Fri 1/8/21
110	Info. to M, P, E	0 days	Fri 1/8/21	Fri 1/8/21
111	**Floor Plans**	**22 days**	**Tue 1/5/21**	**Mon 2/8/21**
112	**Vertial Circulation Plans**	**22 days**	**Tue 1/5/21**	**Mon 2/8/21**
113	Input from Structural, M, P, E	1 day	Tue 1/5/21	Wed 1/6/21
114	Stair Plans	7 days	Tue 1/5/21	Fri 1/15/21
115	Elevator Plans	7 days	Fri 1/15/21	Tue 1/26/21
116	Ramp Plans	3 days	Fri 1/15/21	Wed 1/20/21
117	Info. to Structural, M, P, E	0 days	Tue 1/26/21	Tue 1/26/21
118	**Sections**	**12 days**	**Fri 1/15/21**	**Tue 2/2/21**
119	Stair Sections	1 wk	Fri 1/15/21	Fri 1/22/21
120	Elevator Hoistway Sections	1 wk	Tue 1/26/21	Tue 2/2/21
121	Info. to Structural, M, P, E	0 days	Tue 2/2/21	Tue 2/2/21
122	**Details**	**3 days**	**Tue 2/2/21**	**Mon 2/8/21**
123	Input from Structural, Interiors	1 day	Tue 2/2/21	Wed 2/3/21
124	Treads, Risers, Railings	3 days	Tue 2/2/21	Mon 2/8/21
125	Hoistway	3 days	Tue 2/2/21	Mon 2/8/21
126	Info. to Structural, Interiors	0 days	Mon 2/8/21	Mon 2/8/21
127	**Enlarged Plans**	**10 days**	**Tue 1/5/21**	**Wed 1/20/21**
128	Input from Interiors	5 days	Tue 1/5/21	Wed 1/13/21
129	Revise Drawings	2 wks	Tue 1/5/21	Wed 1/20/21
130	Info. To Interiors	0 days	Wed 1/20/21	Wed 1/20/21
131	**Toilet Room Elevations**	**10 days**	**Wed 1/20/21**	**Wed 2/3/21**
132	Input from Interiors	1 day	Wed 1/20/21	Thu 1/21/21
133	Identify Fixtures, Compartments	2 wks	Wed 1/20/21	Wed 2/3/21
134	Identify Toilet Accessories	1 wk	Wed 1/20/21	Wed 1/27/21
135	Coordinate with Finishes	1 wk	Wed 1/20/21	Wed 1/27/21
136	Info. To Interiors	0 days	Wed 2/3/21	Wed 2/3/21
137	**Interior Elevations**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
138	Input from Interiors	1 day	Tue 1/5/21	Wed 1/6/21
139	Define Arch. Woodwork	1 wk	Tue 1/5/21	Wed 1/13/21
140	Define Wall Mounted Equip.	1 wk	Tue 1/5/21	Wed 1/13/21
141	Coord. Elements between Disciplines	1 wk	Tue 1/5/21	Wed 1/13/21
142	Identify Misc. Details	1 day	Tue 1/5/21	Wed 1/6/21
143	Info. To Interiors	0 days	Wed 1/13/21	Wed 1/13/21
144	**Misc. Details**	**5 days**	**Wed 1/13/21**	**Wed 1/20/21**
145	Input from Interiors	1 day	Wed 1/13/21	Thu 1/14/21
146	Specialties	1 wk	Wed 1/13/21	Wed 1/20/21
147	Wall Mounted Conditions	2 days	Wed 1/13/21	Fri 1/15/21

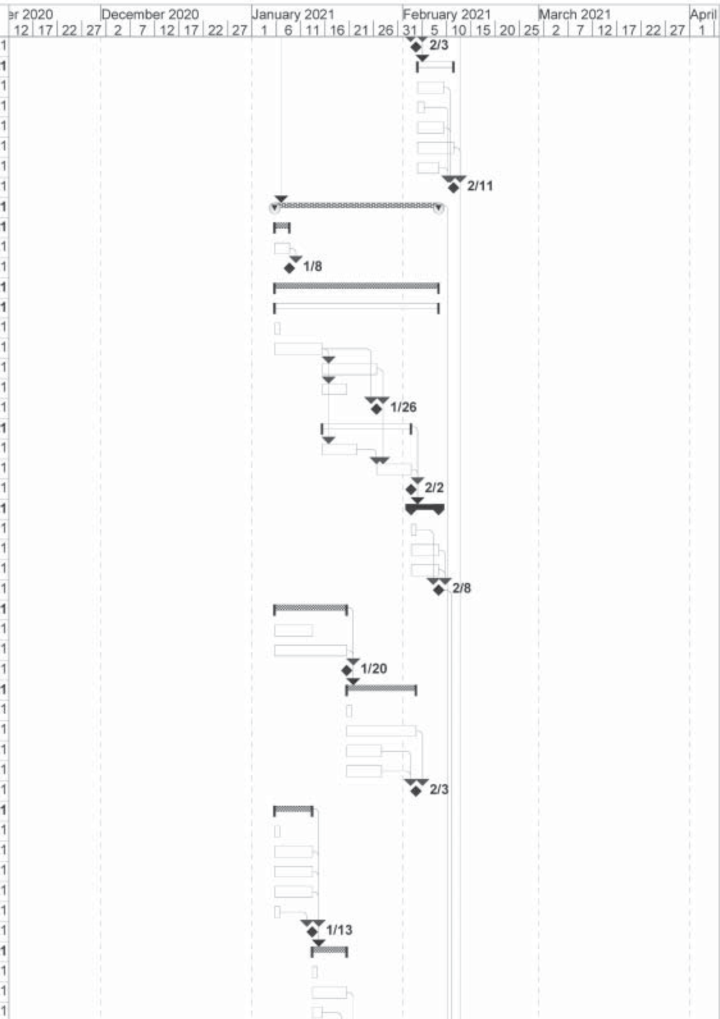

FIGURE 6.26 Construction Documents Workflow.

ID	Task Name	Duration	Start	Finish
148	Material Transitions	2 days	Wed 1/13/21	Fri 1/15/21
149	Info. To Interiors	0 days	Wed 1/20/21	Wed 1/20/21
150	**Partitions Systems Details**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
151	Plan Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
152	Underside of Construction, Ceiling	1 wk	Tue 1/5/21	Wed 1/13/21
153	Sill Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
154	**Door/Frame Details**	**10 days**	**Tue 1/5/21**	**Wed 1/20/21**
155	Head, Jamb, Sill Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
156	Door Schedule	2 wks	Tue 1/5/21	Wed 1/20/21
157	**Arch. Woodwork Details**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
158	Info. From Interiors	1 day	Tue 1/5/21	Wed 1/6/21
159	Revise Drawings	1 wk	Tue 1/5/21	Wed 1/13/21
160	Info. To Interiors	0 days	Wed 1/13/21	Wed 1/13/21
161	**Misc. Plan Details**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
162	Unique Conditions	1 wk	Tue 1/5/21	Wed 1/13/21
163	**Reflected Ceiling Plans**	**15 days**	**Tue 1/5/21**	**Wed 1/27/21**
164	**Enlarged Ceiling Plans**	**10 days**	**Tue 1/5/21**	**Wed 1/20/21**
165	Input from Interiors	1 day	Tue 1/5/21	Wed 1/6/21
166	Locate Ceiling Elements	3 days	Tue 1/5/21	Fri 1/8/21
167	Define Materials	2 wks	Tue 1/5/21	Wed 1/20/21
168	Identify Misc. Details	1 day	Tue 1/5/21	Wed 1/6/21
169	Info. to Interiors, M, P, E	0 days	Wed 1/20/21	Wed 1/20/21
170	**Ceiling Details**	**5 days**	**Wed 1/20/21**	**Wed 1/27/21**
171	Soffit Conditions	4 days	Wed 1/20/21	Tue 1/26/21
172	Cove Conditions	4 days	Wed 1/20/21	Tue 1/26/21
173	Material Transitions	4 days	Wed 1/20/21	Tue 1/26/21
174	Expansion/Control Joints	4 days	Wed 1/20/21	Tue 1/26/21
175	Equipment Supports	4 days	Wed 1/20/21	Tue 1/26/21
176	Misc. Details	1 wk	Wed 1/20/21	Wed 1/27/21
177	**Finish Plans**	**10 days**	**Tue 1/5/21**	**Wed 1/20/21**
178	**Enlarged Plans**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
179	Info. From Architectural	3 days	Tue 1/5/21	Fri 1/8/21
180	Floor Patterns	5 days	Tue 1/5/21	Wed 1/13/21
181	Identify Misc. Details	1 day	Tue 1/5/21	Wed 1/6/21
182	Coord. With Architectural	5 days	Tue 1/5/21	Wed 1/13/21
183	**Finish Details**	**5 days**	**Wed 1/13/21**	**Wed 1/20/21**
184	Info. From Architectural	5 days	Wed 1/13/21	Wed 1/20/21
185	Floor Transitions	2 days	Wed 1/13/21	Fri 1/15/21
186	Applied Wall Finish Terminations	2 days	Wed 1/13/21	Fri 1/15/21
187	Misc. Details	3 days	Wed 1/13/21	Mon 1/18/21
188	Coord. With Architectural	5 days	Wed 1/13/21	Wed 1/20/21
189	**Furniture Plans**	**15 days**	**Tue 1/5/21**	**Wed 1/27/21**
190	Coord. with Architectural, M, E	3 wks	Tue 1/5/21	Wed 1/27/21
191	**Casework & Equipment**	**7 days**	**Tue 1/5/21**	**Fri 1/15/21**
192	**Interior Elevations**	**5 days**	**Tue 1/5/21**	**Wed 1/13/21**
193	Casework/Equipment Elevations	1 wk	Tue 1/5/21	Wed 1/13/21
194	Services	1 wk	Tue 1/5/21	Wed 1/13/21
195	Coordination with all disciplines	1 wk	Tue 1/5/21	Wed 1/13/21
196	**Casework Sections**	**1 day**	**Wed 1/13/21**	**Thu 1/14/21**

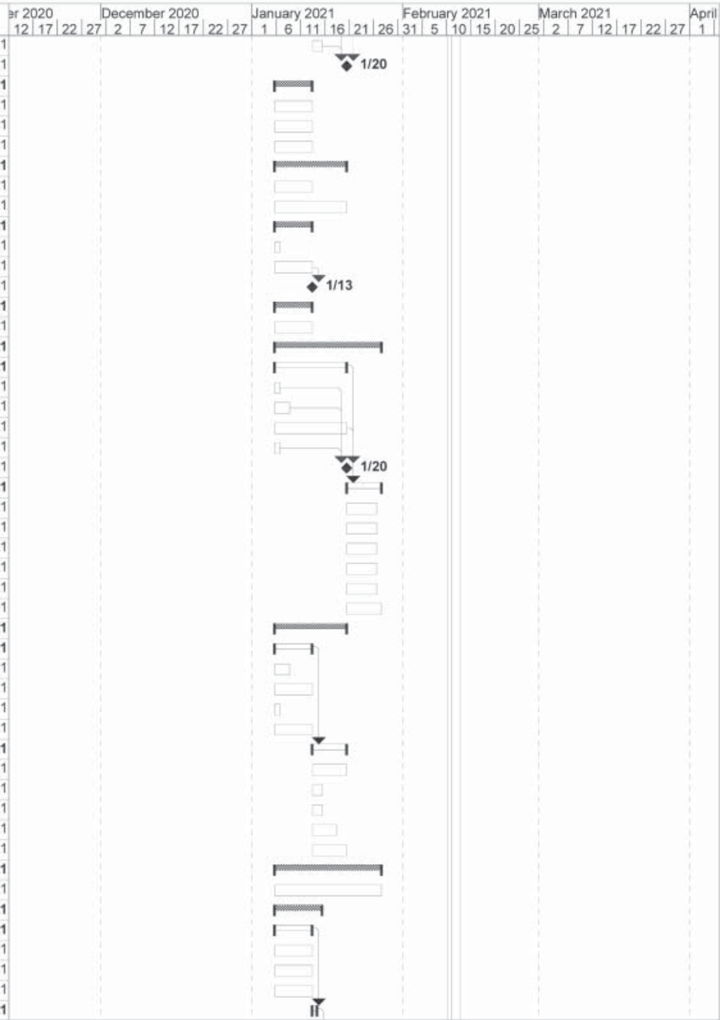

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FIGURE 6.27 Construction Documents Workflow.

ID	Task Name	Duration	Start	Finish
197	Coordination of Elements	1 day	Wed 1/13/21	Thu 1/14/21
198	Coord. With M, P, E	1 day	Wed 1/13/21	Thu 1/14/21
199	**Details**	**1 day**	**Thu 1/14/21**	**Fri 1/15/21**
200	Misc. Conditions	1 day	Thu 1/14/21	Fri 1/15/21
201	Coord. With M, P, E	1 day	Thu 1/14/21	Fri 1/15/21
202	**Site Plans**	**10 days**	**Tue 1/5/21**	**Wed 1/20/21**
203	Input from Landscape, Civil, M, P, E	1 day	Tue 1/5/21	Wed 1/6/21
204	Signage	4 days	Tue 1/5/21	Mon 1/11/21
205	Specialties	2 wks	Tue 1/5/21	Wed 1/20/21
206	Material Patterns	1 wk	Tue 1/5/21	Wed 1/13/21
207	Info. to Civil, Landscape, M, P, E	0 days	Wed 1/20/21	Wed 1/20/21
208	**Specifications**	**10 days**	**Fri 1/22/21**	**Mon 2/8/21**
209	Coordination Review	2 wks	Fri 1/22/21	Mon 2/8/21
210	Constructability Review	2 wks	Fri 1/22/21	Mon 2/8/21
211	Gather Product Information	2 wks	Fri 1/22/21	Mon 2/8/21
212	**Work Cycle 3 (Refinement/Organization)**	**10 days**	**Thu 2/11/21**	**Thu 2/25/21**
213	**All Drawings**	**10 days**	**Thu 2/11/21**	**Thu 2/25/21**
214	Refinement & Organization	2 wks	Thu 2/11/21	Thu 2/25/21
215	**Specification Editing**	**10 days**	**Thu 2/11/21**	**Thu 2/25/21**
216	Coordinate with Drawings	2 wks	Thu 2/11/21	Thu 2/25/21
217	**Work Cycle 4 (Annotation)**	**5 days**	**Thu 2/25/21**	**Fri 3/5/21**
218	**Annotation for all Sheets**	**5 days**	**Thu 2/25/21**	**Fri 3/5/21**
219	General Notes	5 days	Thu 2/25/21	Fri 3/5/21
220	Keyed Notes	5 days	Thu 2/25/21	Fri 3/5/21
221	Legends	5 days	Thu 2/25/21	Fri 3/5/21
222	Dimensioning	5 days	Thu 2/25/21	Fri 3/5/21
223	References	5 days	Thu 2/25/21	Fri 3/5/21
224	**Project Info. Sheets**	**3 days**	**Thu 2/25/21**	**Wed 3/3/21**
225	Cover Sheet	3 days	Thu 2/25/21	Wed 3/3/21
226	Project General Info.	3 days	Thu 2/25/21	Wed 3/3/21
227	Discipline Info.	3 days	Thu 2/25/21	Wed 3/3/21
228	**Coordination of Drawings and Specifications**	**5 days**	**Thu 2/25/21**	**Fri 3/5/21**
229	Review all Drawings/Specs	5 days	Thu 2/25/21	Fri 3/5/21
230	Coordinate with Consultants	5 days	Thu 2/25/21	Fri 3/5/21
231	**Work Cycle 5 (Quality Control & Approvals)**	**12 days**	**Fri 3/5/21**	**Tue 3/23/21**
232	**All Drawings & Specifications**	**10 days**	**Fri 3/5/21**	**Fri 3/19/21**
233	Final Checking/Coordination - 95% Design Review	10 days	Fri 3/5/21	Fri 3/19/21
234	Final Page Turn	0 days	Fri 3/19/21	Fri 3/19/21
235	**Internal Approval/Sign-off**	0 days	Tue 3/23/21	Tue 3/23/21
236	**Submit Drawings/Specs for Permitting**	0 days	Tue 3/23/21	Tue 3/23/21

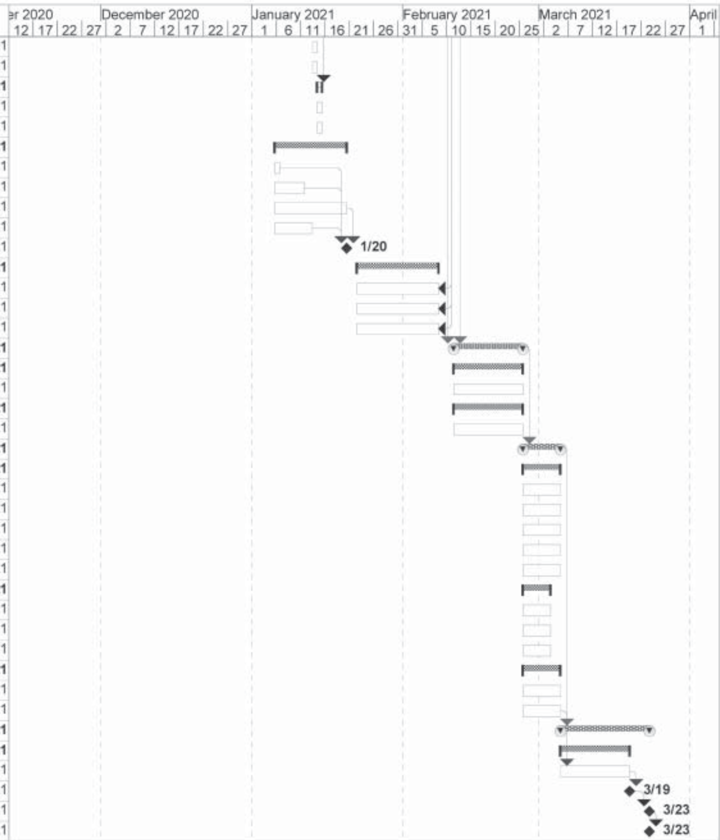

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FIGURE 6.28 Construction Documents Workflow.

PROJECT ROADMAP
A Path Ahead

The following is a roadmap that identifies overall activities with a phase driven coordination approach. It can be adapted to fit your project's phasing and applied to a corresponding time schedule.

The primary goal is to facilitate early decision making to concurrently design a constructible building that is also within budget.

CONDUCTOR

The Project Architect is responsible to organize and coordinate all team members to complete their tasks. Structural, MEP, Civil and other consultants are at times your clients. You must set all parameters affecting their work and see that this information along with that which they provide flows to all concerned in a timely manner.

WORK & INFORMATION FLOW

Along with a more traditional schedule that ID's milestones, determine a more granular Pull type schedule that identifies and choregraphs the needed interdependencies between the Architects and Engineers work. An important part of this is to determine an **Information Exchange Schedule** - or when we need to supply or "trade" information with each other. This is best accomplished in a team meeting where all issues can be raised affecting the project and a schedule agreed upon. All information must be routed through the project architect and documented.

CONTEXTURE

"*The act, process, or manner of weaving parts into a whole.*" - Webster's New Collegiate Dictionary. Building elements such as beams, columns, ducts, exterior skins, roof systems and finish grades must be designed to fit together correctly, meet all codes and the solution documented.

PROCESS

Preliminary Design / Schematic Design - verifies the Project's definition (what the client wants & will spend) along with the schedule and begins the design exploration to develop a solution to the project's needs.

Design Development - develop planning and design with code and building system issues investigated. A primary goal is to “solve the puzzle” of the project and finalize planning, design, code and building systems & constructability.

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FIGURE 6.29 Project Roadmap.

The Beginning of CD's - consultant team organization and parameters set, disperse project information to consultants.

50% - 95% thru completion of CD's - remaining time is spent documenting the solution and coordinating documents.

ALWAYS

Record and subsequently copy appropriate team member(s) any Owner, vendor or consultant information affecting project parameters including subtle issues. (i.e., Owner comments about things that they may like or dislike such as HVAC does not cool adequately somewhere. Why? Can this be avoided in the future?) Significant comments and important project parameters are sometimes only casually mentioned and must be listened for and then documented.

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FIGURE 6.30 Project Roadmap.

PROJECT ROADMAP
PRELIMINARY / SCHEMATIC DESIGN

PROJECT COORDINATION

GENERAL

- ☐ Identify scope of work - building and site
- ☐ Is the Owner's budget reasonable?
- ☐ Review the project schedule and deliverables, are they reasonable?
- ☐ Work out Schematic Design deliverables and dates w/ AEC team
- ☐ Identify GC or CM and type of delivery process - Design-Bid-Build, CMAR, etc.
- ☐ Determine general construction phasing approach
- ☐ Determine applicable codes and AHJ agencies
- ☐ Determine the overall life safety strategy (building construction type, allowable areas, height limitations, paths of egress, stairs, rated corridors, separation between new and existing additions (if required), etc...)
- ☐ Order specific code publications as required.
- ☐ Obtain copies of existing plans, specifications, if applicable; geotechnical reports, topographic surveys, etc.
- ☐ Is a Plat required?
- ☐ Verify that existing site utilities are sufficient for the project - sewer, water, electricity, gas, etc., and identify preliminary routings.
  - Review existing easements and whether new are required.
- ☐ Define LEED / Sustainability goals for project, if applicable
- ☐ Is elevator study required?
- ☐ Identify major equipment (production, kitchen, medical, elevators, dumbwaiters, etc.) These are items the contractor needs to be aware of, they impact construction x load, size, space requirements. Anything affecting layout and other disciplines.
- ☐ Determine major building systems
  - Building exterior skin systems and roof
  - Determine interior finishes along with a cost value range
  - Structural systems and preliminary layout
  - MEP systems including locations of mechanical and electrical rooms; initial equipment selections and layouts; initial routings of ductwork and major conduit runs; shaft locations and initial plumbing and electrical fixtures
  - Identify telecom and low voltage systems and MDF / IDF room locations.
- ☐ Determine an initial site grading approach.
- ☐ Identify the extents and scope of demolition.

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FIGURE 6.31 Project Roadmap.

- ☐ Prepare the BIM Execution Plan

ACTIVITIES

- ☐ Conduct a **Collaborate (Pull) Planning** session with the AE team.
- ☐ Conduct a **Building Systems Review** w/ client, AE team, contractor, & other project stakeholders
- ☐ Have a **Technology Charette** to determine systems (IDF requirements / size, backbone, DAS, wireless capabilities, etc...). What future IT systems are anticipated - how should current design address future capabilities?
- ☐ Consider a **Design Thinking** event w/ client to define their needs & expectations
- ☐ Initial code review with AJH(s)

COORDINATION

- ☐ Identify consultants and begin dialogue on major systems.
- ☐ Work through initial routing of major MEP systems in lobbies, atriums and similar public spaces.

CIVIL

- ☐ Copy with all surveys

STRUCTURAL

- ☐ Copy with Geotechnical report

MEP

- ☐ Copy with all surveys

CHECK THAT

- ☐ Building is located behind all required setbacks

DELIVERABLES

NARRATIVE BOOKLETS

- ☐ PPD outline specifications with summaries of all building systems
- ☐ Identify all potential project costs (i.e., "pots of money")
- ☐ List project issues and assumptions

DRAWINGS

ARCHITECTURE

- ☐ General sheets; Life Safety Plans; floor plans; building elevations; wall and building sections; roof plan, interior elevations

STRUCTURE

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FIGURE 6.32 Project Roadmap.

☐ General sheets and notes; Foundation and Framing plans.

CIVIL

☐ Overall site and utility plans

MEP

☐ Mechanical, Electrical and Plumbing plans with initial system layouts (single line diagrams, limited or no device locations)

FOOD SERVICE

☐ Floor plan layout; initial equipment list

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FIGURE 6.33 Project Roadmap.

PROJECT ROADMAP
DESIGN DEVELOPMENT

GENERAL

☐ Finalize functional space planning
☐ Finalize all building systems including building skin
☐ Finalize Life Safety Plan strategy
☐ Select UL design numbers for rated elements.
☐ Finalize interior finishes and FF&E
☐ Finalize all equipment selections & obtain cut sheets / criteria
☐ Work through plan & section details sufficiently to enable overall horizontal and vertical dimension control of all elements affecting other disciplines, i.e., structural, MEP, and food service. This requires an understanding of building equipment location and clearance requirements.
☐ Dimensionally set the structural grid (coordinate with wall and stair sections)
☐ Determine shear wall locations
☐ Locate expansion joints (if required)
☐ Dimension control for elevators, stairs, and building perimeter.
☐ Identify areas with sloping or recessed slabs (check that the reduced slab thickness does not conflict with UL requirements).
☐ Finalize the site grading approach and establish basic grades near building. Set building finish floor elevation.
☐ Initial concepts for Signage / Wayfinding
☐ BIM - resolve major conflicts with AE team coordination
☐ Finalize HVAC system. Locate & size mechanical and electrical rooms (preliminary MEP major equipment sizes with cut sheets). Determine and coordinate major duct riser locations.
☐ Determine individual Door Hardware & security requirements
☐ Identify doors with electronic hardware and work through door security issues
☐ Coordinate specifications verbiage to be used in documents. (i.e. "face brick" on the drawings should correlate with the words "face brick" in the specifications)
☐ Determine Construction Drawing set organization and work through Cartoon Set

ACTIVITIES

☐ Conduct a **Pull Planning** session with the AE team.
☐ Perform BIM clash detection coordination
☐ Code review w/ AHJ(s)

COORDINATION

☐ Meet with consultants and review strategy for building systems. Are there conflicts?
☐ Is the building scheme workable? Does it interface well with existing facilities?

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FIGURE 6.34 Project Roadmap.

- ☐ Copy Structural and MEP w/ equipment cut sheets / criteria
- ☐ Copy all consultants w/ UL Design numbers

CHECK THAT

CIVIL

- ☐ Existing street signs, drain inlets, telephone/power poles, valve boxes, manhole covers, etc. do not interfere with new site improvements such as building, drives or walks.
- ☐ Site utilities connect to the building and coordinate with MEP
- ☐ Site property line dimensions agree between survey & Civil

STRUCTURAL

- ☐ Columns and grid lines match between disciplines

ARCHITECTURAL

- ☐ Dimensions agree between structural and arch for column grid and overall dimensions

MECHANICAL/PLUMBING

- ☐ Background plans match architectural. (Consultant should use updated copies of floor plans)

ELECTRICAL

- ☐ Background plans match architectural. (Consultant should use updated copies of floor plans)

DELIVERABLES

NARRATIVE BOOKLETS

- ☐ Draft specifications. Alternatively, for many projects it is sufficient to still use PPD outline specifications with summaries of all building systems
- ☐ Verify all potential project costs (i.e., "pots of money")
- ☐ List project issues and assumptions

DRAWINGS

ARCHITECTURE

- ☐ General sheets; Life Safety Plans; floor plans; building elevations; wall and building sections; roof plan, interior elevations

STRUCTURE

- ☐ General sheets and notes; Foundation and Framing plans.

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FIGURE 6.35 Project Roadmap.

CIVIL

- ☐ Overall site and utility plans

MEP

- ☐ Mechanical, Electrical and Plumbing plans with initial system layouts (single line diagrams, limited or no device locations)

FOOD SERVICE

- ☐ Floor plan layout; initial equipment list

LOW VOLTAGE

- ☐ Floor plan layout; initial equipment room layouts

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FIGURE 6.36 Project Roadmap.

PROJECT ROADMAP
The Beginning of CDs

GENERAL

- [ ] Review BxP BIM with AE team
- [ ] Setup document exchange - BIM files, PDFs
- [ ] Devise a means to advise team members when one member makes a change that affects others. (A door swing change at the end may affect light switch locations, ADA requirements, etc.)
- [ ] Identify areas with heavy loading for structural engineer (equipment, HVAC, etc...)
- [ ] Finalize grades around building.
- [ ] Field verify existing conditions and document (notes, drawings, photos, video)
- [ ] Begin to work out specifications Front End (coordinate with construction manager if applicable)

ACTIVITIES

- [ ] Conduct a **Pull Planning** session with the AE team.
- [ ] Perform BIM clash detection coordination

COORDINATION

- [ ] Meet with consultants and review building systems. Are there any conflicts?
- [ ] Coordinate entry/exit points at building for utilities with Civil and MEP.

Copy all Consultants with:

- [ ] Cutsheets / info for all building systems & components (windows, roof, skin system...)

Copy Structural with:

- [ ] Dimension control info for elevators, stairs, all floor openings, building perimeter.
- [ ] All information, including equipment and fixture cutsheets, from MEP
- [ ] Food Service equipment information
- [ ] Finish grades around entire building (to comply with ADA and drain water - affects brick ledge heights and depths of grade beams/footings).
- [ ] All areas with slab depressions, sloping slabs and slab platforms (tile floors, special equipment, showers, HVAC equipment, food service equipment).

MEP

- [ ] Confirm areas with heavy loading (HVAC equipment, etc)
- [ ] Provide cut sheets for all major equipment (RTU, AHU, pumps, sumps). Include sizes and weights. Does equipment fit in spaces - horizontally and vertically?
- [ ] Identify areas requiring recessed floors? (such as boiler rooms)

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FIGURE 6.37 Project Roadmap.

- ☐ Validate shaft sizes
- ☐ Share Door Hardware & security markups

FOOD SERVICE

- ☐ ID areas with slab depressions, sloping slabs and slab platforms.
- ☐ Locate all drains/trench grates.
- ☐ Provide preliminary equipment schedule.

CHECK THAT

CIVIL

- ☐ Site layout and finished floor elevation(s) match architectural.
- ☐ New underground utilities do not conflict with each other, existing site utilities or elements.

STRUCTURAL

- ☐ Finished floor elevation(s) match architectural.
- ☐ Structural design basics agree with Geotechnical Report. If not, why not?
- ☐ Foundation, floor and roof framing plan grid lines, columns and column orientation line up with each other.

ARCHITECTURAL

- ☐ Existing/new work is identified on drawings (site plan, floor plans, roof plan, etc.)
- ☐ Building expansion joints match structural.
- ☐ Elevations agree with floor plans and wall sections (expansion joints, openings in wall, parapet heights, etc.)
- ☐ Wall sections agree with building sections
- ☐ Drawing note verbiage agrees with specifications

MECHANICAL AND PLUMBING

- ☐ Utility entry/exit points at building agree with Civil
- ☐ Areas that have sprinklers are correctly identified. Note how to handle special areas with sprinklers, such as skylights or ceiling features.
- ☐ Mechanical rooms are adequately sized with clearance for maintenance

ELECTRICAL

- ☐ Electrical rooms are correctly located and sized with clearance for maintenance
- ☐ Electrical panels are not recessed in rated walls
- ☐ Site electrical items are located correctly and agree with Civil and Architectural

FOOD SERVICE

- ☐ Background plan matches architectural (consultant should use updated copy of our floor plans)

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FIGURE 6.38 Project Roadmap.

PROJECT ROADMAP
50% CDs

GENERAL

- ☐ For renovations or additions, will exiting need to be re-routed during construction? Coordinate with Owner (& Contractor if applicable) and identify on drawings (and/or specs).
- ☐ Are there any building systems or items such as HVAC that need to be phased during construction? i.e., an existing AHU being replaced may supply surgery - what parameters must contractors observe? Identify on drawings (and/or specs).
- ☐ Fill out the Door Hardware Matrix Chart (or otherwise document individual door hardware functionality) and send to door hardware consultant to prepare hardware schedule. (Hardware consultant to provide proposed schedule with cut sheets for all hardware scheduled)
- ☐ Finalize Signage / Wayfinding

COORDINATION

- ☐ Meet with consultants and review building systems. Any conflicts?

Copy Civil with:

Dimension control for site features, i.e., paving, walks, etc.

Copy Structural with:

- ☐ Dimension control for HVAC shafts.
- ☐ Dimension control for openings in foundation walls for doors, louvers, etc.

MEP

- ☐ Provide cut sheets for all plumbing fixtures, chair carriers, grille types, drains and light fixtures.
- ☐ Advise MEP of all exterior glazing choices. MEP to confirm in writing that HVAC system will work correctly with glazing systems.
- ☐ Copy MEP w/ Door Hardware Matrix Chart - highlight doors w/ electronic locking
- ☐ Copy MEP w/ final Door Hardware Schedule and cut sheets

CHECK THAT

CIVIL

- ☐ Extent of construction, landscaped, irrigated, sodded, etc. agrees with other disciplines.

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FIGURE 6.39 Project Roadmap.

☐ Profile sheets agree with civil plans and do not have conflicts with other utilities or construction.

☐ Above ground items such as power/telephone poles and equipment do not conflict with other work.

☐ Dimensioned distances for drainage systems are correct and agree with that shown on profile sheets.

STRUCTURAL

☐ Areas with slab depressions, sloped slabs or slab platforms are shown and match architectural.

☐ Slab opening dimensions for all stair, elevator and mechanical shafts agree with architectural and MEP.

☐ Roof openings for all MEP items are shown and dimensioned.

☐ Piers, footings and foundation beams are sized and identified on schedule or on drawings.

☐ Columns and floor beams are sized and identified on schedule or on drawings.

☐ Dimensions agree with architectural.

☐ Drawing notes agree with Specs.

☐ Structural supports for HVAC, electrical and building equipment items (AHU, RTU, etc) are shown.

ARCHITECTURAL

☐ Door, borrowed light and window openings agree with interior/exterior elevations.

☐ Glazing types are specified.

☐ Large and small scale plans coordinate.

☐ MEP and food service are using current backgrounds with wall ratings turned on.

☐ MEP equipment items are shown on roof pan with roof walkway, roof access (ladders and hatches) shown.

☐ Are Alternates consistent between disciplines and Specifications?

☐ Equipment items fit and required clearances (including operational) are met.

MEP

☐ Housekeeping pads are located.

☐ Roof drains and lines agree and work with architectural.

☐ Are walls furred for vertical pipes?

☐ Are walls furred for vertical chases?

☐ All piping follows down, floor to floor, and that pipes penetrating structural foundation elements do so correctly.

☐ Duct and piping clear beams, girders, lights and ceiling features.

☐ Plumbing riser diagram matches plan and fixtures.

☐ Fire and/or smoke dampers are correctly located.

☐ Voltage, phases, horsepower, descriptions are identified consistently between mechanical and electrical drawings.

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FIGURE 6.40 Project Roadmap.

- ☐ Thermostats are located logically.
- ☐ Items such as thermostats, switches, outlets, etc. are "sensitively" placed in areas of importance, such as lobbies, atriums, etc.
- ☐ Building equipment is shown and "hooked" up.

ELECTRICAL

- ☐ Panel board designations are correct on riser diagrams.
- ☐ Items on emergency power are correct.
- ☐ Odd items on emergency power are verified with Owner and MEP consultant.
- ☐ Conduit runs, trenches, etc. that affect structural are coordinated.
- ☐ Hospital equipment is shown and "hooked" up.

FOOD SERVICE

- ☐ Scheduled equipment is consistent with plans and specifications.
- ☐ Equipment interfaces with MEP correctly and vice-versa.
- ☐ Slab depressions, sloped slabs and slab platforms agree with structural.

SPECIFICATIONS

- ☐ Spec information regarding phasing or construction exiting agrees with drawings.
- ☐ Items noted as "as indicated on drawings" or "as shown on drawings" are actually indicated or shown on drawings.

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FIGURE 6.41 Project Roadmap.

PROJECT ROADMAP
95% CDs

COORDINATION

- ☐ Meet with consultants and review building systems. Are there any conflicts?
- ☐ Review all specs.
- ☐ Do a site walk-thru with demolition plans to verify accuracy
- ☐ Establish final print date, seal date, etc. w/ AE team

CHECK THAT

CIVIL

- ☐ Final grades comply with ADA
- ☐ Titles are correct

STRUCTURAL

- ☐ Length of columns is consistent between schedules and details
- ☐ Each section or detail is correctly flagged
- ☐ Titles are correct.
- ☐ Verbiage is consistent with specifications
- ☐ All notes are referenced and consistent

ARCHITECTURAL

- ☐ RCP lighting layout agrees with electrical
- ☐ RCP grille locations agree with mechanical
- ☐ Room Finish Schedule finishes is in specifications
- ☐ Room Finish Schedule information agrees with plans. (Ceiling heights may be in schedule or noted on RCPs - not both)
- ☐ Door Schedule information agrees with plans
- ☐ All notes are referenced and consistent.
- ☐ Titles are correct
- ☐ Verify all building areas
- ☐ Review Door Hardware Schedule from consultant

MEP

- ☐ All notes are referenced and consistent
- ☐ Plumbing fixtures match schedules
- ☐ Titles are correct
- ☐ Final backgrounds plot with wall ratings on

ELECTRICAL

Page 14

FIGURE 6.42 Project Roadmap.

☐ All notes are referenced and consistent
☐ Titles are correct
☐ Final backgrounds plot with wall ratings on

FOOD SERVICE

☐ All notes are referenced and consistent
☐ Title are correct
☐ Final backgrounds plot with wall ratings on

SPECIFICATIONS

☐ Index titles, section numbers and numbers of sheets agrees with actual body of specs
☐ Specs coordinate with and complement drawings
☐ Thickness, spaces are shown in specs or on drawings, not on both

END OF DOCUMENT

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FIGURE 6.43 Project Roadmap.

CHAPTER 7

Strategic Areas

We have looked at different ways of understanding the architect's work and tasks; now let us dig deeper into the architect's playbook and look at specific applications that can be part of a Lean approach to project delivery.

There are many ways of providing design services, some good and some not so good. Does it really matter? We are suggesting that it does. A Lean approach looks at the underlying issues that affect our work to simplify where we can, to remove waste, and to facilitate a better flow. We choose to organize this discussion into what we call essentials for better project delivery that have application to every firm:

- Accelerate decision-making
- Effective communication
- Strategic modeling
- Targeted reviews
- Streamlining documentation-more on that in Chapter 8

ACCELERATE DECISION-MAKING

It can be a challenge to execute work well given the often frenetic pace and the all-to-often two steps forward, one step back of project delivery. As discussed earlier, the primary goal of design firms is to obtain work and then progress it forward and that this *movement* is the mechanism for billing clients. Decisions are the principal means for allowing projects to advance, and whatever we can do to accelerate making them helps the project – the assumption being that it is an appropriate decision.

For decades, many firms minimized their efforts during the design phases and instead staffed up during the construction documents (CD) phase where the bulk of the project fees were. Most project issues were finally resolved during the CD phase, and it was not uncommon to make significant project revisions during that period as we discovered that many areas of the project had not been well thought out. Today, the trend is often just the opposite, with significant time and effort spent during design phases addressing function and aesthetics but to the detriment of the construction documents. In both cases, fundamental project issues often remain unresolved, and the results are the same as having decisions changed later in the project: rework is required. A Lean approach to keep the project flowing is to identify decision points and potential constraints, determining what needs to be resolved and when.

Building Systems Review

The earlier decisions are made that can be relied upon, the less likely that wasteful project revisions must be made later, causing setbacks. One strategy for doing this is to conduct a building systems review. This is a modified form of a design charrette that does not look at aesthetic or functional design but rather is an in-depth examination of each component system comprising the project. Early agreement on building systems, basis-of-design products and materials, and finish expectations has a positive downstream effect.

Project Example

Midway through the schematic design phase of an 11-story building, a building systems review was conducted by the design team. This was a scripted 2-day meeting with the client, construction manager (CM), architects, engineers, and other minor consultants. The objective was to discuss design parameters and make decisions on all building systems from foundations, waterproofing and superstructure, mechanical and electrical systems, vertical circulation, building envelope including the roof, as well as primary interior materials and even how cabinetry would be constructed.

The architectural and engineering team made recommendations – with the CM concurrently discussing cost, constructability, and schedule. With a project budget already established, value engineering took place during the course of the meeting. The client shared their experience and preferences as to what worked and what did not, along with their current building standards and expectations. They also bought into what became the final selections.

The volume and depth of information and the decisions obtained over two 8-hour meetings contrasted greatly with previous experience on projects where a similar process happened slowly over many months. This depth of qualitative information was usually not known until well into the construction documents phase.

A summary report of the meeting was sent to all participants documenting the outcome. The final project documents, issued about a year later, deviated only in minor respects from what had been determined at the building systems review.

A building systems review can scale with the project. On a much smaller design–build office building, it entailed a 3-hour meeting during schematic design with the design–build contractor, the primary decision-maker from the client's side, and the architect. One by one the engineers were brought in to review their systems in detail. The result was the same with most building parameters sufficiently determined within a cost framework to let the design team rapidly move forward.

A full-size sample of the building systems review agenda (Figure 7.1) is located in the Appendix. It can be adapted and structured to suit your project type, size, and location.

FIGURE 7.1 Building systems review agenda.

Necessary ingredients: A detailed agenda that is preloaded with the architect and engineer (AE) team's recommendations with participation by project stakeholders and decision-makers.

Best time: schematic design phase

Decision-Making

Decision-making processes, or the lack thereof, have a significant effect on a project's ability to move forward. There is a strategic advantage to understanding what information is needed for others to make decisions and perform their work. Whether it is the client, the contractor, or our consultants, we should make it a priority to obtain and share the necessary information in a timely manner, which benefits everyone.

A great decision can lead to a brilliant outcome, whereas a poor or delayed decision can create a domino effect of rework and mistakes or even lead to the omission of necessary information. Decisions are usually best when not made in haste, and most require some prior planning and research to be reliable. Would you buy a car without learning about it first or taking a test drive? Then why would you, for example, not research a material thoroughly before specifying it for a project?

Consultants and other team members not located in same office, including those working remotely, are especially dependent on well-timed decisions. The timeliness can impact the delivery of everyone's work product and be the cause of missed deadlines and uncoordinated documents. The notion of *team* implies that we are all dependent on each other. If the architect is delayed in completing the reflected ceiling plan layout because of poor planning decisions, there can be an unfavorable downstream effect on multiple consultants such as electrical and lighting, security, fire sprinkler, and mechanical engineer.

Think of decisions strategically and the impact they have as you progress through the project.

Identify Client Decision-Making Processes

It is not just our own team's decisions that affect project flow. Do you consider the client as a member of the project team? Obviously, they are part of the overall project, but we recommend engaging them almost like a consultant when it comes to decision-making. Client determinations that are made late or subsequently changed can create delays in the overall project flow, and it may be difficult to hold them accountable, obtain additional design fees for rework, or extend the schedule. However, there may be ways to help them make the best decision initially – or, if changed later, to understand the project ramifications. How do you communicate this to your clients? It is best to tread lightly in the messaging and understand their point of view, as they are the ones who hired you to deliver the project and ultimately make the final call. Including them in a pull planning (or collaborative planning) exercise can be a remarkably effective way to let clients see where their decision-making (or lack thereof) impacts the work of others and the overall project progress. At a minimum, incorporating key decision points or action items in your project schedules and meeting agendas that are shared with your clients helps to keep them at the forefront.

Sometimes clients change their minds because they were given insufficient or inaccurate information.

There is a great benefit to understanding your client's internal processes for decision-making. This helps avoid awkward conversations and misunderstandings. Some clients have committees or multiple stakeholders; others may silo decision making to just one or two key people. Whether working with a school board, hospital administrators, or the local dentist, it helps to know who the audience is and how they operate. Also consider the amount of time required for decisions to be made and how best to record and communicate them. The dentist may be able to make a choice on a paint color immediately, whereas a school board may have a separate committee to do the same and take weeks to decide. Either way, if this is not accounted for in your project timeline, delays may jeopardize progress and create undue stress on all parties.

Early Contractor Involvement

The impact of design–assist and similar efforts where contractors are engaged early in project development has proven to be very advantageous. Design–assist is where a major subcontractor is engaged during the project design phase to provide system design input and help with validating costs for their scope of work. It eliminates the need to develop and evaluate multiple systems and cuts out time wasted specifying multiple components and designing to products that may not be used. It is a Lean process in many respects. Space planning can be right-sized to equipment requirements, construction document detailing may be minimized for some aspects, procurement may be accelerated to speed up construction, and shop drawings can be streamlined. Prime examples of this include heating, ventilation, and air-conditioning (HVAC) systems and equipment, elevators, curtain wall and building enclosure systems, plumbing, and electrical systems.

There is some risk to this approach from the client's perspective, and it requires some project dollars to be spent to engage the design–assist contractor and for the management of the process by the CM or general contractor.

Authorities Having Jurisdiction

Employing a strategy to engage early with the Authority Having Jurisdiction (AHJ) is another aspect of accelerated decision-making. Having a dialogue about the overall project, the expected review timeline, life safety approaches, and firefighter access facilitates smarter planning up front and can eliminate delays during plan review later. Understanding the different approaches in the interpretation of code sections will benefit everyone's understanding of the project's design. For example, one task that is better done early in design is to calculate the occupant load on a floor to ensure that there is sufficient capacity in the egress components to safely exit the building. How the AHJ interprets the loading of a breakroom, conference room, or an open office environment can greatly affect the sizing. Getting these agreed to before moving the planning too far along allows the design to proceed without modifications later due to faulty assumptions.

EFFECTIVE COMMUNICATION

When is the last time you had to think about how to communicate? Maybe you have traveled somewhere you did not know the language – or even visited a different region in your own country where they speak with a local dialect or use certain phrases you are not familiar with. This can be frustrating. We do not think of it often, but many aspects of our business operate the same way. To effectively communicate your ideas and designs, thought should be given as to who the audience is and how to best convey information to them in a way that they can understand. With design documentation, our objective is to instruct contractors without speaking – using written text (specifications) along with models and drawings that combine text, graphics, and images. Therefore, consider everything you issue as an opportunity to inform and instruct the end user, requiring as few additional directions as possible.

How we convey information is almost as important as the information itself.

Types of Communication

We are interacting constantly with our clients, consultants, and project team, and it would be impossible to do our job without using some form of communication. Thanks to technology, we have an abundant number of ways to do this (Figure 7.2): in person, on paper, in an e-mail, over text, via instant messaging (IM), through fax, on video, and on the phone. With so many options, it is easy to

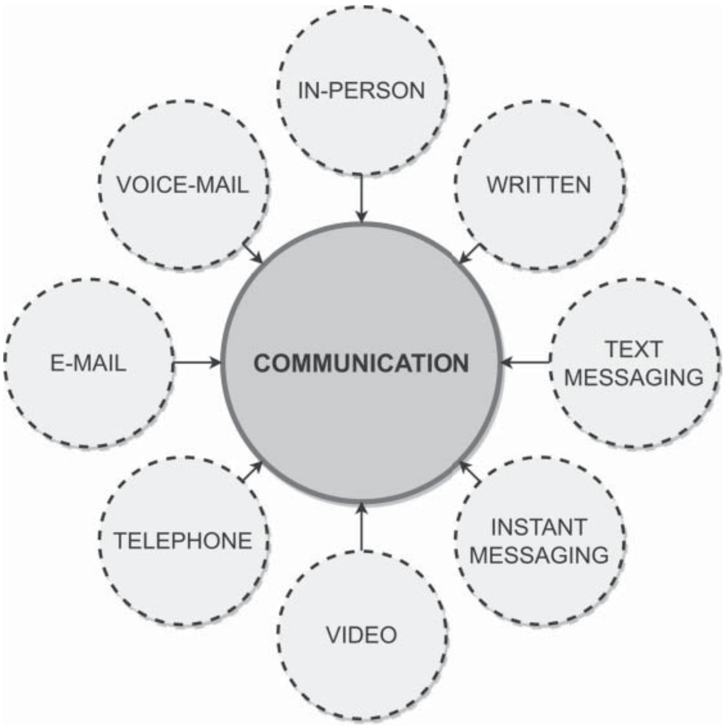

FIGURE 7.2 Types of Communication

start to mix the platforms. However, this risks our message losing clarity and opens up the possibility of actually miscommunicating our original intent, especially if it is regarding the same subject or issue. If we are not purposeful, we create an incomplete record of project-level communication. It would be advantageous if everyone documented the conversations and filed them in a searchable, central location, but there is seldom enough time for that in today's business environment.

The sheer number of ways to communicate and the amount of correspondence that travels back and forth can be overwhelming. In today's rapid-fire society, there is the expectation of an instant reply, hence the increasing use of instant communication tools. On any given day, hundreds of e-mails may find their way to your inbox. How many can be effectively responded to? Doing so takes time and reduces your productivity, and your job can feel more like that of an administrator than a design professional. With the always connected world, there is no escaping interruption from an increasing array of sources.

For example, on a project in construction the project superintendent calls the architect immediately after e-mailing a request for information (RFI). The conversation goes something like this:

> Superintendent: Hey Architect, I need an answer on that RFI I just sent you. It is holding up progress on site.
> Architect: What RFI? Let me check my e-mail. Oh, there it is. I have not had time to look at it yet.
> Superintendent: Well, can you look at it now while I wait. I need an answer.
> Architect: I will have to get back to you, I am about to go into a meeting.

More likely than not, the superintendent will not be satisfied with the response, but this situation will repeat itself many more times during a project. Waiting for a response is almost not accepted any longer in society, and the sender of the e-mail can feel ignored if a response is not sent back almost immediately, setting up a potential adversarial relationship. There may not be an easy solution for this, although a preconstruction meeting can establish agreed upon communication protocols to perhaps prevent this type of situation from occurring.

E-mail can also be used as a passive–aggressive way of avoiding direct communication. There is a tendency to send an e-mail in lieu of making a phone call. E-mails are an essential form of correspondence as they create a written record of questions and answers, but they also break down the human interaction that used to occur more frequently. The same goes for text messaging. It is not uncommon to now text a client, consultant, or contractor. Texting or instant messaging are ubiquitous, but neither is in the public domain and may be hard to retrieve. However convenient they are, what happens to those conversations?

A more effective solution may be to have all communication go through a system that will track and sort the different forms of communication. It may be worthwhile for your company to invest in a project management software program. You may already be interfacing with these types of systems on a regular basis without even realizing it. Many contracting firms use these for their record keeping of submittals, RFIs, schedule, and document management. Some solutions also may be used as a project hub or project information exchange. These solutions allow collaboration to occur in real time by interfacing different software programs into a single location that facilitates access to project content. Some of the solutions available as of the publishing date of this book are SharePoint, Newforma, ProCore, OneNote, PlanGrid, and BIM360. We anticipate new ones will be developed.

The consolidation of tools can be thought of as a train station or distribution center where goods come to be sorted and shipped out, thereby streamlining communication. Consider the example in Figure 7.3, where the project team has access to several resources in a project hub that can be used as the primary method of communication in a project. By using the homepage of the hub for announcements, upcoming schedule notification, and project notes, the reduction of e-mail traffic and attachments to e-mails is reduced and more effective. No longer can a team member say they did not get the e-mail when everyone always has access to the same information. To be effective, daily maintenance may be involved to ensure correctness and clarity of information.

Know Your Audience

Be sure to know who your audience is, and take steps to make sure that they understand what you are saying in the documents you are providing. Communicating clearly to clients in a way they can understand is vital to accurately conveying our ideas and gaining consensus around the design solution. Sometimes decisions are later reversed by clients simply because they agreed to something that they had an incomplete understanding of. Your client may be a teacher or doctor; they might be the code official. Most are not design professionals, and many do not understand the conventions used, including 2D graphics such as floor plans and elevations with notes, dimensions, and symbology. Do they understand the terminology you are using? Terms such as *schematic design* and *design development* can sound foreign to a university administrator or corporate vice president.

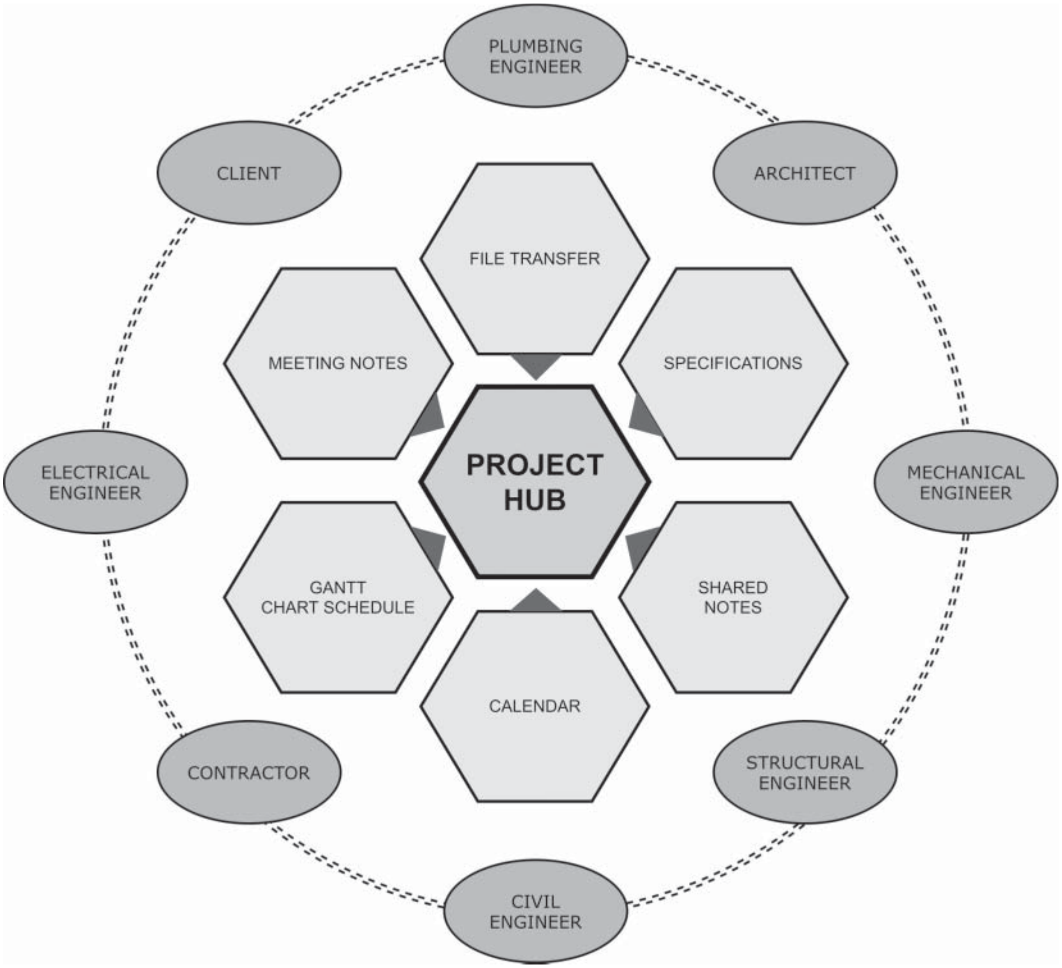

FIGURE 7.3 Project hub concept.

Be aware of the architecture-speak we use every day when working with people who are not in our profession. Make yourself easy to understand by using layman's terms with laypeople. For example, do not use the word *fenestration* if you are talking about a window, and do not call a glass display case a *vitrine*. They might think you are from a different continent; keep your terms simple! If, however, you do wish to talk like an architect, a widely circulated *and amusing* document on the Internet called "Do-It-Yourself Architectural Dialogue" provides guidance on the correct way to communicate. The document offers choices to make up 40 000 sentences that sound impressive; for example, "Architecturally thinking, the life-cycle cost control necessitates that urgent considerations be made of the pragmatics of value engineering." Inspiring as this sentence sounds, it is absolute nonsense!

Meeting Effectiveness

It can be excruciating to sit in a conference room when it is for a meeting you consider to be unnecessary. How many in-person meetings can be considered a waste of your time? According to a 2017 article in *Inc.* (https://www.inc.com/rohini-venkatraman/4-ways-to-design-brain-friendly-meetings-according-to-neuroscience.html), over 50% of meetings are unproductive, while 25% of time is spent on irrelevant issues. We are sure you all have experienced the same findings. Is there a solution? We suggest that there is. However, it does take some preparation. Often, a meeting is conducted without having a goal. It should be structured with agendas prepared and outcomes defined. If it is scheduled for an hour, try to stay on track and finish sooner. Few will be offended by giving time back. Meeting minutes should be issued within 3 working days, which keeps the content fresh in your memory as you write them.

Visual Communication

The powerful digital tools available today allow architects and engineers to convey information in ways that were not possible a generation ago. Drawings, graphics, and imagery from multiple software programs can be combined with relative ease to tell the graphical story of a project in a way that is understandable by all.

The project example in Figure 7.4 is from the design development submission for a large hospital addition. Similar to the office building in Chapter 6, it was prepared in an 11 × 17 format. The digital booklet is sizable, with almost 500 pages for a $450 million project. Most of the content was generated over the course of the design phase itself and organized onto sheets using presentation software.

> **It is a worthy goal to never again share traditional drawings with nontechnical clients but instead to leverage modern digital tools to produce information rich, colorful, and easily understood deliverables.**

The document has marketing flair, and the use of color and graphics speaks a visual language that is easily understood by nonarchitects. The audience for this booklet was administrators (those with a master's in business administration and departmental managers), nurses, doctors, and contractors. With the final version consolidated into Adobe PDF format, it was easily viewable on a tablet computer or using a projection screen for review with large groups. It could also be e-mailed or printed.

This same project used the 11 × 17 design booklet format for the earlier concept and the schematic design packages. Many of the same drawings and graphics from sketching programs, building information modeling (BIM), computer-aided design (CAD), and presentation software were used a second or third time, being refined as the design progressed. This allowed for easy comparison with earlier design packages and illustrated the progression of the design.

Advantages of this type of deliverable are abundant. First, it provides a graphical record. For many projects such as institutional, healthcare, and K–12 work, it is common to provide the client a graphical record of the planning process and the design decisions made. Second, it is easily shared. Documents prepared using digital software products allow for simple distribution and viewing. Third, it is qualitative and quantitative. Simple markup of PDFs using colored symbols and notes easily conveys qualitative aspects that traditionally are not developed and documented until later

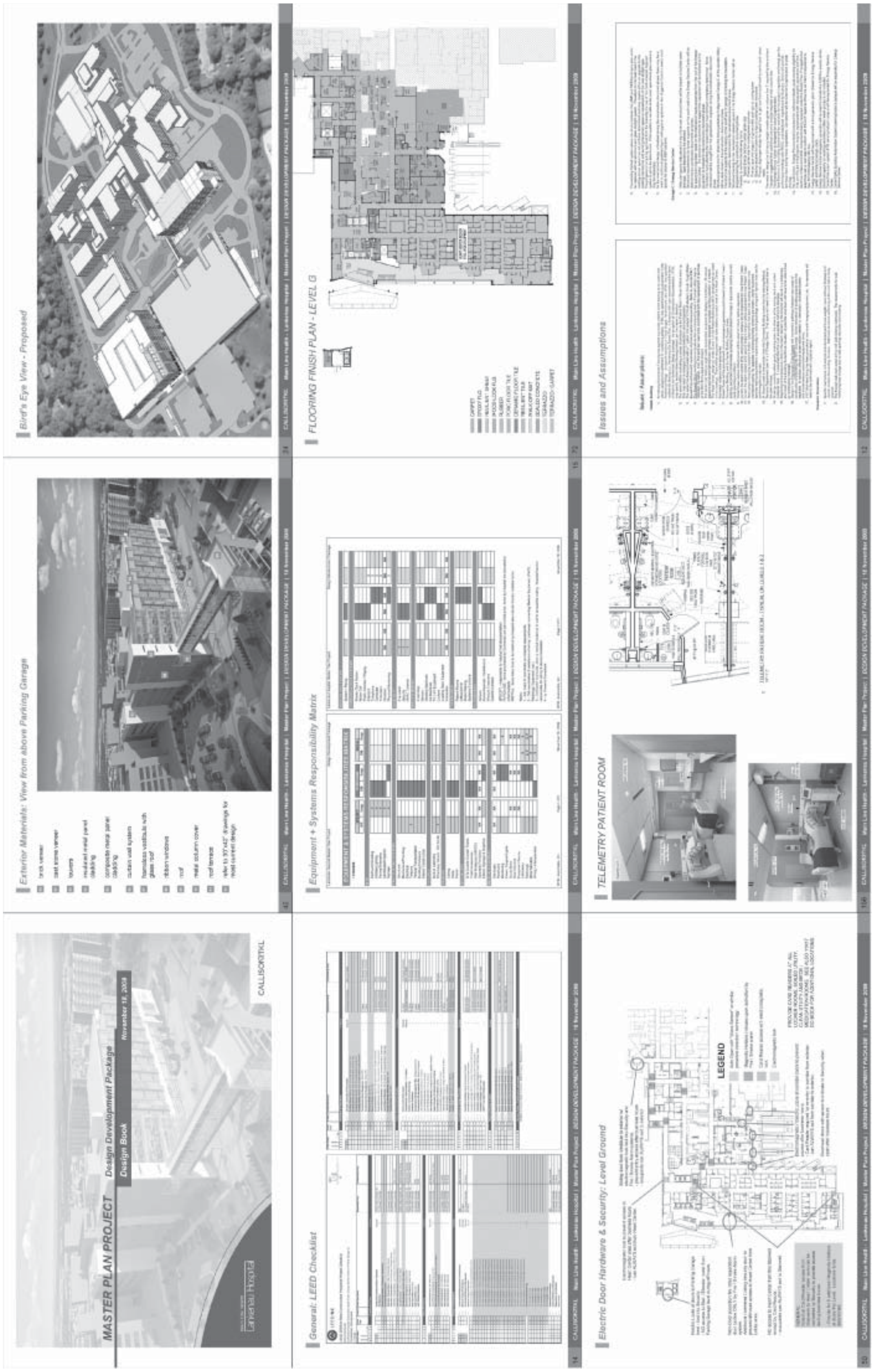

FIGURE 7.4 Design development deliverables. *Source:* © 2009 CallisonRTKL Inc.

phases in the project and that can have a significant effect on budgets. Fourth, it is quick to produce. Comprehensive packages can be readily assembled using graphics and imagery previously created for design meetings with annotation added in presentation software. Fifth, it provides clarity. Graphics and imagery transcend language and culture and are readily perceivable versus reading through narrative or technical drawings alone. The use of 3D increases comprehension as images convey context and are perceived as a whole instead of readers mentally assembling information from various documents. Data are often diffused within large document sets, and the objective here is for design decisions and areas of project complexity to become visible and readily understood.

STRATEGIC MODELING

For those who have adopted BIM, the use of this software has changed the way we do our work and in many ways for the better. But just as with anything that is new or different, has this technology not also allowed creation of new poor practices or allowed us to more quickly and, on a larger scale, perpetuate old poor practices? It is our observation that often additional effort is spent modeling minute details that have no relevance to bidding or construction just because it is possible to do so. Every tool requires skill to be used effectively, and the use of software is no different. Technology has brought about great improvements in the design and performance of tennis rackets, but tennis players understand that natural ability is still honed by practice and must be combined with a strategy to win tournaments. Design professionals must know how to wield the tools in their hands.

It is also important to understand who will be using the BIM and the drawings derived from it. You also need to know the limitations faced in construction, for example, the fact that the overall building layout for foundations and superstructure is often performed during inclement weather. Until the building is dried in, rain, snow, heat, and wind all have an effect on the work performed. As the project progresses, different trades build upon the work of other trades and must deal with issues of construction tolerance and imperfect work by others. This downstream effect has an impact on how we should look at documentation.

Accuracy and Precision

A generation ago, accuracy in drawings was limited to the type of pen or pencil used to place linework. Twirling a pencil as you drew a line helped ensure a consistent line width; pencils with different grades of lead were used depending upon the line thickness required. Drawings were reasonably accurate but more importantly represented relationships in a diagrammatic form. Dimensions were calculated, not derived, and had to be worked out independently of the drawing itself. CAD changed this approach, but those who moved from hand drafting to CAD still understood the limits of drawings for contractors in the field.

BIM, just like CAD, can zoom in and see almost infinitesimal detail and there is an idea that greater precision in the model is necessary. When precision is imbued into the model and then required by dimensioning that indicates tolerances beyond what contractors can achieve in the field, time has been wasted. It is an indication that the design professional does not understand the realities of construction and how the model and the documents derived from it will be used. How accurately should we be modeling? As accurately as we can, except it is easy to model at 1/256” precision even though there is little value in doing this. Construction tolerances are not this precise, in fact, anything less than

1/8” is difficult to achieve on a commercial construction site for most trades other than the fabrication of cabinetry and some prefabricated components. We also need to remember that the cabinet that is built to a tighter tolerance will be located next to a partition that is built to a different tolerance level. However, we do believe that there are areas in BIM models where it is preferable to model with great accuracy, one example being the structural column grid. The grid serves as a measured benchmark and datum for the horizontal dimensional control of the project. Even so, given their importance, they should be located in increments of no less than an 1/8”, and in virtually no situation should dimensions call for greater than 1/8” precision. Model accurately, but dimension to an 1/8” precision. Remember this: accuracy in modeling does not mean that building elements are necessarily constructible or that layouts are well-thought-out.

> **The 1/256” level of precision is only for modeling and not documentation purposes. Unless necessary for a highly critical location such as for grout joints or paneling, do not dimension less than to 1/8” precision. Doing otherwise is placing undue value to something that cannot be achieved by the trades. Of course, there are always exceptions, and it truly depends on the scale and complexity of each individual project.**

Dimensioning in BIM also has consequences due to the nature of how wall assemblies are modeled as it uses actual material sizes such as 5/8” gypsum board or 3 5/8” brick units. Previously, many CAD users drew 5” wide partitions for what was intended to be a 4 7/8” wall (3 5/8” metal studs with 5/8” gypsum board on each side). When placing dimensions to one side of a partition, it is best practice to dimension to the side that yields a whole dimension in lieu of one with fractions. This is illustrated in Figures 7.5 and 7.6 using identical building geometry, just dimensioned to the other side of the

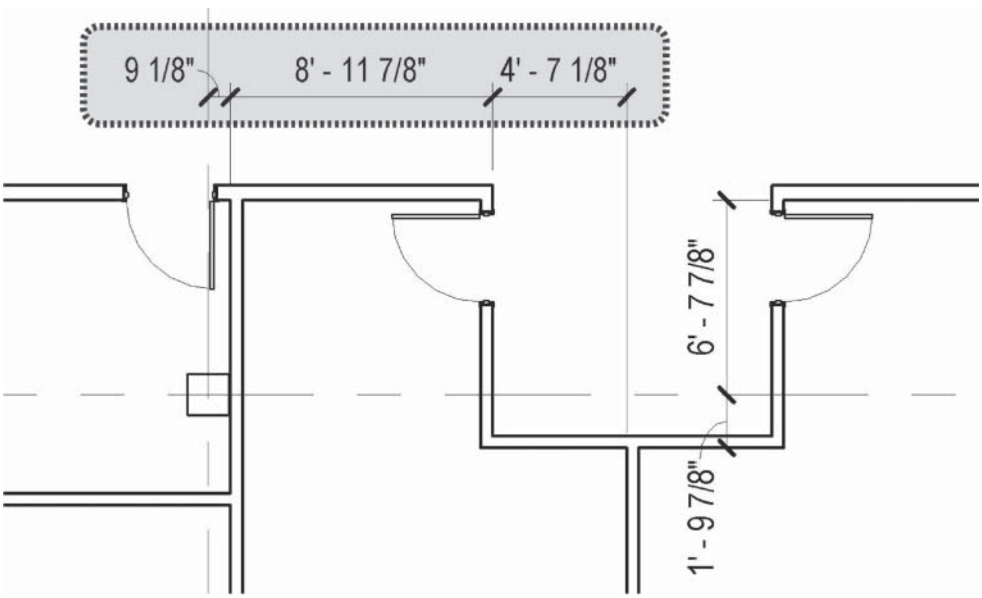

FIGURE 7.5 Fractional dimensioning.

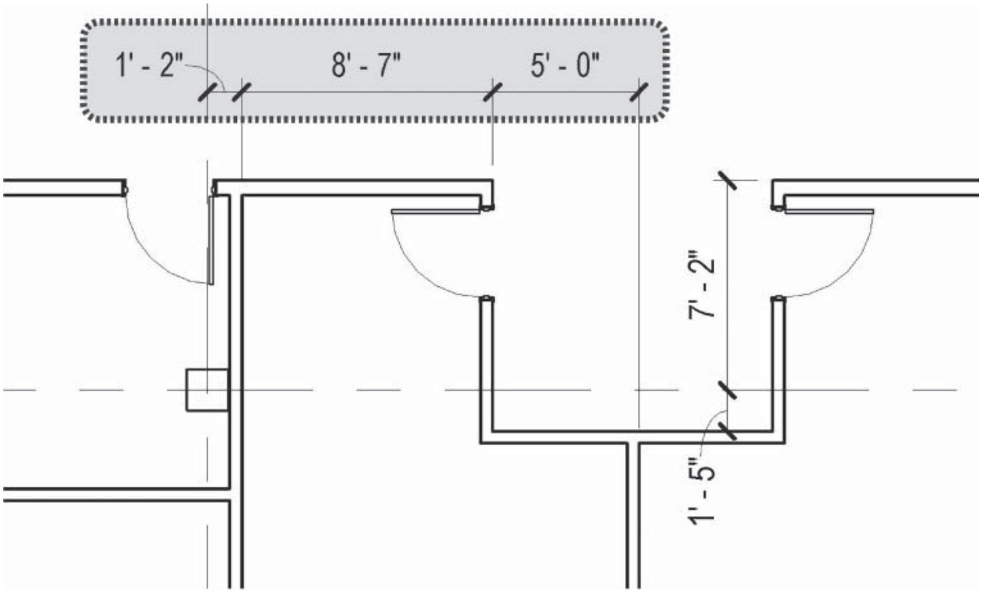

FIGURE 7.6 Whole dimensioning.

partition. Does the precision of the image in Figure 7.5 add value to the layout, or do you think the contractor would prefer the image in Figure 7.6?

Another example is stairs and railings. We do not miss the days of drawing stairs in CAD, trying to calculate out the correct number of risers to make a code compliant stairway, but stairs automatically generated by BIM can lead to hours of frustration as well. Consider the illustration in Figure 7.7.

Trying to resolve the clean representation of the railing to the stair wasted hours of effort – all because the landing is not connected to the stair component, which was unknown at the time. It was frustrating trying to solve the problem to just get the model to appear correct, and for what outcome? It would not make the stair fabricator think that the railing was not continuous. No, the outcome became trying to make the model perfect. With the upcoming deadline looming, it was decided to abandon trying to solve the modeling problem – not because it could not be accomplished but because a few sheets further into the set were the typical stair detail sheets. The railing return was clearly drawn as a typical return condition and was referenced by virtue of the general notes on the stair sheet, thereby rendering the exercise futile. The point of this is not to spend time trying to be precise in the modeling if it is not necessary for any other reason than trying to make it look right! Be strategic and model what you know and what is needed for construction documents. For the foreseeable future, the BIM model will still be used to show intent, and it is not intended to be a reality-based construction model. The industry may develop to such a point where BIM will drive manufacturing directly. At that time, we anticipate subcontractor involvement to take the BIM model to that next level, as fabrication issues involve another type of expertise.

We are not suggesting that modeling efforts be abandoned entirely, as a well-coordinated BIM model is exactly why this technology is an asset to design firms. However, we are suggesting thinking wisely about what level of detail you model and how precise the model needs to be.

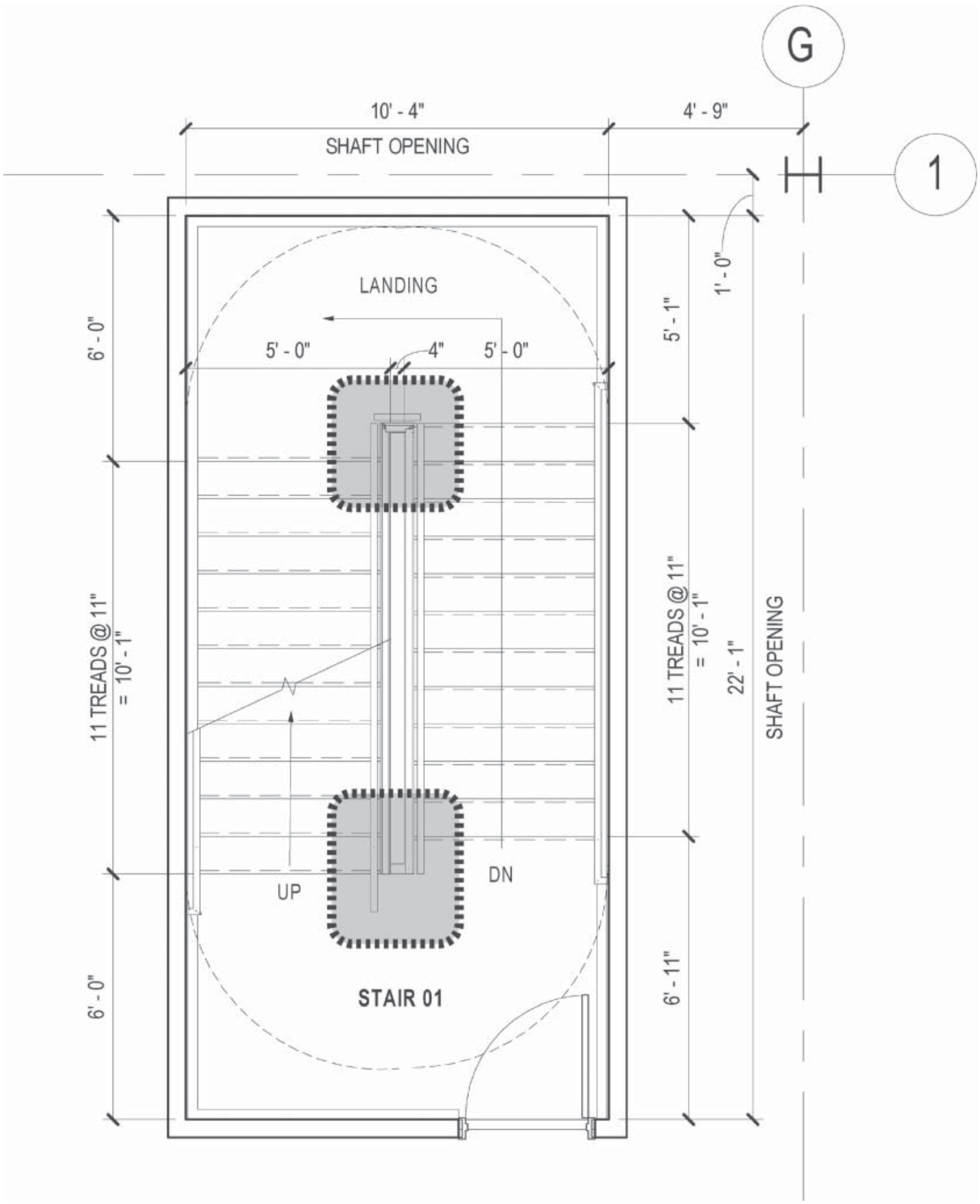

FIGURE 7.7 Stair handrails.

Figure 7.8 shows a dimensioned slab edge drawing with high degree of precision. Is it reasonable to think that rough concrete formwork can be built to 1/16” of an inch precision or even why we would want it? It is not practical. Experienced construction field superintendents have indicated that if they receive drawings such as this, they will typically increase the opening width without asking. So when producing these types of drawings, it makes everyone’s job less complicated to use whole dimensions – or at a minimum, with 1/2” precision for such elements. Also notice the dimensional precision throughout the example; formwork is rarely this precise.

Detailing Sequence

The railing example is one many readers may have encountered in your own practice. Another practical example of being strategic in your modeling is demonstrated in the following sequence of development.

Figure 7.9 is of a BIM model from a complex, high-rise hospitality project showing an elevated outdoor terrace; in it, the exterior is to the left. The BIM model that includes the concrete superstructure is provided by the structural engineer and linked into the architectural BIM model, which eliminates duplicate modeling across disciplines. The architectural model includes the exterior curtain wall and additional elements such as a guardrail and soffit panels to sufficiently indicate the design intent of the terrace. In this view, the building appears incomplete, but for purposes of design intent and its use to produce renderings it is at an adequate level of detail for these purposes. Understandably, it is not a construction model and is not intended to be used in that manner.

Figure 7.10 represents a 1/4” = 1’–0” scale wall section of the same location. In this view, more clarity has been added on top of the model geometry. This was achieved using drafting components and filled regions with the main model as an underlay. This hybrid approach to drawing is highly effective and provides a greater understanding of the project, yet it is still not precise. At 1/4” scale, model precision is not mandatory; what is being conveyed is a more detailed design intent and better understanding of the relationships of materials and vertical dimensional control. Furthermore, a wall section at this scale is generally used to identify major building systems by notes or tagging and provides callouts for the locations of larger-scale details.

Figure 7.11 is drawn at 1 1/2” = 1’–0”, where greater precision is applied to the documentation of the terrace. At this scale, the goal is to show the intended construction, how materials relate, and the layers of waterproofing and flashing. This final sequence is fully drafted in the callout view with BIM components and materials. It represents the final construction document–level detail. The model is used as an underlay to assist in the drafting, with some components from the 1/4” section visible; the remainder is filled regions, linework, and additional components.

The progression from model to detail demonstrates a strategy that allows the 3D model to remain less *heavy* and layers on more detail as needed in 2D format to provide the contractor with the information needed to build the project. Strategic modeling means the model can remain nimble and less burdened with extra information when shared among the entire project team.

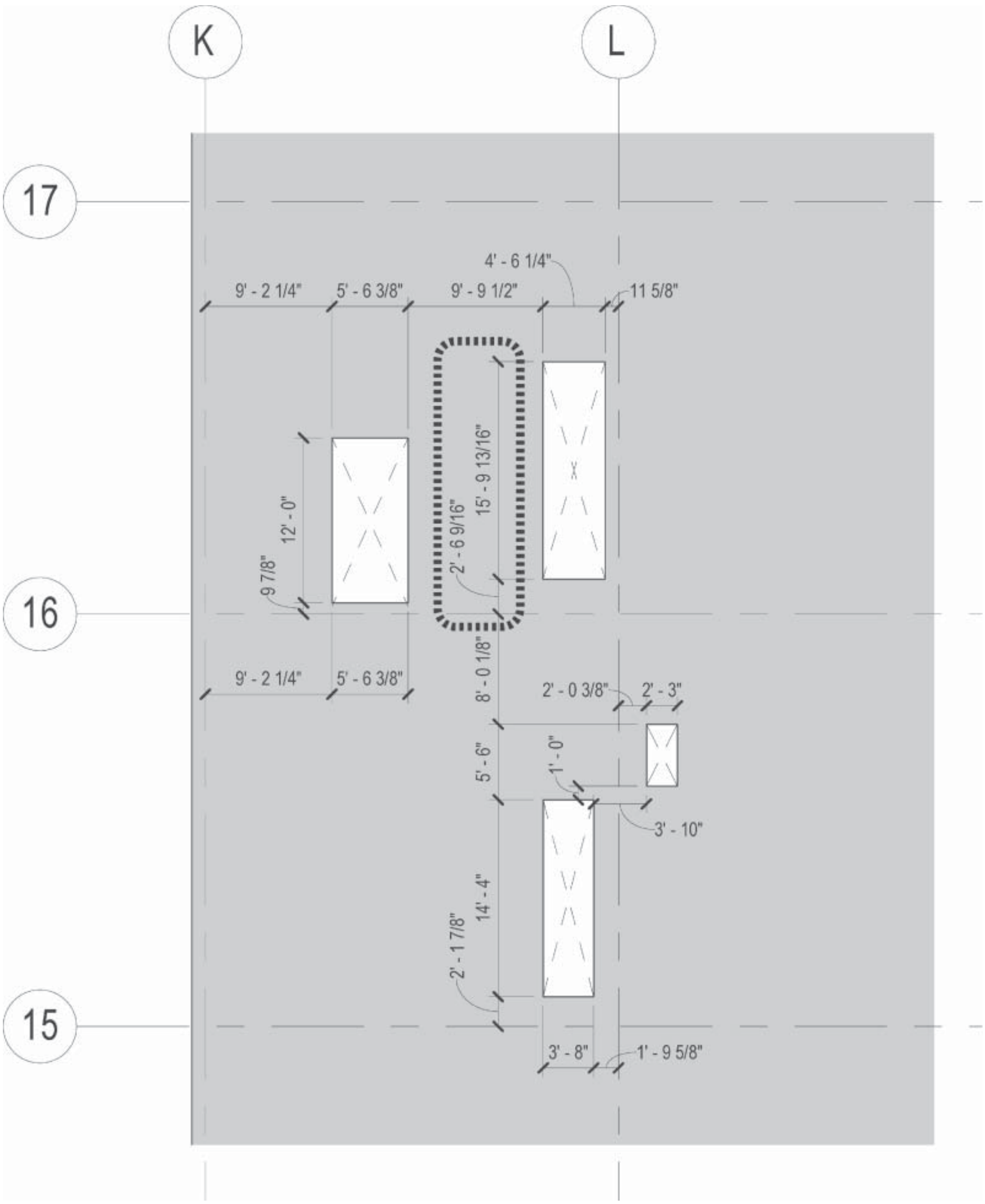

FIGURE 7.8 Slab edge drawing.

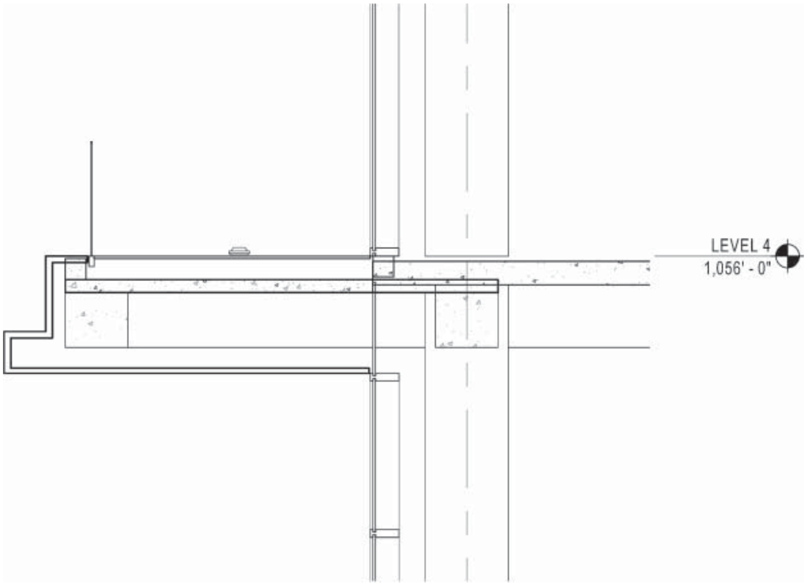

FIGURE 7.9 BIM model. *Source:* GWCCA.

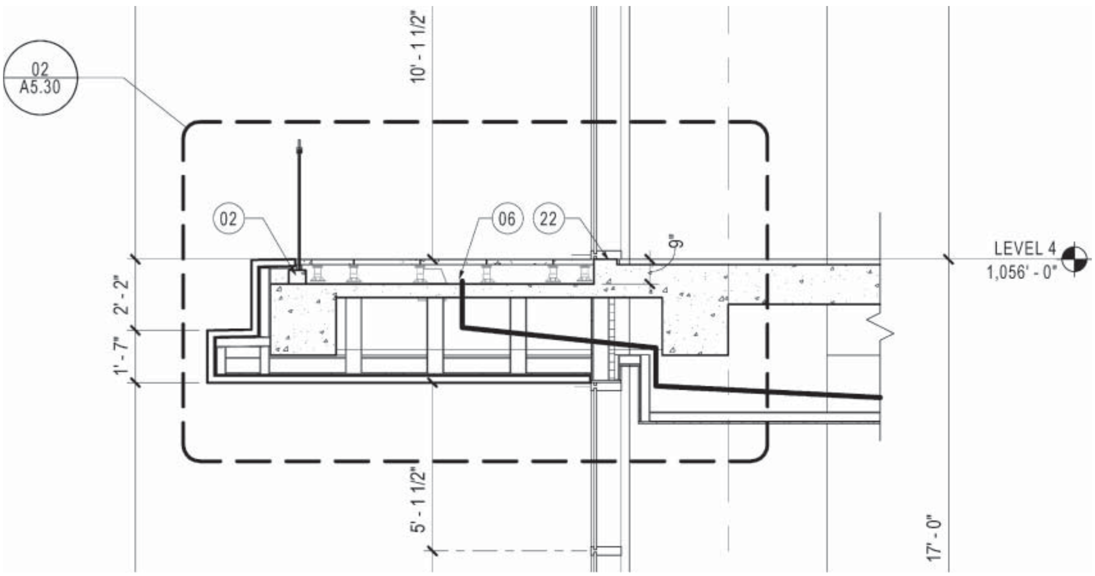

FIGURE 7.10 Wall section. *Source:* GWCCA.

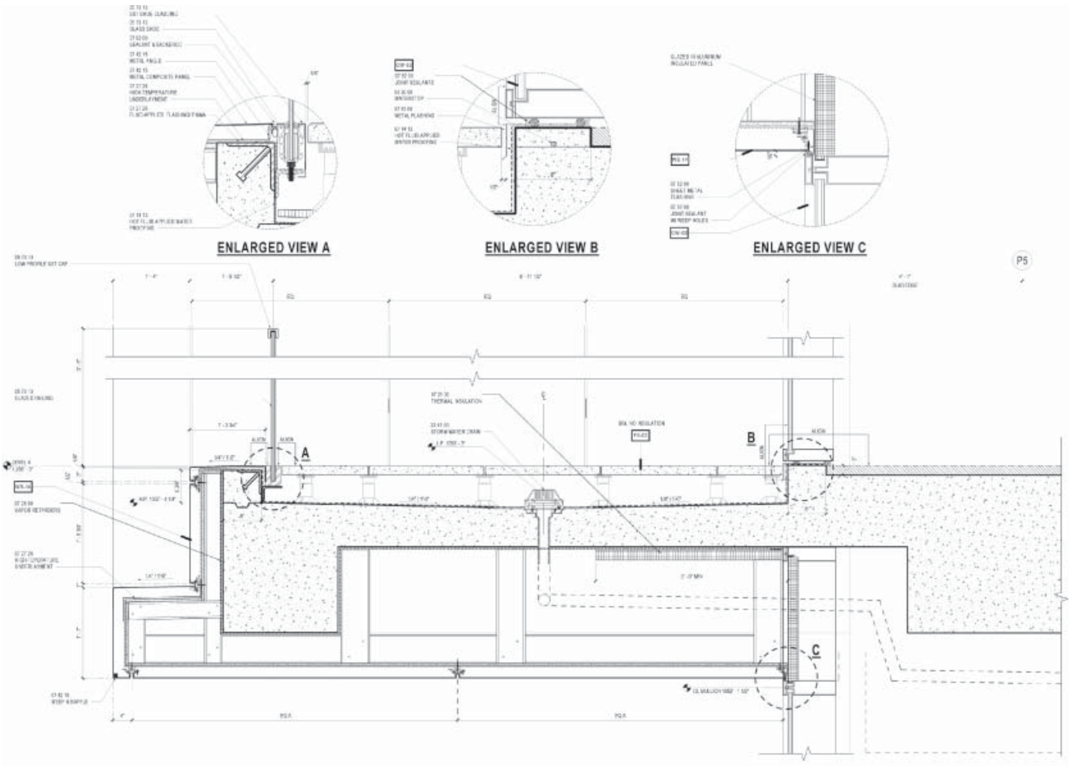

FIGURE 7.11 Detail. *Source:* GWCCA.

LOD AND THE NEED TO THINK BEFORE MODELING

The BIM Forum has led development of current Level of Development (LOD) documents for use by the design and construction industry. For each phase of design and continuing into construction, this document sets forth recommended levels of BIM development reflecting that for which the model can be relied upon. It states:

> The Specification is not a set of requirements as to what is modeled when or by whom. Rather it is a language by which users can define these requirements for their own firms or projects. This clear articulation allows model authors to define what their models can be relied on for, and allows downstream users to clearly understand the usability and the limitations of models they are receiving. (BIMForum, 2019)

In other words, in the interests of fostering a better workflow among all project stakeholders, there is a level of accuracy in the modeling of elements and their components that is expected, which changes over time. It recognizes that early in design, the building systems are being determined and may change, and it thus sets a basic level requirement for their representation in the model. Over the course of the project, as the design is refined, the BIM should reflect that. Ultimately, subcontractor information related to the fabrication and installation of elements can be included.

Note that they are not discussing a level of detail but of model development.

Inherent within this approach is the idea that for a BIM to be relied upon, from a modeling standpoint, it should also reflect a level or depth of thinking by the designers. As the project and BIM progress, we should be modeling systems we understand, have thought through, and know to be appropriate. It is vital for architects and engineers to sufficiently think through the design including the building systems and how they relate to each other. We can put it this way: *Think slowly, and model quickly*.

Deferred Modeling

The composite MEP plan (Figure 7.12) is from the 30% schematic design phase document issue for an approximately 20 000 ft^2 office building. The documentation was produced using a color-coded PDF markup consisting of linework, circles, rectangles, and text over an architectural floor plan from the BIM. The engineer of record noted that typically an engineer in training would have started their BIM-related MEP work 2 weeks prior to issue. For this project, some prior thought was given to the systems, but the actual work was done the morning of the document issue by the project engineer. By deferring the modeling, half of the normal fee was used by comparison. The document itself was simple to produce, and by using color each system stood apart visually for easy review and estimating.

The client decided to double the size of the building, adding a second floor. This necessitated an additional services agreement with extra fees for all disciplines. The saved fee from the initial effort was almost completely profit.

This design–build project (Figure 7.13) followed the same approach as the administration building using a PDF color markup for the plumbing drawings. With some prior thinking about systems and routing, this sheet was completed in 90 minutes for this schematic design issue.

Some observations are as follows. First, methodologies that defer engineering modeling until later phases allow flexibility for the architectural team to continue development of the design and for the plans to settle down. They help preserve engineering fees by not committing effort to modeling actual MEP systems that must be reworked later. Second engineering efforts focus on the building systems analysis and design instead of project fees, the software, and deliverables. And thirdly, depending on how a firm performs project accounting, it is important to not realize all the savings at this point as profit since the modeling will still have to be done.

Approaches like this will not work for every project, but they will for many and with great benefit to the entire team. Too often the software platform and its capabilities become the focus of the work, distracting from thinking through and resolving project design issues and building systems. A judgment call is needed for when to be diagrammatic versus accurate and where conveying design intent is appropriate instead of exacting precision.

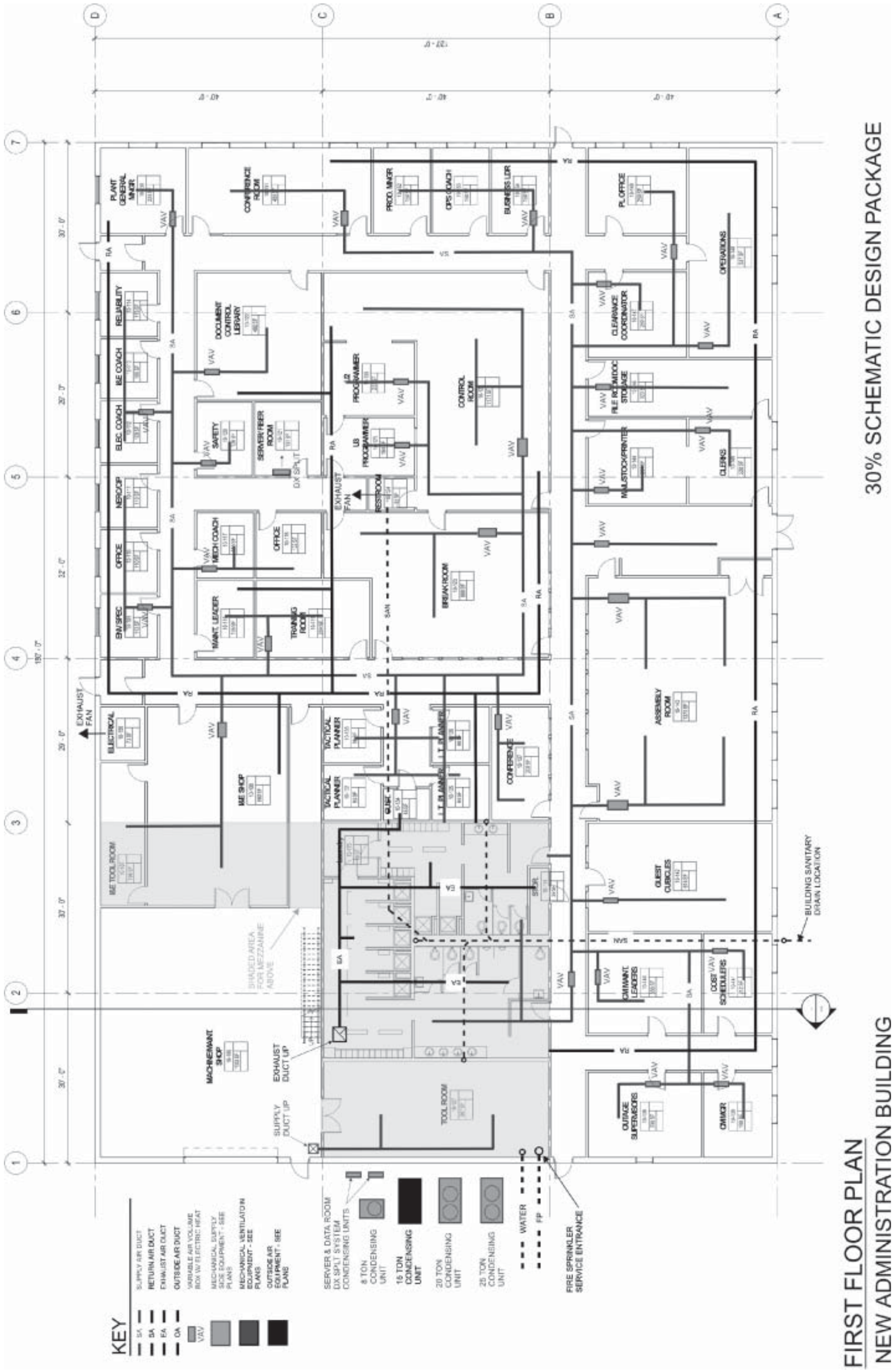

FIGURE 7.12 MEP plan for administration building. *Source:* BRPH.

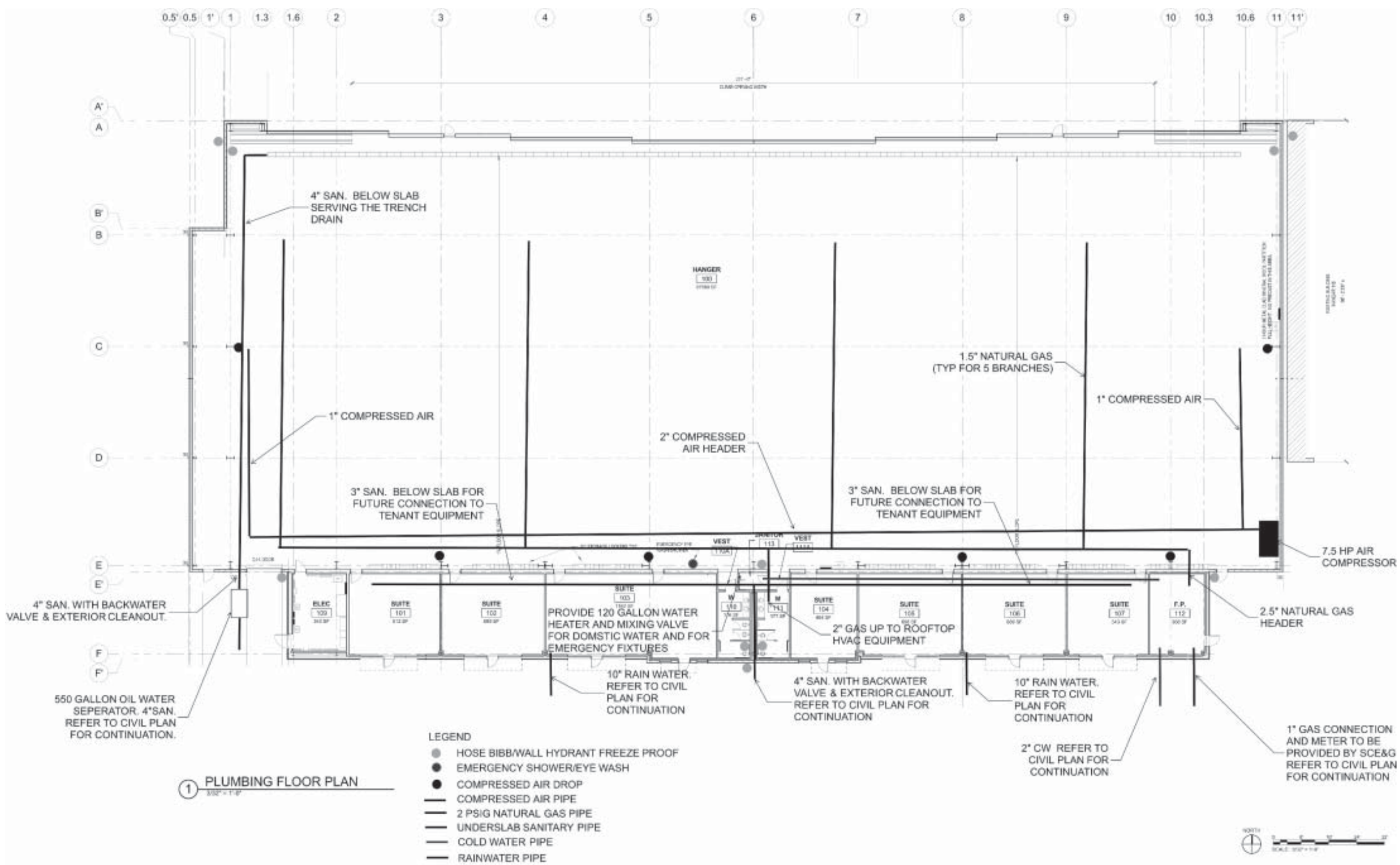

FIGURE 7.13 Plumbing plan for an aircraft hangar. *Source:* BRPH.

TARGETED REVIEWS

Targeted reviews are a part of an overall quality concept, which was reviewed in Part I of the book. Most firms have some system of quality control to review their work for completeness and to reduce errors and omissions. How often is this left to the very end of the project, or how often are assessments made after the documents are issued? Our observation is that this happens all too often. Would it not be better to perform reviews during development of the project, occurring at differing stages of completeness? In this type of review scenario, we would be looking for certain things early in design and different issues during the construction drawing phase. In addition, checking periodically can be more productive than reviewing in one sitting; the later reviews and checking are completed, the more disruptive it can be to the project.

Figure 7.14 shows traditional document issues: schematic design (SD), design development (DD), issue for permit (IFP), and issue for construction (IFC). Each has a different *focus* of effort. Prior to the documents being sent out, a review should be performed to assess if we have sufficiently addressed the pertinent issues, with a goal of eliminating the likelihood the project will need to be revised later. The *audience* for the deliverables varies by *phase,* and, as discussed earlier, understanding who the audience is should influence what information we show and how we display it – all done in order to better communicate.

With many projects having limited time and staff resources, there is little value checking for accessibility or equipment clearances at the SD phase; conversely, there is great value in discovering and addressing the need for an additional set of stairs to meet life safety requirements. In the first case, the floor plans can be expected to go through additional stages of refinement with walls moving about; in the second, a set of stairs is a floor plan disruptor as it extends vertically up through the building.

Consistent with the discussion in Chapter 6 on the project roadmap, the SD and DD phases work through foundational project issues, seeking to define the scope clearly and validate budgets. The resulting deliverables present the owner overall concepts and design intent for approval and for cost validation, prior to moving into preparation of construction documents. The contractor may also be part of this process when engaged early by the owner. Their inclusion as part of the audience is due to

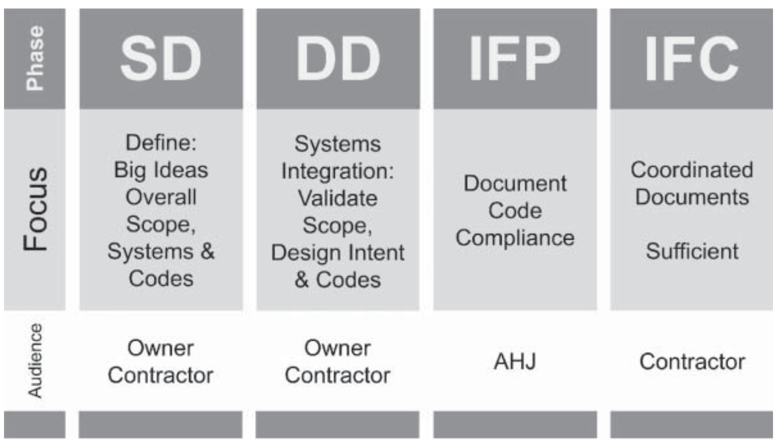

FIGURE 7.14 Targeted reviews.

the role of cost estimator and helping assess constructability and the larger issues related to the work of construction.

The audience shifts again at the IFP phase to the Authorities Having Jurisdiction (AHJ) with the primary focus for this deliverable to present the design solution in a way that illustrates compliance with regulatory requirements. These typically include life safety and zoning standards, requirements for storm water and sewer, site drainage and erosion control, energy code compliance, and many others. The documents at IFP have evolved to share the design solution with much more detail than the owner requires for their review and with more descriptive information than a contractor would generally need to construct the project.

The IFC phase is for the contractor's use in bidding and constructing. The documents must be sufficient for this purpose. Note that we have not used the terms *complete* or *100%* to describe the documents. They are in some respects an instruction manual, used by the contractor to determine quantities and understand the quality. The contractor will provide multiple additional drawings and informational submittals to add another level of detail related to their purchase and fabrication efforts after the job is bought out.

Quality Assurance and Quality Control

Much has been written about the differences between quality assurance (QA) and quality control (QC), and it will not be debated here. Our experience is that most professionals combine the two terms into one, using the common terminology of QA/QC. While this phrase is often misused throughout design firms, it means essentially the same thing: checking the documents prior to the end of a phase. Figure 7.15 visualizes the traditional phase checking approach that exists in most of our daily practices: complete a phase, perform a QA/QC check either before or after the set has been released, repeat the cycle. This approach has been used for decades and can be effective in catching issues, albeit by finding problems after they occur and after the problems are embedded into the documents. What this does not do is proactively address issues to either prevent them from happening or to be caught earlier. You will notice that the CD phase check is typically performed prior to release of the documents.

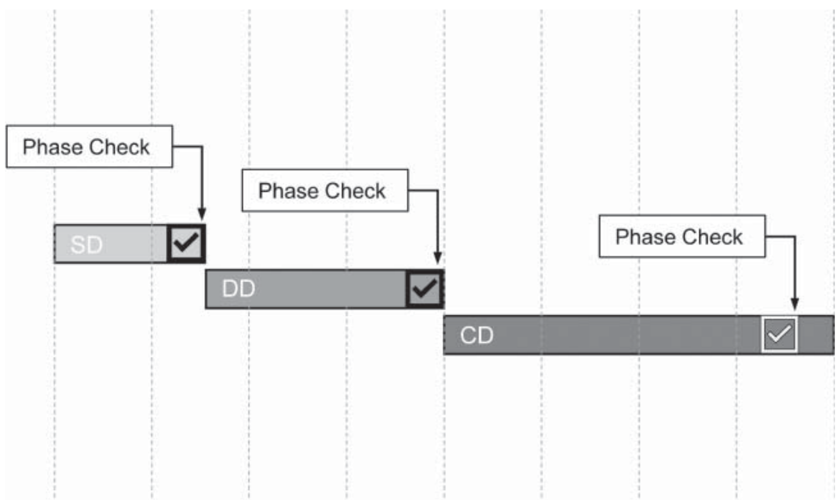

FIGURE 7.15 Traditional QA/QC approach.

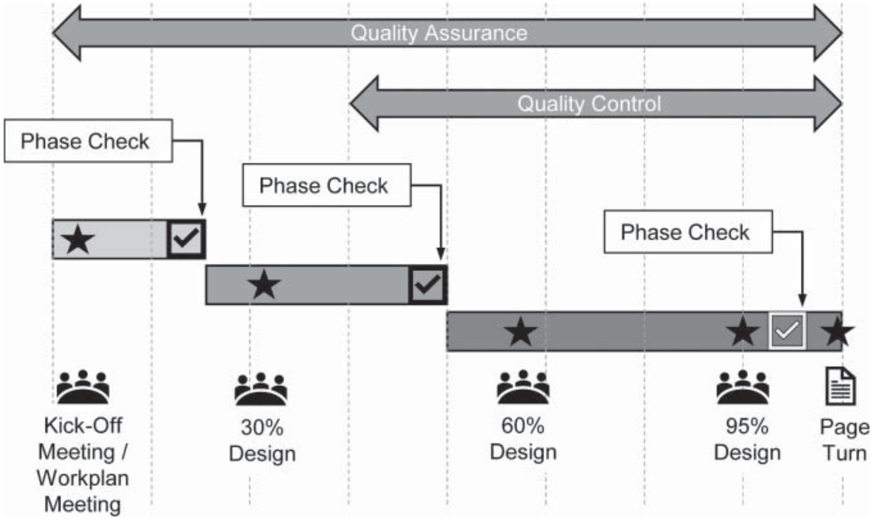

FIGURE 7.16 Project Excellence Planning.

We observe the following disadvantages to this approach. First, there is little meaningful engagement with experienced staff who perform the phase check. A debrief is often conducted, but after the fact. Second, the work is often considered complete when checked, thereby negatively affecting profit if rework must be performed. And third, the opportunity to adjust the trajectory of project delivery is compromised, as the phase is already complete. Again, affecting profit if a decision is made to change documentation strategy.

Seeing the disadvantages of the traditional approach presented in Figure 7.15, it appears as though there can be a more effective way if we rethink the process of project checking. A solution that engages senior staff earlier in a project to avoid the common pitfalls of standard end-of-phase checking has merit and should be explored. Looking at a more comprehensive approach, a system that provides value and a payback to our firms on many fronts was developed to address the shortcomings. Project Excellence Planning (PEP; Figure 7.16) takes a fresh look at checking and focuses on three critical phases to achieve project excellence:

- Phase I: Systems
- Phase II: Detail
- Phase III: Quality

Along with other tools presented in the book such as the project roadmap in Chapter 6, this can be combined to form a structured approach for reviewing documents that can be implemented across a studio, office, or firm.

Project Excellence Planning

Formalizing a quality process is not a new idea, but occasionally it takes a bold step to look at something through a totally different lens. Rethinking the traditional QA/QC process, this process breaks down the barriers of senior staff participation and the frequent aversion to involving them throughout the project. The time spent is minimal compared with the overall total number of hours expended during a project. This system places value on continuous QA and QC. What better teaching method than to sit with less experienced staff and go through the process of project checking and development? In this approach a PEP team is assigned to the project and follows it through completion of the project's design.

Along with rethinking when the senior staff is engaged, the check-ins occur at a percentage of overall project design completeness: the beginning of SD represents 0% design, and the completion of CDs represents 100% design. For example, the 30% design check-in lands within the traditional design development phase, with 60% design landing in the construction document phase. The timing is a suggested guideline and may vary based on each project. The key takeaway is to not wait too long into each phase for a review. This method does not reduce or take away from the traditional process since we are not suggesting eliminating milestone phase checks either by nonproject-related staff or the PEP team. Milestones are typically dictated by the project contract, and there may be a contractual responsibility to perform a QA/QC phase check. While the PEP team can perform the check, especially on a small to medium-size project, we believe that it still remains important to get fresh eyes on the project when the milestone is complete.

How is this considered Lean? By having multiple check-ins in addition to end-of-phase reviews it allows for a better project flow, incorporates best practices, reduces time wasted on rework, and trains staff at the same time. These check-ins can be considered mini apprenticeships for junior staff – learning as they are working.

But what about having senior staff involved in the project? Won't this affect the project profitability? Managers who are too focused on project financials may ask this question. The response is no – the hours spent with the project and team have a net positive effect. Time, fee, and rework spent on the end-of-phase checks are reduced due to higher-quality documents (Figure 7.17; see the end of the chapter for a comprehensive graphical version of this method).

Phase I: Systems Excellence

The definition of systems excellence is this simple phrase: setting the project up for success. This phase establishes the overall project financial strategy, onboards consultants, assigns staff, introduces the scope of the project and goals to the team, sets up protocols, and begins the design and technical development. In this context, *systems* are also the firm's processes and best practices that are to be incorporated, along with determining the major building systems. The project roadmap and building systems review charette examples from earlier in the book may be helpful if used in conjunction with this phase.

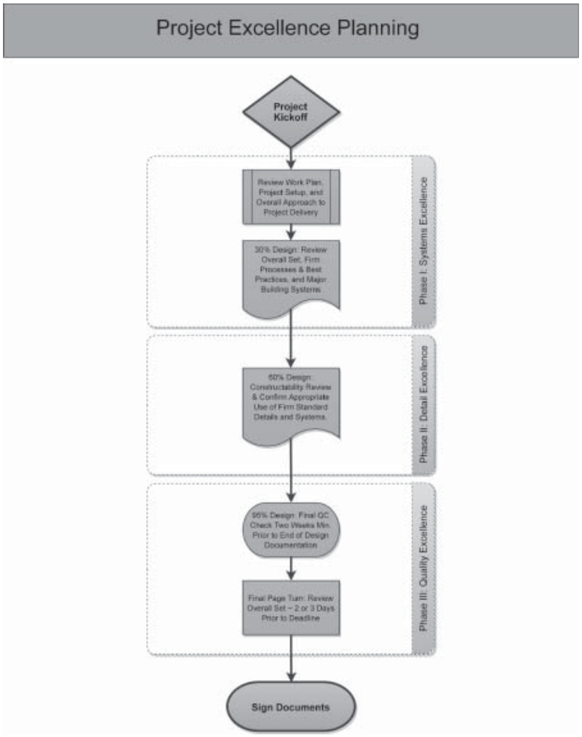

FIGURE 7.17 Project excellence planning overview.

One of the biggest mistakes we see made on new projects is the desire to get started right away without regard to a delivery strategy. Stephen Covey observed that we should always begin with the end in mind, and doing that requires us to think strategically before fully starting the project.

Our observation is that the projects that begin with a good strategy are the ones that are most successful. To help accomplish this, a kickoff meeting is crucial but is often excluded, especially on smaller projects. Such a meeting sets the ground rules for the entire team (including consultants) and identifies the scope of the project and responsibilities for everyone. This should occur as soon as possible after the successful project commencement. To be productive, an agenda must be distributed to the team prior to getting together. The involvement of the PEP team also begins with this initial meeting. Suggested topics to cover (at a minimum) are project goals, team structure, scope of services, deadline overview, pull planning strategy, sustainability approach, engineering systems approach, specifications approach and protocol, communication protocols, and scope of consultants services.

Following the kickoff, the internal team begins to focus on setting up the basic elements prior to a more focused workplan meeting. This is an internal meeting (without consultants) identifying in detail how the firm will deliver the work based on a deeper understanding of the effort required. Some prerequisites are (at a minimum) preliminary code analysis, BIM execution plan, cartoon set and preliminary sheet index, and BIM model setup.

Being prepared with these items helps shape the discussion and allows the PEP team to grasp the structure of the work and give input based on experience to suggest other gotchas to be aware of. The outcome being to make any adjustments early on so the team can start with confidence. Having this engagement early also makes for a better transition from schematic design to design development. The end of milestone phase check for SD occurs prior to the next step, which is the 30% design review.

The second step of phase I occurs early in the DD phase and serves as an opportunity to reset or rethink the strategy of the delivery by adjusting the workplan based upon project financials and ongoing development following the SD phase. This meeting allows the PEP team to review the overall setup of the documents and help identify and ensure that firm resources (guidelines and standards) are understood and incorporated. With this early interaction, the PEP team can introduce and explain concepts one on one and increase the retainage of the information being explained. This also eliminates the awkward *Why did you do it this way?* conversation that can happen later on. While the setup is important, more impactful conversations about major building systems and code compliance are key at this stage. Reviewing the code approach strategy helps identify complicated occupancy requirements, floor opening protection, separation requirements, and plumbing fixture counts, among other things. The building systems review confirms the project team is on the right track and allows for advice on best practices to be incorporated. The end of milestone phase check for DD occurs prior to the next step, which is the 60% design review (Figure 7.18).

FIGURE 7.18 Project excellence planning review.

Phase II: Detail Excellence

Detail excellence is characterized as an in-progress review of specific elements, focusing more on the uniqueness of the project and how best to approach the out of the ordinary conditions. It occurs at a critical stage of the project, 60% design and follows closely after the end of DD. QA remains a priority throughout the project, but QC begins in earnest during this phase. Reviewing early in CDs serves to help guide the project team through completion. Once again, this offers an opportunity to reset and assess the overall workplan and make any final adjustments. The key items to look at are (1) review set for appropriate use of firm standard details, partitions, schedules, keynoting, and so forth; (2) review constructability of unique details; (3) review building system transition details like expansion joints, parapets, canopies, and offsets; (4) discipline and consultant coordination; and (5) finalize code study and life safety plans.

Coming out of this discussion, completion of the documents will be better on track. It should be expected that the PEP team will be consulted during the remainder of CDs to discuss additional items as they arise.

Phase III: Quality Excellence

Phase III is the stage where QC is examined at a higher level. The first portion is the 95% design review – more commonly known as 95% CDs. This is intended to be a pencils-down full set review of all work for overall coordination of disciplines, constructability, life safety, specifications, and graphic standards. To have a successful review this internal deadline must be scheduled and enforced, meaning consultant work must be complete prior to this to allow for the set to be compiled in its entirety. Work should be considered complete except for the comments received out of this review. We suggest scheduling this review 2–3 weeks minimum prior to the final page turn, depending on the size and complexity of the project, giving the PEP team ample time to mark up and the team to address the comments. The third-party milestone phase check should be held concurrently, if necessary.

The last step in the review is the final page turn: a visual quality control review of the set. This provides the opportunity to check the final sheet index, title block correctness, miscellaneous lines on the sheets, overlapping call outs, missing BIM or CAD file links, sheet organization, and any other immediately noticeable graphic inconsistencies.

Observation: If the set looks good, it is generally easier to navigate by the end user.

An effective method for carrying out the page turn in the digital age is to be in a room with multiple computers and monitors: one to review the electronic drawing set; the other running BIM to allow for immediate corrections to occur. This is an interactive meeting with the senior reviewer, project architect, and at least one other person to incorporate corrections in real time. At the conclusion, the set will be complete and ready to sign and submit. The expectation is for there to be no surprises.

Advantages of the multiple phase III reviews are that it (1) pushes consultants to be complete their work early, allowing time for final coordination review; (2) provides an opportunity to reduce staff at the end of CDs to preserve fee; (3) depending on the scope of the project, replaces the milestone check, reducing the need to double up the reviews; and (4) serves as a teaching moment for staff to learn the quality expectations of the senior reviewer.

Additional Thoughts on QA/QC

The PEP approach can be highly successful but should not be considered the be-all and end-all. A complementary review approach that is also successful is the room-by-room coordination method. This technique is where the entire project team meets together for several days, reviewing the project in a methodical way – room by room. For a given space, systems such as power, lighting, fire alarm, smoke detectors, thermostats, diffusers, exhaust, sprinkler heads, ceiling finish, wall finishes, floor finishes, doors and hardware, equipment, and furniture are all reviewed. The result being a better coordinated building with potentially less conflicts, fewer RFIs, and less change orders. The most effective stage to hold this meeting is during the middle of the CD phase.

We present these ideas for you to use how you wish, realizing that there is no single approach that works for every firm. Experiment with different methods or follow one of the ones we have described in detail, but realize that it is possible to improve the quality of the work, lessen risk, and enhance the bottom line if thought is given to the process you implement.

WHY DO QA/QC PROCESSES VARY BETWEEN REVIEWERS?

This question is a common refrain from managers who hear comments from staff that quality checks are different among reviewers in the office. The straight answer is that every reviewer has different skills and is on the lookout for different things. Their experience shapes their knowledge, and no two reviews by the same individual are identical. Quality is subjective and is difficult to perform consistently among multiple persons. However, we can approach consistency with checklists (see Chapter 6) that are more objective, but they are also open to interpretation. It should not be the expectation that all reviews be the same. One reviewer may do more redlines and mark up all the issues and try to complete the drawings, whereas another one checks for overall quality and will circle areas that need development rather than redline. There is no one-size-fits-all approach; just be sure the expectations are understood.

Bonus Idea – A New Metric

Looking back at firm metrics from Chapter 6 for inspiration, the idea of a new metric emerges, one called Project Quality Commissioning (PQx). The measurement of quality in design is something that is often brought up in conversation. The question of *How is the quality of the CDs?* elicits a very subjective response, so let us see if we can apply a more objective quality score. Thinking of how building commissioning (Cx) applies to building envelopes, sustainability, mechanical systems, and life safety systems, among others, to determine if a building performs as designed, why not apply a similar concept to project quality? If it helps with excellence in delivery, it seems like a worthy goal.

Project Quality Commissioning (PQx)

Description: The verification and measurement that prescribed QA/QC processes are followed throughout the project.

Outcome: This can be compared with established financial and project performance metrics to gauge effectiveness.

Project Quality Commissioning (PQx) Scorecard

		Total Points Available	Points Assigned	Total Points Received
SYSTEMS EXCELLENCE	**Workplan and Project Setup Review**	20		
	Define Workplan, Milestones, Hours		2	0
	Assign Team and Roles		2	0
	Hold Kick-Off Meeting		2	0
	Create BEP		2	0
	Prepare Cartoon Set / Sheet Index		2	0
	BIM Model Setup		2	0
	Perform Preliminary Code Analysis		2	0
	Schedule Workplan Meeting with PEP Team		2	0
	Hold Workplan Review Meeting		2	0
	Adjust Workplan		2	0
				0
	SD Milestone Phase Check	25		0
	30% Design Review	20		
	Schedule Meeting with PEP Team		2	0
	Hold 30% Design Review Meeting		2	0
	Review Workplan Progress		2	0
	Review Set Organization		2	0
	Review and Confirm use of Applicable Prototype Sheets		2	0
	Review Major Building Systems		2	0
	Review Code Approach		2	0
	Review Life Safety Plans		2	0
	Adjust Documents		2	0
	Refine Workplan		2	0
				0
	DD Milestone Phase Check	25		0
DETAIL EXCELLENCE	**60% Design Review**	20		
	Schedule Meeting with PEP Team		2	0
	Hold 60% Design Review Meeting		2	0
	Review Workplan Progress		2	0
	Review Set for Appropriate use of Systems		2	0
	Review Constructability of Unique Details		2	0
	Review Systems Transition Details		2	0
	Review Code Approach		2	0
	Review Life Safety Plans		2	0
	Review Consultant Coordination		2	0
	Adjust Documents / Refine Workplan		2	0
				0
QUALITY EXCELLENCE	**95% Design Review**	20		
	Schedule Meeting with PEP Team		2	0
	Hold 95% Design Review Meeting		2	0
	Review Overall Set and Coordination		2	0
	Confirm Major Building Systems are Coordinated		2	0
	Review Constructability of Unique Areas		2	0
	Review Completeness of Specifications		2	0
	Visual Quality Control		3	0
	Review Life Safety Plans		3	0
	Make Corrections to Documents		2	0
				0
	Final Page Turn	20		
	Schedule Meeting with PEP Team		4	0
	Hold Final Page Turn Meeting		4	0
	Review Overall Set and Coordination		4	0
	Visual Quality Control		4	0
	Make Corrections		4	0
				0
	CD Milestone Phase Check (Optional 3rd Party)	50		0
	Total Points Available	200		
	Total PQx Score			0

FIGURE 7.19 Project quality commissioning.

This idea envisions creating a tracking scorecard (Figure 7.19) that accounts for processes completed, the result being the assignment of a PQx score to the project. The score of each project can then be compared with hard metrics such as profit, project net multiplier, number of RFIs due to document quality, and percentage of change orders due to document quality. The goal is to see if there is a correlation between a higher PQx score compared with the other metrics. In other words, will a higher score equate with greater profit or reduced RFIs? The postulation is that it should.

Realizing that no two projects are exactly the same, if a trend starts to show that having a systematic approach to quality across differing projects does have impact, the theory will prove its value. Many points systems in practice today are an exercise of chasing a higher score, but the outcome is meaningless if the reasoning behind it is misunderstood. The purpose of the points in the PQx system is to assign measurement value rather than only to check the box. It will become of value if a concerted effort is applied to track progress and assign points. Modeled around the PEP technique, this idea is not fully developed yet, but we offer this preview and challenge others to build upon it or create your own worthwhile measurement.

The key metric we are trying to capture is whether our efforts to deliver work with excellence have actually achieved that objective. Teams whose projects have a low fee and are well executed should be not viewed detrimentally when compared with similar projects with a more generous fee.

REFERENCE

Level of Development (LOD) Specification Part I & Commentary For Building Information Models and Data April 2019 Copyright 2019 BIMForum – www.bimforum.org.

RESOURCE MATERIAL

Figures 7.20 – 7.26: Project Excellence Planning
Figures 7.27 – 7.32: Building Systems Review

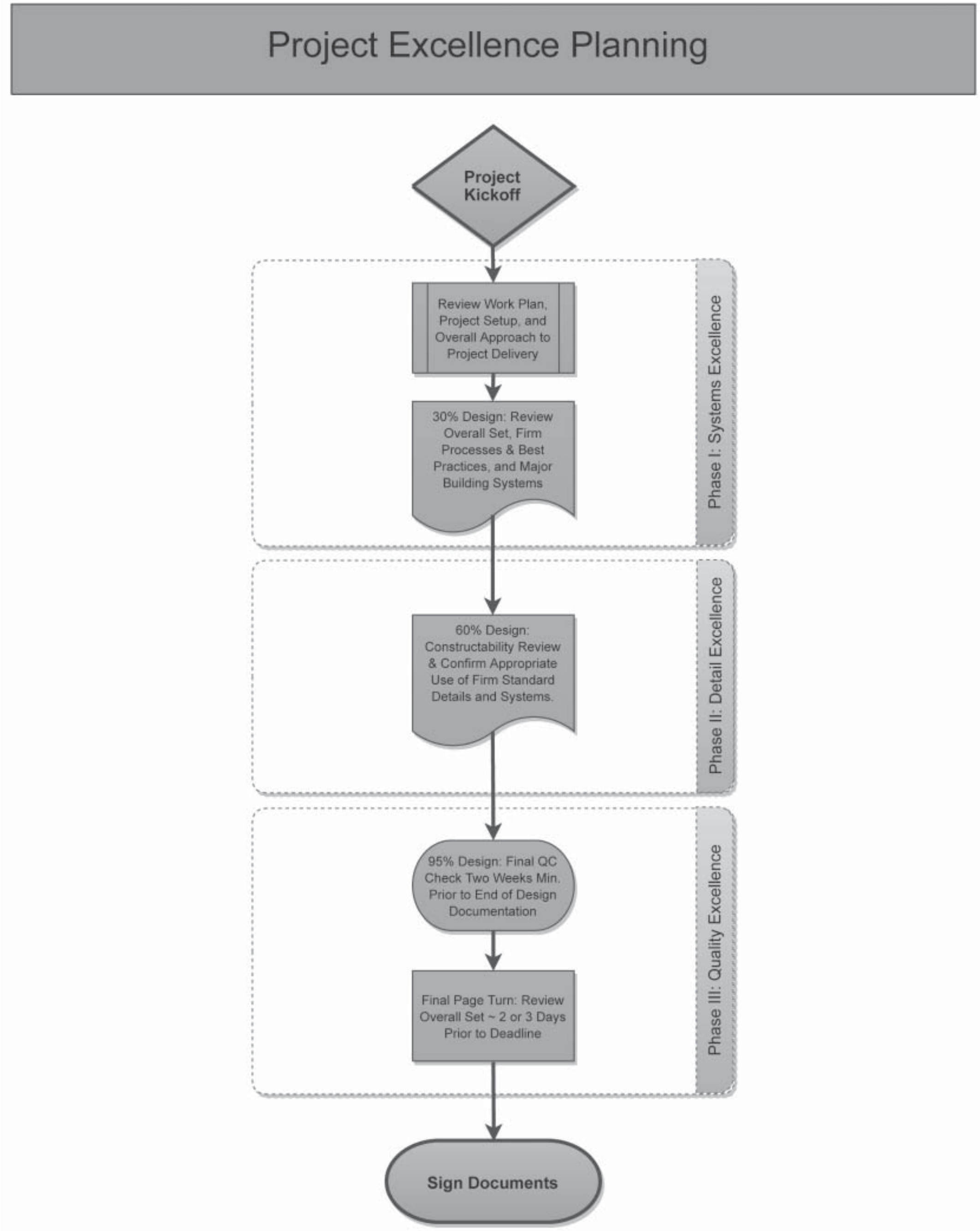

FIGURE 7.20 Project Excellence Planning.

Project Excellence Planning

Summary

Overview

Project Excellence Planning is an on-going series of "touchpoints" throughout the project life which increases the opportunity to do things right the first time by guiding the project team to recognize potential time savings and identify possible issues earlier in the project.

The terms **Q**uality **A**ssurance and **Q**uality **C**ontrol are the basis of Excellence and are the foundation for this process.

Definitions

Quality Assurance:

- A systematic methodology for doing things right
- A state of mind
- Continuous cycle
- Has the ability to improve the bottom line

Quality Control:

- Confirming that documents meet the requirements of codes
- Technical review for constructability and lessons learned
- Per project basis
- Can be objective or experience-based
- Can affect bottom line positively or negatively

Workplan: An essential part of Quality Assurance. A series of steps that outlines the approach, defines and divides the scope of work, outlines the importance of timely decisions, and acts as a roadmap to the overall delivery.

- Know what is required by contract
- Identify fee breakdown by phase
- Project Schedule (including key milestone dates)
- Deliverables and Tasks at each phase
- Prepare a Cartoon Set or Sheet Index to justify the effort required
- Staffing - FTE required based on anticipated schedule and fee
- Prepare a BIM Execution Plan

Project Excellence Planning Team:

- One or two senior-level architects familiar with the firm processes and tools with proven project leadership and performance.

FIGURE 7.21 Project Excellence Planning.

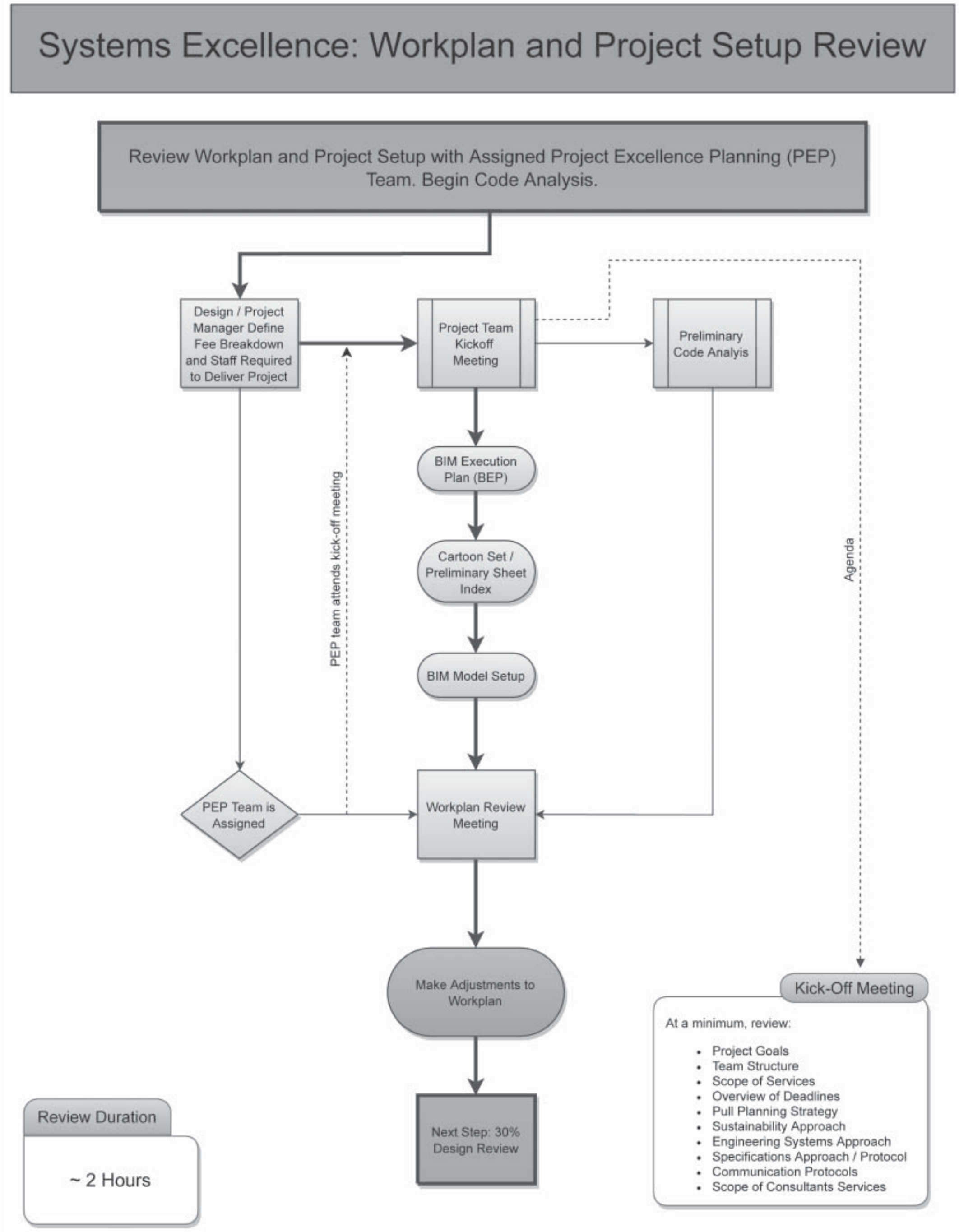

FIGURE 7.22 Project Excellence Planning.

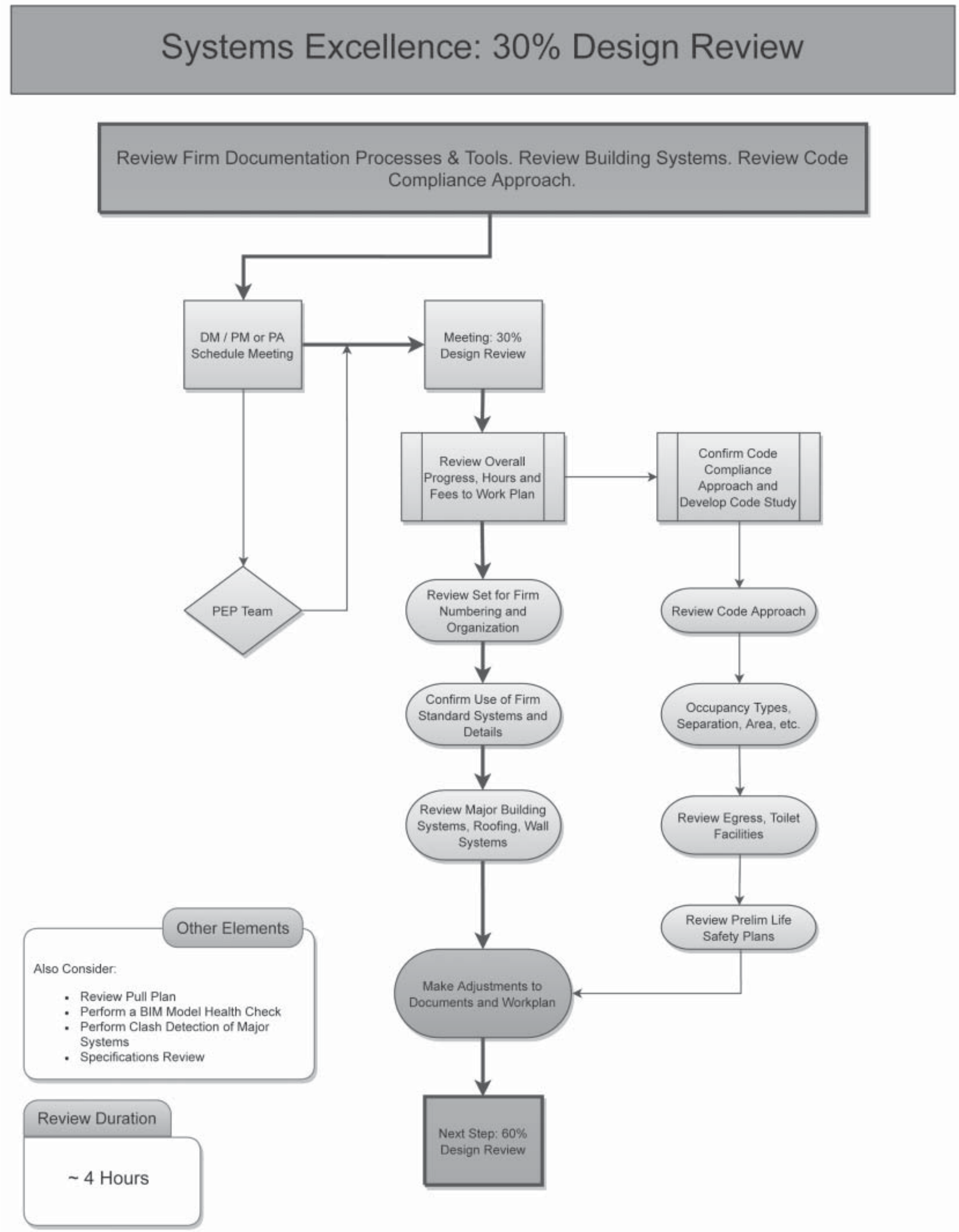

FIGURE 7.23 Project Excellence Planning.

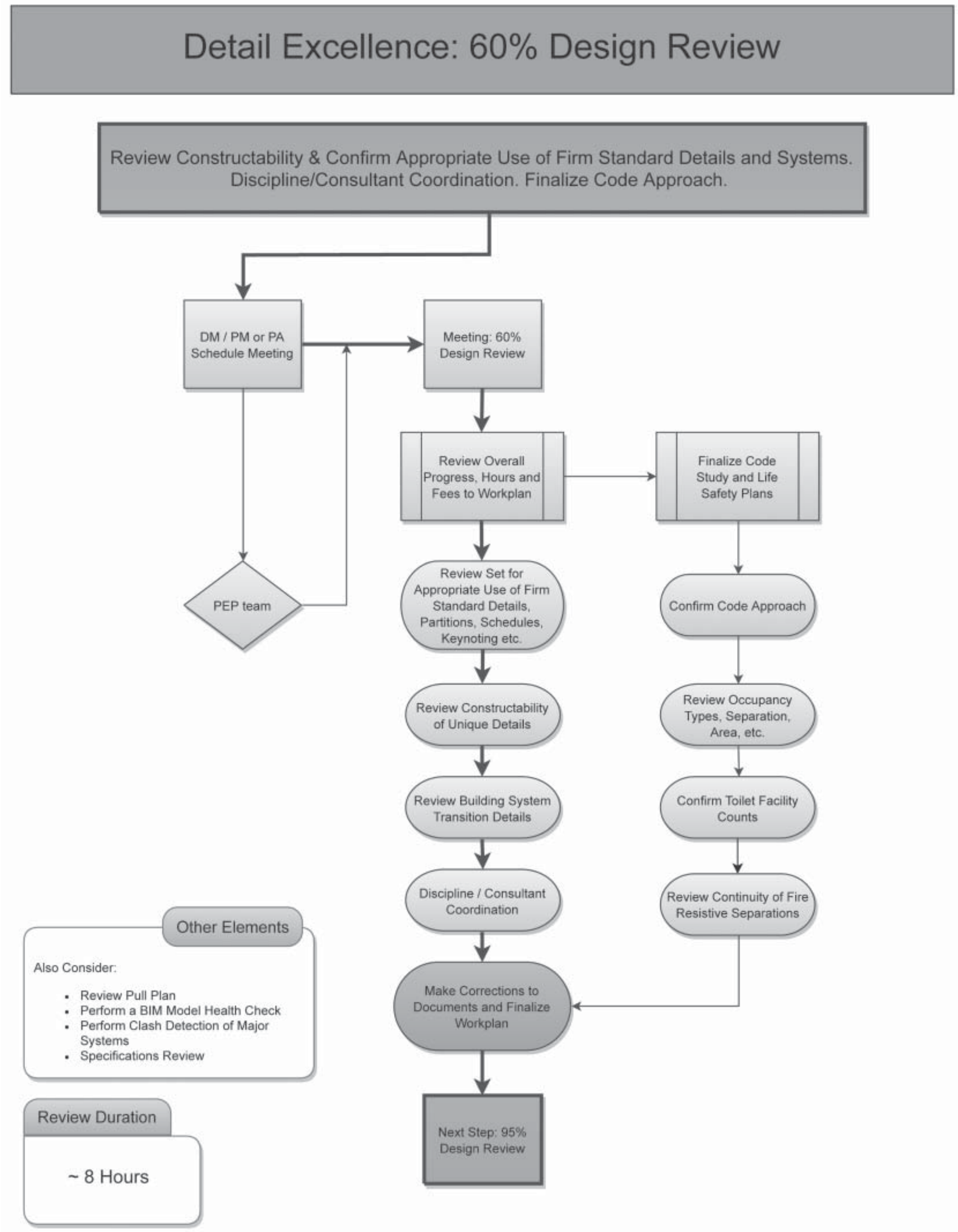

FIGURE 7.24 Project Excellence Planning.

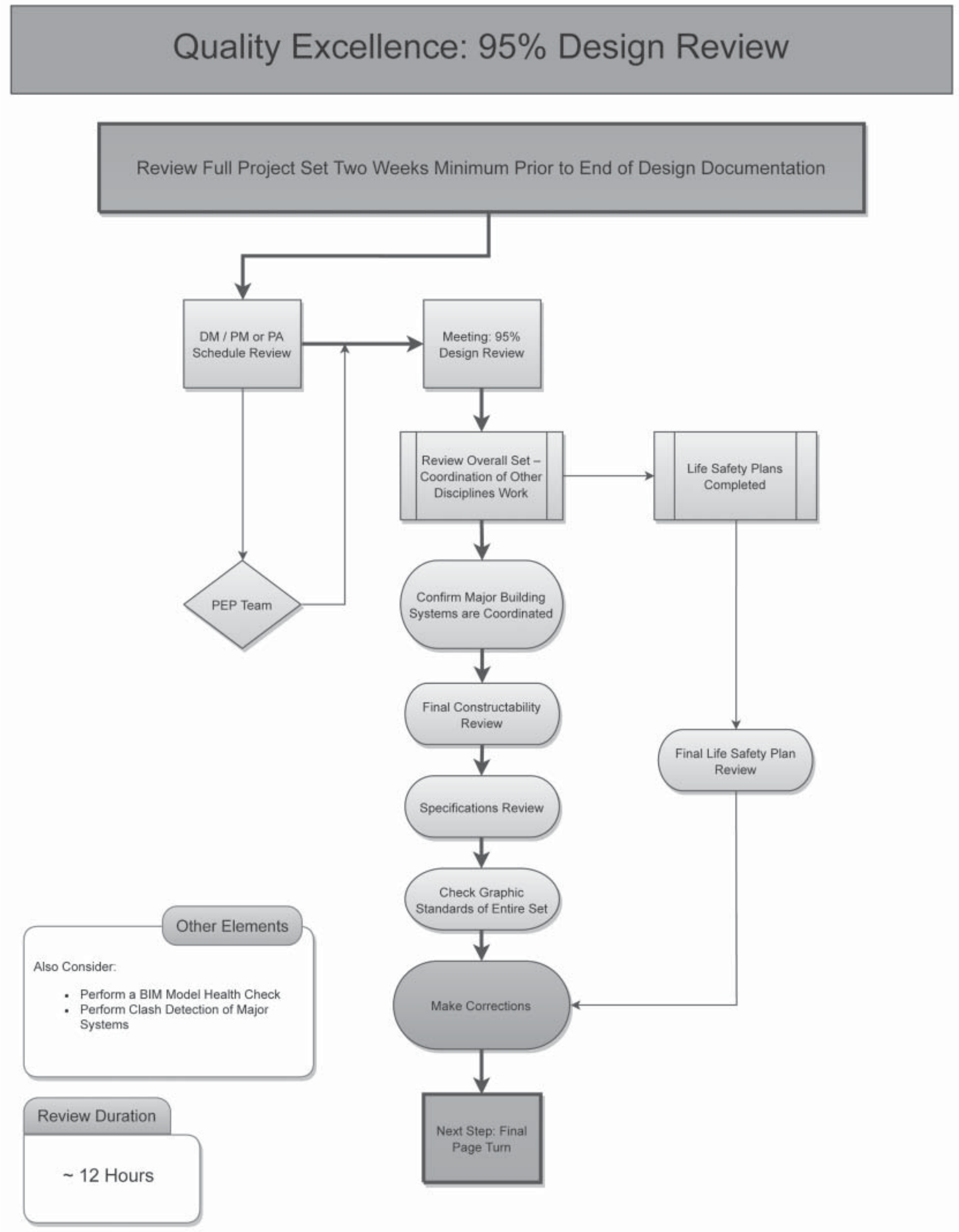

FIGURE 7.25 Project Excellence Planning.

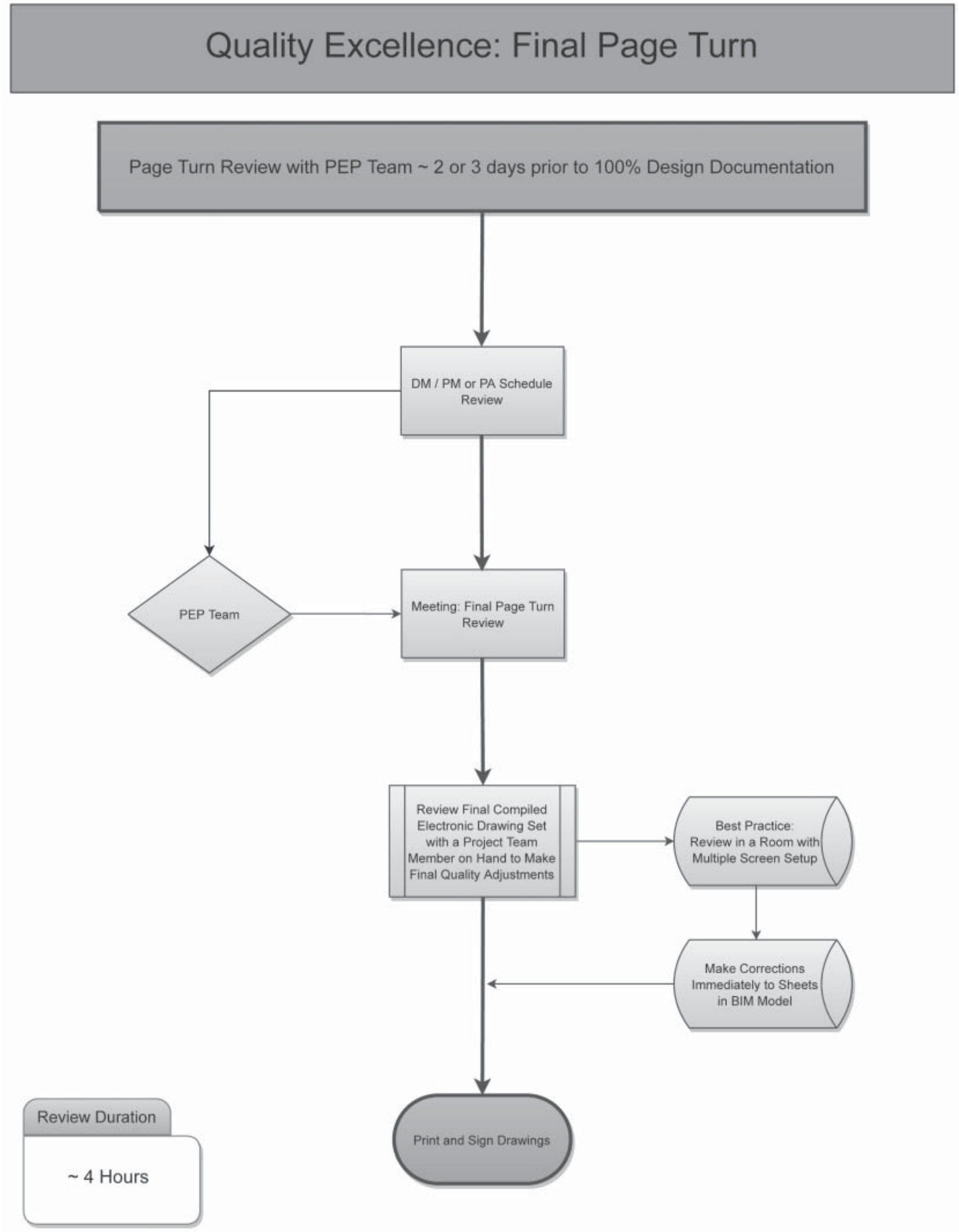

FIGURE 7.26 Project Excellence Planning.

BUILDING SYSTEMS REVIEW

Date

Project Name
Project Number

Edit this Agenda to suit the project type & time(s) available – delete what is not applicable (i.e., Charette can be done in a day or less as needed.

AGENDA

Tuesday, October 4

Type in this document to reflect the meeting decisions. Put "Not Applicable" for items that don't apply instead of deleting them. That provides a written record that they were discussed and do not apply.

INTRODUCTION - 8:30 – 8:45 am

Introduction to the Charette, its purpose and goals.

a.) Disaster preparedness (flood, hurricane, attack)
b.) Future infrastructure (planned for growth)
c.) Preferred vendors
d.) Plumbing over IT area?

FOUNDATION SYSTEMS – 8:45 - 9:30 am

a.) Geotech recommendations.
b.) Spread footings versus piers-benefits and disadvantages.
c.) Area of structural slab at 1't Floor – water penetration issues.
d.) Waterproofing systems - types and maintenance.
e.) Vapor Barrier / location

STRUCTURAL FRAMING SYSTEMS – 9:30 - 10:15 am

a.) Steel vs. Concrete; Fireproofing
b.) Floor by floor review of anticipated usage - present and future
c.) Slab-on-Grade (SOG) vs. Suspended Slab –long term issues re: plumbing / maintenance?
d.) Long term deflection of the slab edges-how much?
e.) Floor rebar placement-any precautions about locating penetrations?
f.) Setup for future vertical expansion
g.) Lightweight concrete vs. normal concrete
h.) Column grid layout and brace or shear wall locations (if necessary)
i.) Floor to Floor heights
j.) Any special equipment (what, where, how much does it weight, does it require a depression or special shielding)
k.) Any other depressions (showers, janitor closets, terrazzo, etc.)
l.) Any special vibration requirements

BREAK – 10:15 - 10:30 am

Page No. 1

FIGURE 7.27 Building Systems Review.

BUILDING SYSTEMS REVIEW

Date

Civil & Landscape – 10:30 – 11:15 am

a.) Local requirements and contacts
b.) City wastewater, storm and water capacity requirements
c.) Existing easements and platting requirements
d.) Traffic requirements
e.) Paving
f.) Who provides utilities?
g.) Site lighting levels
h.) Root barriers for trees
a.) Landscape budget? Roof gardens?

ROOFS & PENTHOUSES – 11:15 – 11:45 am

a.) Roofing material preferences, including flashing materials.
b.) Low slope roofs
c.) High slope roofs
d.) Overflow drains or through the wall scuppers?
e.) Roof walkway pads or elevated decks.
f.) Window washing equipment-davits, tie-backs, electrical outlets.
g.) Lightning protection?
h.) Special provisions for exhaust stacks.
i.) Parapet height.
j.) Stair access?

LUNCH BREAK - LUNCH SERVED – 11:45 – 12:30 pm

HVAC SYSTEMS – 12:30 – 2:00 pm

a.) Review of the shared building services and floor mechanical rooms on each level, with focus on equipment room sizes and layouts.
b.) Floor by floor review of special HVAC requirements.
c.) Equipment preferences?
d.) Special ductwork needs-fittings? Insulation type?
e.) Control system-digital, interface with existing, remote readout / control? Energy Conservation concerns.
f.) Noise / vibration issues.
g.) Floor coating system in mechanical rooms.
h.) LEED implications

ELECTRICAL SYSTEMS – 2:00 – 3:00 pm

a.) Any aluminum permitted in distribution system?

Page No. 2

FIGURE 7.28 Building Systems Review.

BUILDING SYSTEMS REVIEW

Date

b.) Conduit guidelines (types permitted and locations where conduit is required), and where is plenum rated cabling permitted?
c.) Light fixture preferences?
d.) Outlet selections-material, color, color coding.
e.) Circuiting-Owner requests, clean circuits, dedicated circuits.
f.) J-boxes and pull strings for Owner supplied systems.
g.) Clocks-battery powered?
h.) Discussion of panel board nomenclature.
i.) Discussion of use of hospital grade flex wiring for normal power circuits in non-patient care areas.
j.) Preferred equipment manufacturers.
k.) Discussion of UPS requirements (IT support and required battery lighting).
l.) Site lighting levels:
m.) LEED implications

BREAK – 3:00 – 3:15 pm

PLUMBING SYSTEMS – 3:15 – 4:00 pm

a.) Material, fixture, and fitting preferences.
b.) Access panels and cut-off valve locations.
c.) Exterior hose bibs and stub-outs for irrigation system.
d.) Floor drain locations and preferences.
e.) Prevent water / fluids to floors below.
f.) Water treatment systems.
g.) Preferred equipment manufacturers.
h.) LEED implications

FIRE PROTECTION SYSTEMS – 4:-00 – 4:30 pm

a.) Types of heads preferred.
b.) Location of swivel joints for coordination with ceiling system.
c.) Pull stations, fire extinguisher cabinets, etc.
d.) Annunciation panel location(s).

OTHER MULTI-FLOOR PENETRATIONS – 4:30 – 5:15 pm

a.) Telecommunications
b.) Computer backbone
c.) Pneumatic tube
d.) HVAC
e.) Exhaust stacks

Page No. 3

FIGURE 7.29 Building Systems Review.

BUILDING SYSTEMS REVIEW
Date

Wednesday, October 5

EXTERIOR VERTICAL SKIN – 8:30 – 9:30 am

a.) Curtainwall system-glass types, color, U-value, coatings, UV block, laminated, condensation concerns at atrium, glazing system on interior of atrium, aluminum extrusions, aluminum finish, gaskets, tie-back provisions?
b.) Masonry Veneer - brick ties; backup sheathing; flashing (end dams); c.) Precast concrete panels-anchorage and wind bracing, thickness, color, aggregate, white cement, reveals, curved, coating?, mockup panel, quality controls, availability / lead time.
c.) Doors-automatic opening? Manufacturer preferences?
d.) Windows: Hurricane resistant? Heat strengthened; tempered; laminated.
e.) Louvers-custom architectural louvers.
f.) Setup for future horizontal expansion
g.) LEED implications

TRASH & WASTE DISPOSAL – 9:30 – 10:15 am

a.) Compactor(s)
b.) Container(s)
c.) Masonry Screening Enclosures

BREAK – 10:15 – 10:30 am

VERTICAL TRANSPORTATION – 10:30 – 12:00 pm

Elevators / Dumbwaiters
a.) Setup for future vertical expansion
b.) Overview: Otis Gen2 Machine Room-less System
c.) Overview: Otis
d.) Review number of openings each level, and which elevators go allthe way to the roof Level'
e.) Elevator speeds
f.) Elevator controls-any special key or card key systems, esp. for Level 5 doctors.
g.) Cab finishes-floors, walls, ceiling
h.) Car control panels-two in each pedestrian car?
i.) Security in cars-intercom, cameras?
j.) Special lighting inside the cabs?
k.) Number of call button risers-any special overrides?
l.) Vestibule requirements on any floors?

Page No. 4

FIGURE 7.30 Building Systems Review.

BUILDING SYSTEMS REVIEW

Date

STAIRS – 12:30 – 1:00 pm

a.) Custom fabricated or "pre-fabricated"
b.) Mesh / infill on stair sides
c.) Special lighting and finishes
d.) Security concerns-cameras; intercoms; Key or card key access
e.) Roof access for maintenance, including penthouse roof

INTERIOR DOORS – 1:00 – 1:30 pm

a.) Hardware Preferences.
b.) Special keying system-i.e. cylinders?
c.) Door material preferences.
d.) Frame with "hospital" style stops, typical?

LOW VOLTAGE SYSTEMS – 1:30 – 2:30 pm

a.) DAS – distributed antenna system
b.) Telemetry
c.) Wireless
d.) Medical Communication - Nurse call, paging
e.) Security - infant protection
f.) MATV/CATV
g.) Overhead paging
h.) Infotainment / Music
i.) Master clock systems.

INTERIOR FINISHES – 2:30 – 3:30 pm

a.) 5/8" gypsum board typical. Abuse resistant gyp. bd.; USG Aqua Tough Fiberock; Cement backer board or "Dens-Shield" tile backer at patient room showers. Typical gauge & spacing of metal studs.
b.) Paint specification preferences
c.) Wall protection
d.) Ceiling systems
a.) Attic stock
e.) Flooring preferences
f.) Moisture related flooring problems. Low / no VOC's
g.) Maintenance concerns from Owner? Wood base, wood paneling, and stone floors
a.) LEED implications

BREAK – 3:00 – 3:45 pm

Page No. 5

FIGURE 7.31 Building Systems Review.

BUILDING SYSTEMS REVIEW

Date

CABINETRY – 3:45 – 4:15 pm

a.) Manufactured and / or local shop fabricated
b.) Materials: MDF ' particle board; Plastic laminate exteriors and thin laminate interiors; PVC edge banding; Hinge specifications; Solid surface materials; Marine grade plywood; Type of counter tops in Lab.
c.) LEED implications

TOILET ACCESSORIES – 4:15 – 4:30 pm

a.) Scope of specified accessories versus vendor supplied accessories-i.e. soap and towel dispensers
b.) Manufacturer preferences
c.) Toilet partition construction and style
d.) Handicapped accessibility & handicapped "friendly" restrooms

OTHER ITEMS – 4:30 – 5:00 pm

a.) Medical equipment supports
b.) Wrap-up

END OF AGENDA

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FIGURE 7.32 Building Systems Review.

CHAPTER 8

Streamlining Documentation

WORKING SMARTER

"Costs don't exist to be calculated; costs exist to be reduced." This observation is from Taiichi Ohno, the Japanese industrial engineer who helped lead development of the Toyota Production System. It illustrates well the thinking that underlies their relentless pursuit and elimination of waste. Similar thinking can be applied to streamlining the design professional's work to identify and eliminate wasted effort. This provides benefit when economic times are good and not so good.

Aesthetic and functional design are an exciting part of a project's development where ideas are explored and developed. It calls for creativity and excellence both in substance and in communicating with clients and project stakeholders. Design also carries limited risk. Documentation remains the principal deliverable we provide, occurring at each phase of work. The majority of the project's fees, effort, and risk ultimately lie with development of the contract documents. They are composed of construction drawings and specifications and are an integral component of the legal contract between an owner and a contractor, establishing the basis by which potentially millions of dollars will change hands. Errors and omissions in the contract documents can lead to litigation with adverse financial consequences and can ruin client relationships. To these ends, architects and engineers must strike a balance between the quantity and quality of information developed, and it is in their interest to provide documents that are sufficient for their purpose. Surprisingly, greater attention is often paid to aesthetic and functional design, and the task of developing the technical design with the resulting documents is left to less experienced teams with limited resources. Some firms outsource portions of this effort.

The approaches discussed in this chapter seek to streamline many aspects of the documenting effort and spend our time on the areas of greatest risk and project complexity. Chapter 4 discussed briefly the widely accepted practice within design firms of allowing many ways of documenting work that vary by team, office, market sector, and personality. Understanding that some differences must exist due to project type, project size, and client requirements, there is great value to be realized by working similarly across the office and firm.

I am always surprised at how much architects and engineers discount the amount of time wasted in unique documentation of repetitive design elements.

—John W. Gill, PE, PMP

Models and drawings communicate concepts, ideas, and a level of precision for the building systems and how they interrelate. Streamlining documentation is rightsizing what is produced and eliminating waste in the effort of doing the work. With modern software, we are in many ways building the building on the computer. Well-designed production processes can aid in the planning, design, integration, and quality documentation of building systems, making the deliverables easier to understand and follow.

Architectural production practices should not be confused with assembly line manufacturing as we are not crafting identical widgets. Project delivery typically entails managing many subjective aspects due to working with people and organizations. Nonetheless, much can be learned by observing the thinking behind good manufacturing procedures and applying the ideas and practices to the more repetitious aspects of our practice (see Chapter 5). For example, develop well-thought-out methods for accurately performing work rapidly and consistently. Couple this with identifying and memorializing productive work methods from across the firm as there is much to learn from seeing how people do their work. Also recognize that variation will exist. A high-rise office building with repetitive floor plates lends itself to small-scale plans where a hotel or hospital with furniture or equipment driven layouts require larger scale plans or multiple plans to identify those items. In addition, develop tools that facilitate client interaction and information gathering during the design phases and then document it back to them in an attractive, easy-to-understand format.

Drawing systems can be used to simplify and streamline documentation. Elements such as partitions, doors, cabinetry, building accessories, and handicapped accessibility clearances can be easily scheduled using drawing methodologies that cover the majority of situations – with additional notes or drawings for atypical situations only. These will be discussed later as prototypical systems sheets. It is important to emphasize with the use of any documenting system, that there is never a time savings in thinking through the issues affecting a project; rather there can be a reduction in documentation and coordination.

IMPACTS FROM THE ADAPTION OF TECHNOLOGY

Most design firms have definitively moved into the camp of employing building information modeling (BIM) software. Unlike computer-aided design (CAD), BIM software natively implements 3D modeling with the ability to embed information into the model elements. Traditional 2D documentation is a derivative of the 3D model, and we think BIM software does this very well (see Chapter 10). The ability to slice and dice the model allows innumerable opportunities to view the building and examine every possible condition and to readily create drawing sheets by selecting and placing views from the model. Changes made in one place show up in every view. With this power also comes the ability to populate sheets with many views, and if we are not careful document sets can become unnecessarily large. This is not a new temptation; it is simply better enabled by technology. Technology allows us to implement poor practices more quickly and on a larger scale just the same as for good practices. When drawings were prepared by hand, preparation was laborious and time-consuming.

Not to discount the effect that pinbar overlay drafting had on the profession, but CAD programs really started the revolution of streamlining and automation of documentation. BIM has allowed the profession to take what CAD did and move the needle even further. There is a nagging feeling though among many in the profession that we have taken a step back in our documentation quality with BIM. Why is that?

There are two schools of thought on this. The first is that the software has made us focus more on the model to the exclusion of the documentation. The second is that perhaps it is not because of the software we are using but the changes that have occurred within the profession.

THE EASY BUTTON

Okay, so the title is not unique, but it provides a picture of how BIM has made wasteful documentation pervasive in the industry. It has become almost effortless to create sections, elevations, and plans without giving much thought as to why they may even be necessary to make.

One symptom is the rampant outbreak of unnecessary interior elevations included in today's construction document sets. Many of them are of nondescript walls devoid of unique features or characteristics, with only routine elements such as a door or random electrical outlet that are documented elsewhere. If there are elaborate material relationships to illustrate or finish patterns that require annotation, there would be no question of the importance of an interior elevation. The question becomes why is this happening? The answer we often hear is, *I thought I was supposed to elevate all walls because that is what my job is*. This misunderstanding to elevate everything must be stopped! Instead, there should be a concerted effort to elevate only what is necessary. If a wall has a marker board located on it, we must think about how best to convey to the contractor where and how high to mount it. Thinking in these terms, the information can often be conveyed in plan view with a dimension to show horizontal location and a note indicating height. Alternatively, they can be scheduled and tagged on floor plans only.

Multiple sections, elevations, and plan views may be created in the model during design to help understand the building and the different conditions. That does not mean they should necessarily be included in the construction documents. Those same views must earn their way onto a sheet because they offer unique information that cannot be found elsewhere.

Unfortunately, the easy button not only applies to interiors documentation but also is contagious throughout a set of documents.

In many ways it is a combination of both. Modeling has become an essential component to the entire project, from conceptual design through construction. The model is increasingly used for many different purposes, and there are more stakeholders. A model also allows for laziness in drawing. It has been observed that less rigor is exercised in developing drawings with BIM as we are not interacting in the same manner with the materials and lines; users do not have the same understanding of what each line represents and therefore do not develop them to the same level of detail as pre-BIM. The profession has changed along with the evolution of CAD and BIM. Where drafting used to be a profession itself, the days of career draftsmen with skills learned over many years is fading away. Drafting is no longer taught to the younger staff by a chief draftsman looking over the shoulder and correcting them as they put lines to paper (Figure 8.1). There is a lack of paper in modern-day offices as well, as we have

FIGURE 8.1 Draftsmen collaborating in the 1930s. *Source:* Library of Congress.

been trained to not waste resources. The result is that fewer checksets are printed, and most drawing reviews are conducted online. This has in turn created a distance and disconnect between those who used to work closely with staff to prepare them for their career.

Example: Commercial Projects

Core and shell office building project composed of three buildings

- 660 000 ft^2 total area
- CAD
- 125 sheets architectural construction documents (CDs)
- Equates to one sheet for every 5280 ft^2 of building area

Core and shell office building project composed of two buildings

- 410 000 ft^2 total area
- BIM
- 156 sheets architectural CDs
- Equates to one sheet for every 2628 ft^2 of building area

This example illustrates a comparison of the evolution of documentation from CAD to BIM. The buildings, while different in size, are comparable in the types of building systems used and complexity of design. The same firm did both projects, nearly 8 years apart. The sheet count comparison did not include general sheets, life safety sheets, or site plans. Upon comparison of both projects by the firm, they noticed that the effort to document the BIM project resulted in an almost doubling of sheets compared with the square feet of building area to sheet count. It shows that BIM was not having the positive impact as was expected, even though the firm adopted BIM several years prior. The comparison was made after the project was found to have significantly overspent their design fees. Not all of that was due to the use of BIM, but a few items stood out: (1) It was too easy to add views and sheets in BIM; (2) less experienced staff performed the modeling and drawing with not enough supervision (i.e., modeling was overdone); and (3) overdocumentation stemmed from each of these points.

These items also led to the following observations and outcomes. First, a higher drawing count equals more manpower. Also, to provide more effective oversight, project managers needed to have a better understanding of the BIM workflow. Work plans also needed to account for additional time to check the documents earlier in the document production and identify wasteful practices.

There were other factors which were not a direct effect of simply using BIM, but emerged from it:

- Within a BIM world, many of us think our job is to model. The benefits afforded by modeling should not be confused with the need to clearly understand what is being designed and the requisite thinking.
- We must remember the goal, which is to produce a set of documents that provides value to the client, contractor, and ourselves.
- Knowing what to draw, projects become overcomplicated due to including information that is not required.

The firm learned quite a bit from this one project as a result of the task of what started out as a comparison with a CAD project. And just like in CAD, poor work practices in BIM will lead to miscalculations. The outcome was an updated approach to quality reviews, increased efforts to train staff, and increased manager awareness of BIM.

Example: Institutional Projects

Hospital 1: 118 000 ft^2

- 51 sheets architectural CDs
- Low change orders
- Equates to 1 sheet for every 2314 ft^2 of building area

Hospital 2: 127 000 ft^2

- 157 sheets architectural CDs
- Low change orders
- Equates to 1 sheet for every 804 ft^2 of building area

These two projects were similar in size, although they were not quite an apples-to-apples comparison – perhaps more like evaluating Granny Smith and Golden Delicious apples. Both were in highly regulated states and utilized large construction management firms using at-risk delivery and union labor forces. Hospital 1 was of modest design and limited budget, and Hospital 2 was a design award winner and was well-funded.

The small team for Hospital 1 forced them to rethink how they documented and to limit redundancy in the construction documents. The constrained construction budget also entailed a concerted effort for the selection and detailing of relatively inexpensive building systems. Hospital 2, by contrast, had a larger, more seasoned design team; the building systems were more costly; and it included a small renovation component.

After reviewing an early set of the Hospital 2 documents, the project architect for Hospital 1 suggested to Hospital 2's project manager that there were ways to significantly lessen the overall size of the construction document set, saving time and effort. The project manager's response was that no changes were warranted as they had a particularly good fee. Message received: it is okay to work inefficiently if you have a good fee.

The over 300%, 106-sheet difference between the drawing sets was due in part to design features and a more complex exterior skin but also to the inclusion of many unnecessary drawings and needless repetition.

6 HOURS = WEEKS OF TIME

Abraham Lincoln reportedly said, "If you give me 6 hours to chop down a tree, I will spend the first 4 hours sharpening the axe." His response demonstrated an understanding of the tool, an axe, and how time spent in proper preparation would give him the best results possible. His goal was not so much to swing the axe hard but to make it the most effective for each stroke. For anyone who has tried chopping down a tree with a dull axe, it is a difficult undertaking.

A senior architect worked with a team on a large retail project under development. The project architect was visibly troubled at the task that lay ahead, the limited time, and a small staff to complete the construction documents. A small team of three gathered in a conference room to review the cartoon set – arguing, brainstorming, and challenging each other's ideas, in particular the belief that drawings had to be done a certain way because it was the industry norm. After 2 hours, the original approach was significantly altered, eliminating many drawings and sheets from the set. The project architect's excited response was, *You have saved me weeks of time*. A math equation came to mind: 6 (man) hours = weeks of time.

In this instance, the tool was CAD and the sharpening was the act of determining what to draw versus not. It is not known if weeks of time were actually saved, but an achievable plan that greatly streamlined the work effort was created. Another observable outcome was that to become better at our work, we must challenge conventional thinking and each other's assumptions.

REDUNDANCY

What is it about having more; is more considered better? It can be – for instance, not many will complain about having more money. But this is not necessarily the case with construction documents. Sometimes more is just the outcome of taking the easy way out (Figure 8.2).

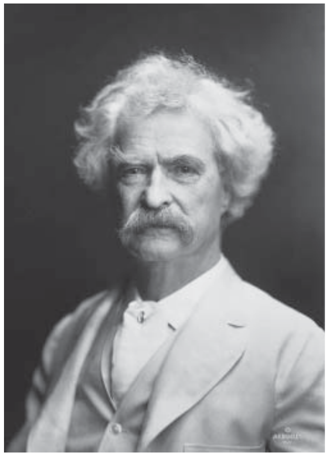


FIGURE 8.2 Mark Twain. *Source:* Wikipedia Commons.

I didn't have time to write a short letter, so I wrote a long one instead.

—Attributed to Mark Twain

Is it easier to create more drawings than thinking of ways to streamline the amount? The answer should be no, but too often this is not the case. It can be easier to not think Lean and take the easy way out.

Many firms are seeing BIM drawing sets swell in size. As we observed earlier, this is not due to increased building complexity but instead the ease with which users can create views and populate drawings onto sheets. Many believe that merely cutting a section or detail from the model to view and study the building guarantees it a right to be on the CD set. What does not change is that every drawing, view, or sheet needs to be managed, which equals time wasted if the set is allowed to balloon in size.

Observation: The quantity of drawings has no relationship to the quality of the documents.

Example: Tenant Improvement Project

Consider the example shown in Figure 8.3, which emerged from a milestone phase check. This project consisted of a tenant improvement for several floors of an existing building. Consisting of 51 sheets, some may consider this an efficient drawing set. However, when the reviewer, a seasoned architect, began to look more closely at the information included in the set, it became apparent that 30% of sheets were not necessary to adequately convey relevant information to a contractor or Authority Having Jurisdiction (AHJ). What if this had been flagged earlier in the documentation process? The effort to develop, coordinate, review, and maintain the extra sheets would have been eliminated, allowing more time to focus on the detailed aspects of the design and saving project fee. The project team did modify the set prior to the release for construction, but the effort was too late to impact the fee already spent.

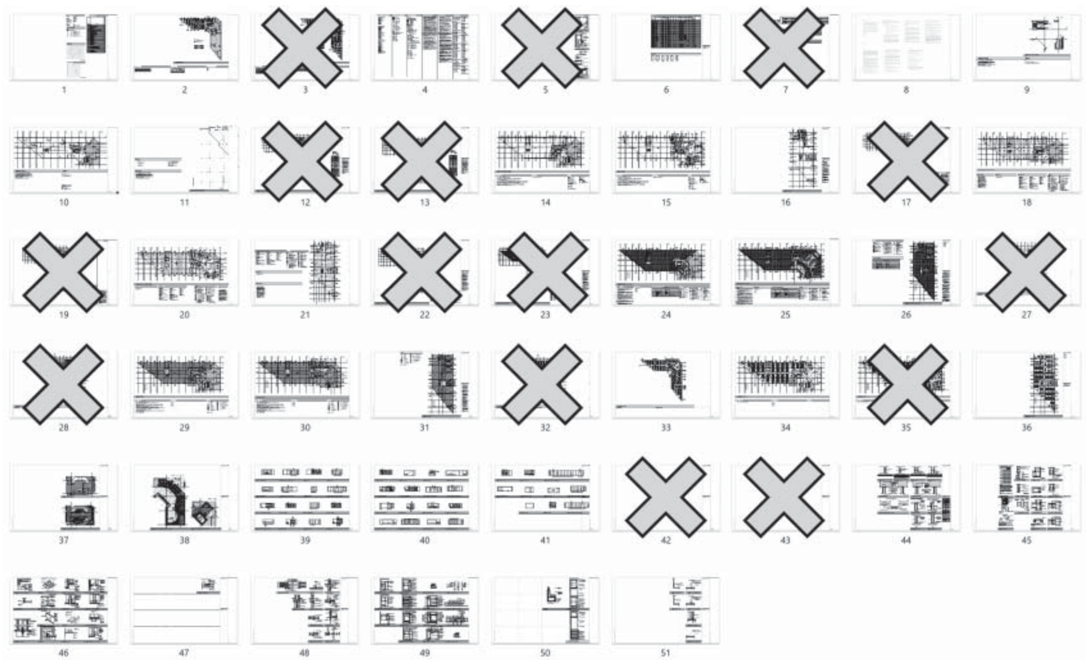


FIGURE 8.3 Sheet count reduction.

Example: Core and Shell Office Building

A more extreme example of the value of engaging experienced leaders earlier in the process occurred with the architectural documentation of a core and shell office building of approximately 220 000 ft^2. The initial cartoon set consisted of over 100 sheets of plans, sections, elevations, details, and more. A check-in meeting was held to review the state of the documentation early in the design development (DD) phase. As the scope of the project was being explained, the senior architect began to make suggestions to streamline the set. Several obvious ways stood out, but the major item suggested to the team was to eliminate the four area plan sheets (four sheets for a single level) into a single sheet showing the entire level. This was accomplished by reducing the drawing scale from 1/8" = 1'–0" to 3/32" = 1'–0". The same strategy was employed for the exterior building elevations. The team revised the set and ultimately completed the CDs on schedule with the sheet count reduced by approximately 50% from where it began. When asked why the documents were set up the previous way, the answer was that the view templates in the firms BIM template were set at those scales and they were unaware it was acceptable to change. Without diminishing the quality of the documents, this sizable reduction was a result of rethinking sheet layouts and a more effective use of drawing scale to convey the same information to the contractor. The project was successfully constructed, with no complaints from the contractor regarding drawing scale.

Observation: Many project teams avoid engaging experienced architects due to their higher billing rates. How do you measure the value of eliminating 1/3 to 1/2 of the sheets? Would a 10% reduction of effort pay for a few hours of time?

A Sinister Plague

Mies Van der Rohe famously observed that less is more. We think of his comments with regards to design but should also consider their application to document preparation and presentation.

Beginning with the introduction of Sticky Back in the early 1980s (a transparent plastic film with adhesive on one side), the copy machine became an instrument allowing us to easily copy and place typical details or schedules onto drawing sheets. Another leap forward occurred with CAD and the ability to copy and paste information from other drawings. It was the start of the cheapening of information. What we did not realize, lurking nearby, was that a sinister plague began to infect our documents – needless redundancy.

Show it once but show it often. If our documents tell the story of a building, many have decided that it is better told three, four, or even more times.

When drawings were prepared by hand (Figure 8.4), redundancy had a difficult time propagating. Sheets of vellum or mylar were expensive, and it took time to generate drawings as they were created one line at a time. Changing a note or drawing was not taken lightly as an entire note might have to be erased when revising; you could not just edit a few words in the middle and have it automatically justified. Both vellum and mylar had tooth – the surface roughness that allowed them to accept pencil or pen. Too much erasing, and the tooth was gone; worse yet, you might end up with a hole in the sheet. These limitations engendered an approach where you thought about what you were going to draw before committing it to paper.

Some institutional clients dictate specific drawing and modeling standards that imbue unneeded redundancy and document complexity. Onerous standards generally arise as a reaction to problems on past projects and may be based around a senior individual's personal preference or the perception that more is better. Discussion with the client may provide an understanding of their concerns and the opportunity to employ methodologies that meet their intent and provide a sufficient level of documentation. In other cases, that may not be possible, and the design firm will need to closely adhere to their written requirements.

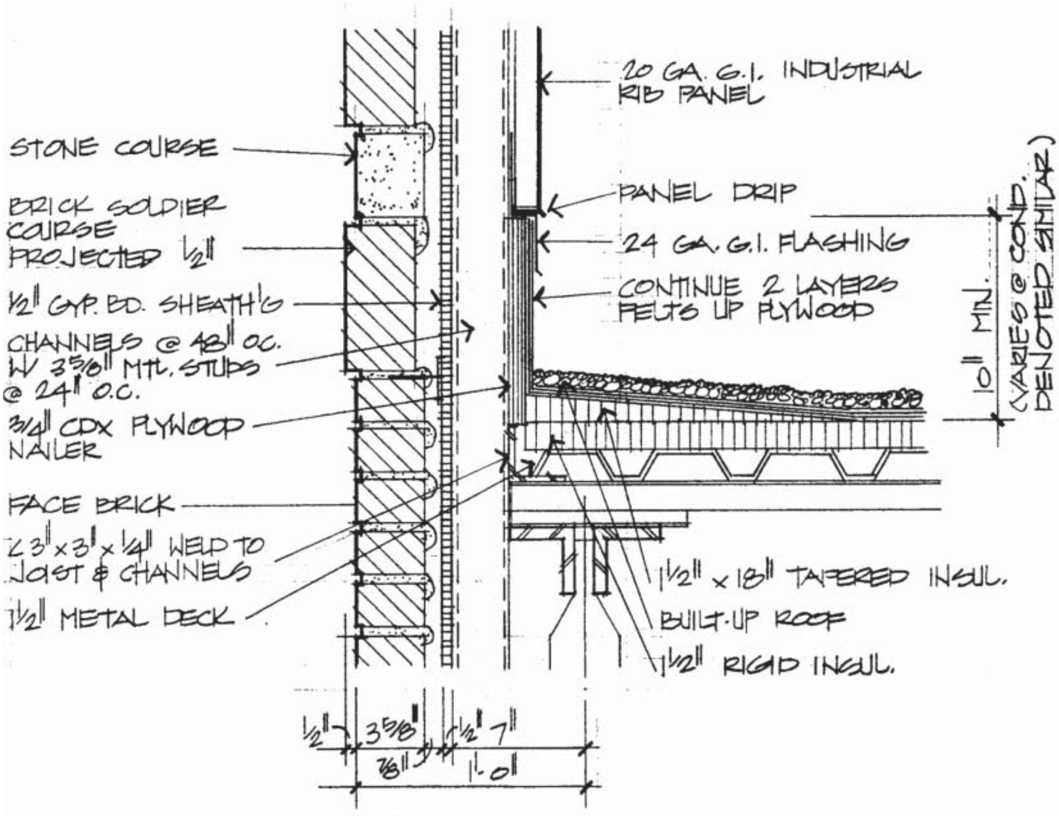


FIGURE 8.4 Drafting by hand.

SIGNAL TO NOISE RATION

In the audio and video world, equipment is rated for its ability to clearly amplify or transmit signals. The amplitude of the signal is compared with that of noise. To distinguish the signal (what we really want to hear or see), its amplitude must exceed the noise – the higher the better. This is known as *signal-to-noise ratio*.

Technology has allowed architects to increase the level of noise within their documents by easily adding information. Modern construction drawings too often lack clarity and become confusing and difficult to follow, both by the graphic density within the drawings themselves and the sheer repetition of the same information in multiple locations.

Downstream Issues: Managing the Presentation of Information

The more times we present the information in the same or slightly different format, the greater the likelihood that errors will be introduced. Everything we document – whether annotation or additional similar drawings – must be coordinated and checked with each other. If changes are needed, each repeating instance must be found and corrected. A good quality control program may catch those mistakes, but the larger questions are, *Why make the mistake to begin with, and why spend the time to detect and correct later?* It is not unlike looking for the children's book character Waldo amid a sea of similar faces.

Detail Redundancy Study

Figures 8.5–8.7 are from an exercise that looked for redundancy in drawing details. Figure 8.5 shows the sheet of details with each redundant word or phrase marked out. Figure 8.6 identifies major portions of drawings that are redundant, beginning with the drawing on the top left of the sheet as the starting point. Figure 8.7 highlights what was judged to be the necessary portions of the details which at a minimum, should be included in the set of drawings. They were the critical intersections of building materials. Due to the clarity of modern printing and PDFs, it was also believed the 1/8" scale drawings would be sufficient for providing overall dimensions of the exterior masonry pilasters.

Partition Tagging – Eliminating Redundancy

Figures 8.8–8.10 demonstrate a streamlined approach to tagging partitions on floor plans. Figure 8.8 shows a common approach to drawing and tagging partitions in BIM. All segments of the partitions are joined to create a clean appearance. The result of doing this is that each segment must be identified so no confusion is created during construction. However, an overabundance of tags is generated which creates a cluttered drawing, now imagine if dimensions, door tags, and plan callouts are included, and you have quite a bit of information to consume.

Figure 8.9 demonstrates a more streamlined approach to tagging the partitions. If the plan view is drawn with partition joins disallowed for different types in the BIM model, then tagging is needed only where different types are unique. The shading in the image represents the default partition type (W3) and is shown here for effect. The W3 type on the left side of the image and the W3 on the right side must be tagged as they are broken by the W6 type. The 12 tags required in Figure 8.8 have been reduced to two tags in Figure 8.9.

Figure 8.10 shows an additional step that eliminates the tag for the W3 type altogether. As the default partition on the plan, a general note is included on the sheet stating that all partition types are W3 unless noted otherwise. Doing this eliminates redundancy, creates less clutter, and saves documentation time.

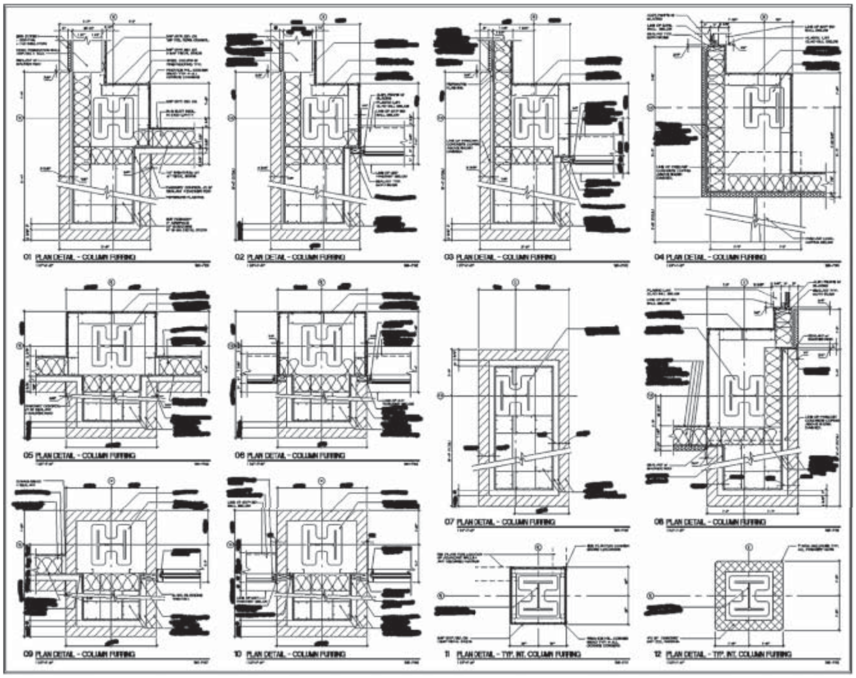


FIGURE 8.5 Shred-a-set: redundant text.

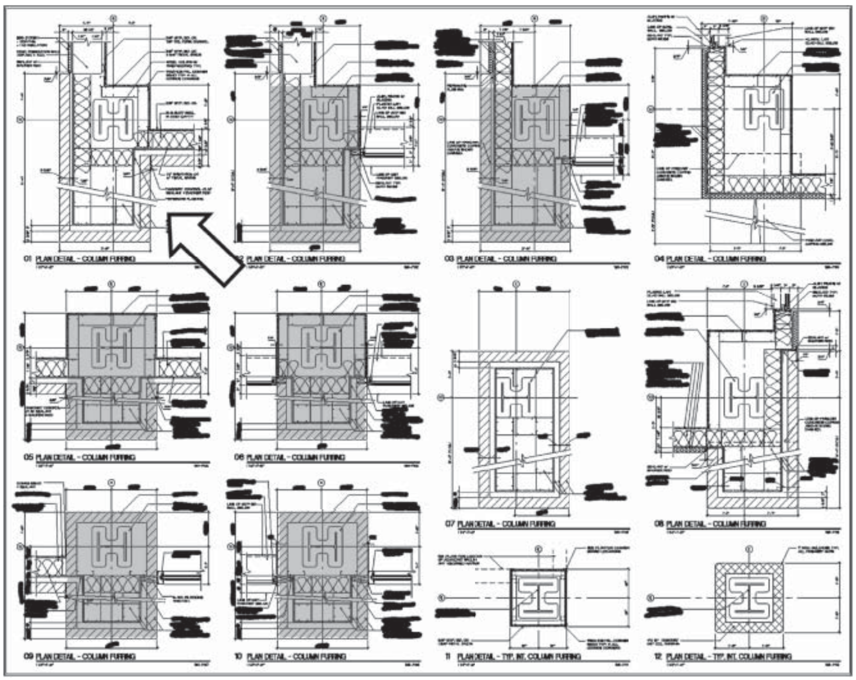


FIGURE 8.6 Shred-a-set: redundant details.

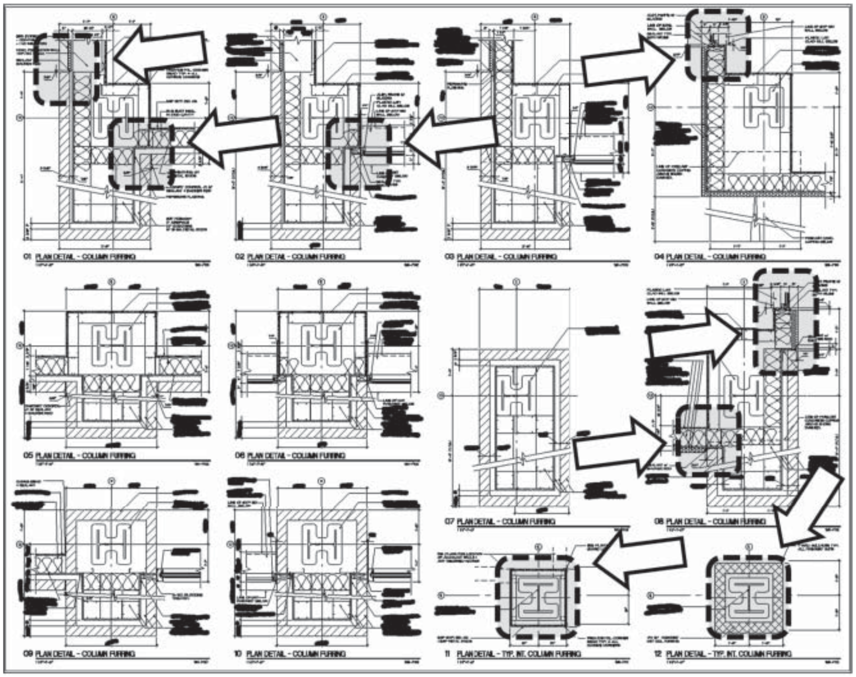


FIGURE 8.7 Shred-a-set: sufficient information.

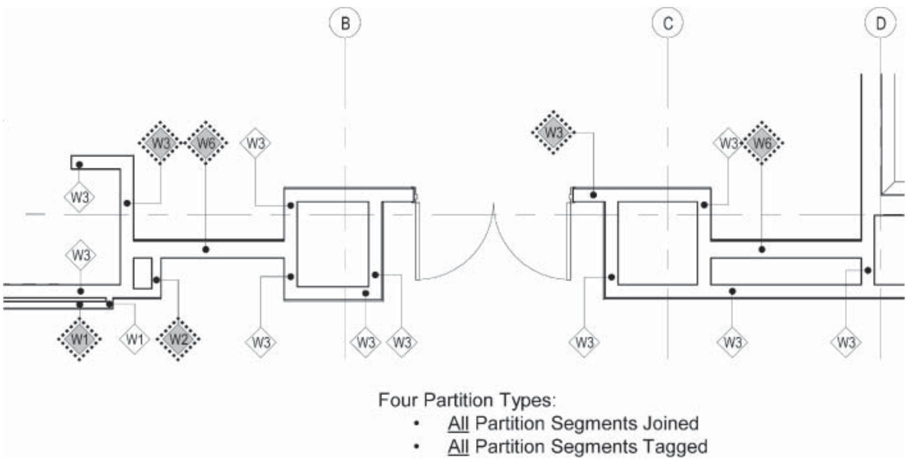


FIGURE 8.8 Partition tagging.

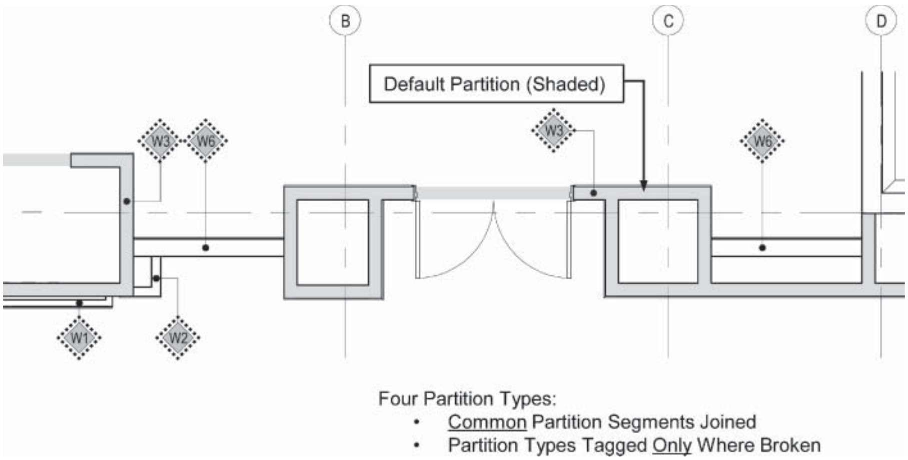


FIGURE 8.9 Streamlined partition tagging.

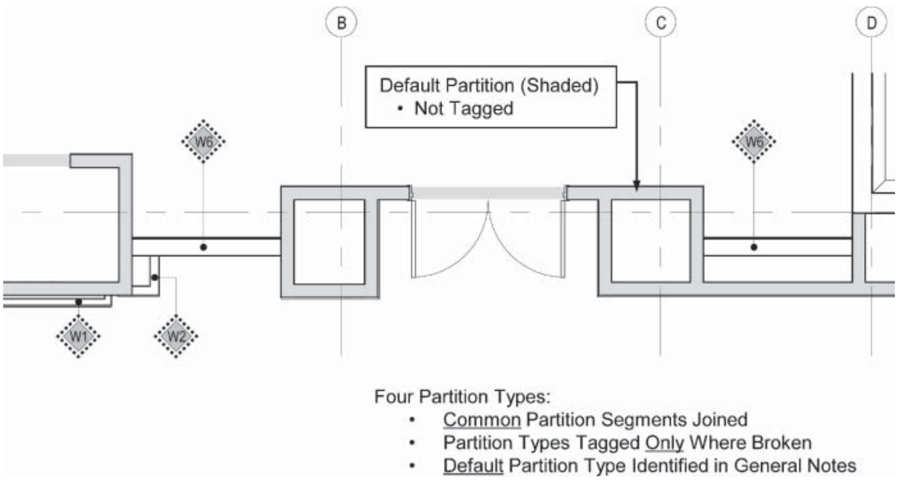


FIGURE 8.10 Default partition tagging.

INBOX

On most days, the average person receives between 50 and 80 personal e-mails (not counting spam), of which probably 90% contain information on products or services they are not interested in. Retailers often send three versions of the same e-mail on the same day, each formatted slightly different. To get to the five or six messages of interest, one must navigate all of them. Not only does this require attention to ascertain the content of each e-mail, but also further action must be taken to then delete the unwanted ones. This is not unlike how our drawings become encumbered with recurring graphics and text showing and saying the same thing multiple times. Finding relevant information becomes more difficult, and every element, including the unnecessarily redundant ones, must be managed for the life of the project including document reviews and coordination efforts.

Exceptions to the Rule

Not every form of redundancy is bad. There are instances when professional judgment deems some redundancy helpful to communicate intent more clearly. For example, the duplication of wall section tags on both the floor plans and the building elevations may be useful in aiding in the navigation of the drawing set. The same thinking applies to dimensioning or detail callouts. Knowing when it is appropriate to repeat these items more than once is nuanced, yet the tendency to repeat them pervades many drawing sets like a plague. Why would we want to show wall section tags in multiple locations? Doing so avoids the user from having to flip back and forth to other drawings, making the set more navigable.

An example of acceptable redundancy is also found in building sections. These drawings are useful to show relationships of interior volumes, connected spaces, and vertical or horizontal relationships that may not be readily understandable from a floor plan. They are also valuable as a roadmap to aid in locating wall sections or even an odd detail that may not be seen from any other location. Knowing this, however, you should avoid the tendency to embellish building sections with unnecessary detail and reannotate them with notes found elsewhere. Useful redundancy is a learned skill.

Is There a Cure?

One way to reduce redundancy is by implementing a systems approach to documenting. This is a method of documenting a system such as doors or cabinetry that by design predetermines where specific types of information can be found and how they are shown. Approaches like this can be graphically intuitive and easy to understand by document users (and document preparers).

Figure 8.11 has two elevations of the same cabinetry. Both are derived from the same BIM model, and each is sufficient for construction. One provides significantly more annotation and is graphically dense. The drawing title on the right-hand elevation includes the room name and number and which wall (E = East) the cabinetry is on. Simply reading the name of the drawing tells you where it is found on the floor plan. Using conventions commonly understood in the industry eliminates the need for much annotation. For example, it is not necessary to annotate for the contractor what BASE CABINET & DRAWERS or WALL CABINETS are, and typical cabinet door and drawer units do not need to be flagged using section marks or otherwise notated. Dimensions are also not required when listing modular sizes. Intelligent information is in the BIM elements, and the mounting height for the top of cabinets, 7’–0” A.F.F. can be set as a default for all cabinetry. Where helpful, information shown on other drawings may be shown for context or dimensionally located but does not need to be annotated again (e.g., accessories like paper towel dispensers, type of plug outlets, overall room dimensions, ceiling heights). Partition tags note the wall material, and the door schedule provides door size. The wall base is scheduled elsewhere.

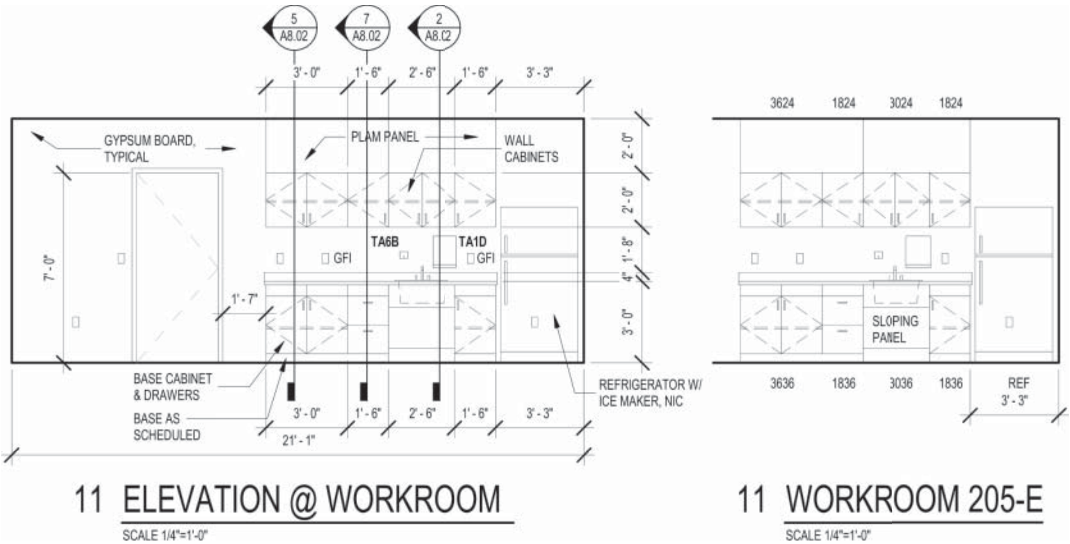


FIGURE 8.11 Cabinetry shown two different ways.

Projects may have multiple sheets of interior elevations, and the savings in time spent to annotate, review, and coordinate can be greatly reduced. Systems documentation is commonly used for partition types, a sheet typically composed of 2D drawings that includes each type of interior partition with all components germane to the wall's composition, for example, materials with their thicknesses and spacings. Graphically tagging the type of partition only on the floor plans makes them easy to understand and follow. Larger-scale plan or section details that delineate the same interior walls need not reidentify the individual components but can instead say PARTITION AS SCHEDULED (Figure 8.12).

The concept of default scheduling (reference *The Architect's Handbook of Professional Practice, 15th Edition, Chapter 10.6 Construction Drawings*) can be layered onto systems such as these to provide the contractor the rules of the system and to establish defaults: EVERYTHING IS "X" U.N.O. – UNLESS NOTED OTHERWISE. The architect's job then is to find and note the exceptions to the rule.

Adding the following three notes to a partition types system greatly reduces the amount of tagging needed on floor plans with no loss of clarity or intent:

- ALL PARTITIONS ARE TYPE 3A, U.N.O. (3A is defined on the partition types sheet)
- MISCELLANEOUS NON-RATED CHASES ARE 5/8" GYPSUM BOARD OVER 2 1/2" METAL STUDS, U.N.O.
- MISCELLANEOUS FURRING AT STEEL AND CONCRETE COLUMNS IS 5/8" GYPSUM BOARD OVER 1 5/8" METAL STUDS, U.N.O.

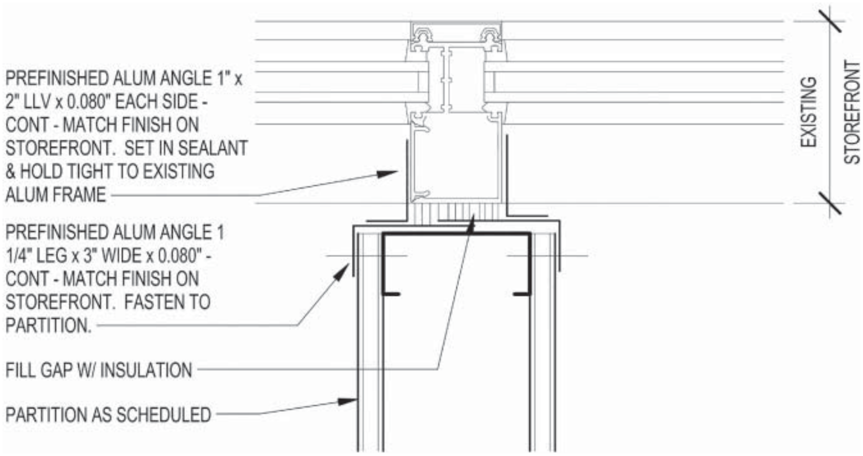


FIGURE 8.12 Partition as scheduled.

A mistake often made with BIM is to confuse accurate modeling practices with the need to repetitively annotate everything. This seems to be a natural tendency and may require intervention by more senior staff members to stop the practice before it gets out of hand!

Redundancy will never quite be eliminated from our documents. But a concerted effort to consider what information we show and where and how we communicate that to contractors and building code officials can go a long way to making documents that are more user-friendly and easier to produce. This also has a benefit to the firm's bottom line.

25% OFF

Most in firm leadership today are aware of continued fee pressures and the complexities of delivering work. It is surprising then that so little attention is given to planning and shaping how we work to minimize waste of our time or effort.

Recognizing that many design firms are content to continue working as they always have, a coupon is provided here for consideration (Figure 8.13). The design and layout can be adapted to a specific firm. It is intended to be shared with clients and used with proposals and other marketing efforts to highlight the firm's willingness to go the extra mile and do what is not required or even needed! Recent projects should be reviewed beforehand to determine the correct percentage of inefficiency to offer. The results may be surprising.

FIGURE 8.13 Firm coupon.

Enjoy the coupon. You may know of a firm that could benefit from using it!

MANAGING VARIATION

Are there better ways to document and what does that look like? Does the BIM environment and modern workflows reduce or eliminate the need for 2D drawings and documentation altogether? These are good questions we will try to address in this section.

Several documenting systems are described here. We recognize that professional practice changes over time, and these may no longer be used at some point – at least in their current form. We share them to highlight the ideas underpinning the efficient workflows and how information can be organized and presented.

Lean has great applicability to manufacturing as those processes are static with significant repetition. Squeezing a few minutes or seconds from a process that repeats thousands or millions of times creates a savings that can be quantified. The design and documentation of buildings is indeed different, but Lean and other process management approaches can still bring benefit. Buildings are composed of many building systems, including interior partitions, MEP systems, doors, cabinets, and interior finishes. Even though they are placed differently for each project, the effort of working through them by drawing, modeling, and coordinating typically involves similar, repetitive steps. Those steps along with the large amounts of repetitious information found on each project can be systematized into workflows that reduce mistakes and require less effort to annotate.

THE COSTS OF MANAGING VARIATION

There is a sense in which the appearance of complexity bespeaks sophistication and value. However, the opposite is true in situations where it gives no added benefit.

On an approximately 70 000 ft^2 municipal building, the structural drawings included a schedule with 174 grade beam types. The construction manager noticed that most were essentially the same design, with only minor differences; others were identical but nonetheless tagged sequentially. The engineer's response when questioned about this apparently unnecessary complexity was, *That's what the computer gave us*.

Upon further examination, 50 different beam designs were found, but with only slight adjustments to rebar sizes they were reducible to just 17 different beams. Feedback from foundation contractors bidding the work indicated they would be overwhelmed with jobsite coordination and checking and would need to hire a separate project manager just to manage grade beam variation – an added cost for no real value.

Unnecessary complexity leads to increased costs for time spent managing variation. This is true both for the contractors who must estimate and then put the work in place and for designers who manage the documents during construction.

Simplicity in documentation can be achieved in part by leveraging the inherent visual information of lines and drawing elements by virtue of accepted industry nomenclature. The examples in Figures 8.18–8.20 were originally developed with presentation software using only lines and shapes. Recognizing the enthusiasm over the ability to assign data to modeled elements, let us not forget that elements simply drawn already possess informational qualities just by their shape, placement, or orientation. This is a powerful means for use in communicating with document users.

The two lines indicated in Figure 8.14 can represent many things, and depending upon who is asked the answer will vary. A civil engineer might think they are a road or sidewalk, a mathematician may describe them as two parallel lines, and a school-age child could say, *Two lines*. An architect or contractor would likely say they are a wall.

Supplementing the two lines with other elements including additional sets of intersecting parallel lines, an arc with connecting straight lines and various rectangles reveals a layout that is understandable by any designer or contractor. Each of the elements in Figure 8.15 could be part of a BIM model with embedded parametric data, but by virtue of their shape and placement they disclose basic information about what they are – walls, a door, and a cabinet with sink. That visual depiction itself can be used to convey essential information. We recognize them as they are displayed using conventional industry accepted symbols and in a familiar context: (a) the small rectangle within the larger one is understood to be a sink (and not a tablet computer); and (b) the semicircle with two straight lines is known to be a door.

FIGURE 8.14 Only two lines.

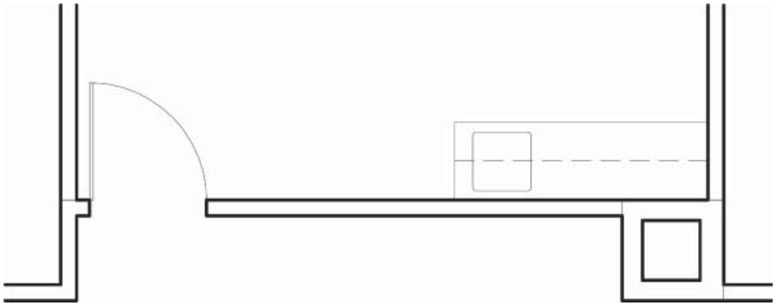


FIGURE 8.15 Inherent graphical information.

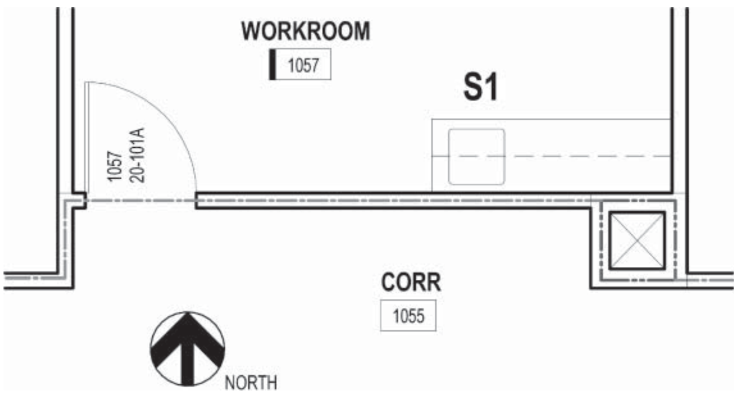


FIGURE 8.16 Further clarity using minimal text.

Adding a limited amount of annotation (Figure 8.16) indicates that yet another level of understanding is possible: some of the partitions are fire rated; the usage of spaces is defined, and north is *up*.

As an observation, architects and engineers can leverage basic graphics and symbology to convey surprising amounts of project data to contractors and to schedule building systems, reducing the graphic density of documents and enhancing comprehension.

Default Referencing

Default referencing is a term coined by Grant A. Simpson, FAIA. It is a methodology that looks at the repetitious elements of a building to see what is in common and how to leverage what is typical when scheduling. One approach is to create rules that apply across the project, such as ALL CABINETRY IS PLASTIC LAMINATE CLAD, U.N.O. or ALL PARTITIONS ARE TYPE X3, U.N.O. In both cases, the very act of modeling or drawing these components visually schedules the work and may not require any annotation. Our task is to identify and document only the cabinets and partitions that do not meet these rules

Scheduling Systems

Default referencing can be used to create graphical scheduling systems by utilizing repeating elements or groupings that are then referenced in way that is easy to see and understand. The plumbing fixture types system covered later in this chapter falls into this category.

Building elements that can be easily scheduled by using a systems approach include interior finishes, seismic and nonseismic partition types and standard details, doors and standard details, plumbing fixtures with toilet accessories and toilet room layouts, cabinetry (with sections, notes, and interior elevations and rules for drawing and modeling), exterior wall and roof types (just like partition types), seismic and nonseismic reflected ceiling plan (RCP) standard details, and metal fabrications for countertops, walls, ladders, door supports, bollards, and so forth.

Visual Quality Control

It is advantageous to look at a set of drawings and have the mistakes reveal themselves by virtue of how the drawing elements are shown in context with other elements. An important corollary is how the lack of information on a drawing or a model can be a purposeful clue and means to indicate there are decisions yet to be made or needed information is lacking.

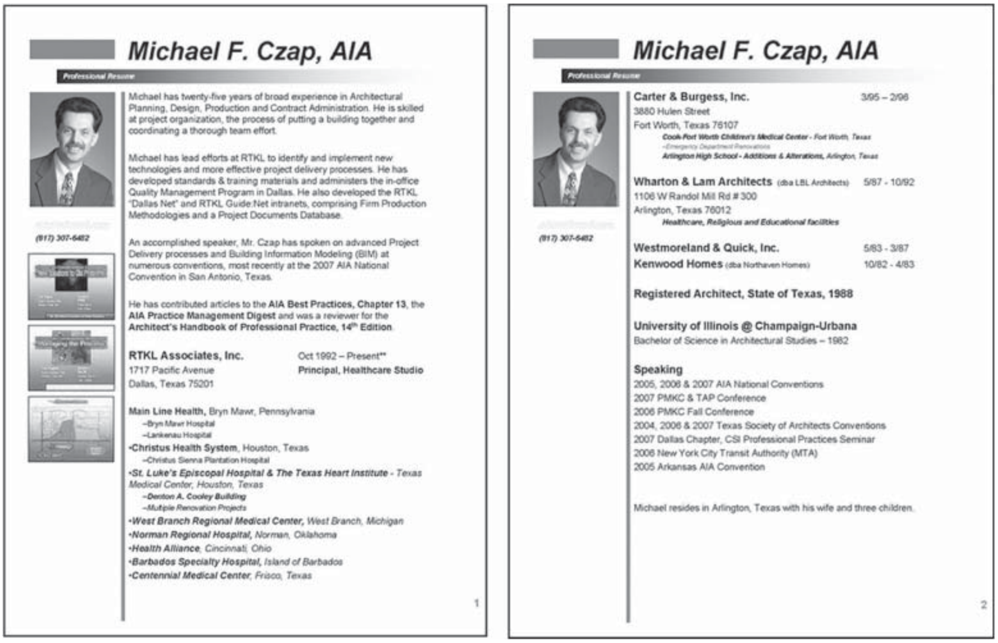
Organization

> **The organization and presentation of information are almost as important as the information itself.**

Figure 8.17 shows a good resume from around 2011: two pages containing a photograph, images, simple graphics with a succinct description, educational background, and experience. But can we make this document communicate more clearly by changing how the information is organized?

Figure 8.18 shows the same resume, only now rearranged over five pages and organized by uppercase and lowercase letters (e.g., A, a, B, b, C, c) plus numbers, punctuation, images, and simple graphics. There is quite a bit of white space, but it can be argued that this is a more logical arrangement and that the grouping of like elements makes common sense. While this methodology is indeed plausible, the message has been lost due to the loss of context between individual elements. There is a difference between seeing information as something to be sorted and considering it as a medium itself to deliver a message.

We have observed that this approach is how many architects organize their documents! Drawings and schedules are scattered across multiple sheets, organized into broad categories such as plans,



Michael F. Czap, AIA

Professional Resume

(817) 307-6482

Michael has twenty-five years of broad experience in Architectural Planning, Design, Production and Contract Administration. He is skilled at project organization, the process of putting a building together and coordinating a thorough team effort.

Michael has lead efforts at RTKL to identify and implement new technologies and more effective project delivery processes. He has developed standards & training materials and administers the in-office Quality Management Program in Dallas. He also developed the RTKL "Dallas Net" and RTKL Guide.Net intranets, comprising Firm Production Methodologies and a Project Documents Database.

An accomplished speaker, Mr. Czap has spoken on advanced Project Delivery processes and Building Information Modeling (BIM) at numerous conventions, most recently at the 2007 AIA National Convention in San Antonio, Texas.

He has contributed articles to the **AIA Best Practices, Chapter 13**, the **AIA Practice Management Digest** and was a reviewer for the **Architect's Handbook of Professional Practice, 14th Edition**.

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Main Line Health, Bryn Mawr, Pennsylvania
–Bryn Mawr Hospital
–Lankenau Hospital
•**Christus Health System**, Houston, Texas
–Christus Sienna Plantation Hospital
•***St. Luke's Episcopal Hospital & The Texas Heart Institute*** *- Texas Medical Center, Houston, Texas*
–Denton A. Cooley Building
–Multiple Renovation Projects
•***West Branch Regional Medical Center,*** *West Branch, Michigan*
•***Norman Regional Hospital,*** *Norman, Oklahoma*
•***Health Alliance***, *Cincinnati, Ohio*
•***Barbados Specialty Hospital,*** *Island of Barbados*
•***Centennial Medical Center***, *Frisco, Texas*

1

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Professional Resume

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Arlington High School - Additions & Alterations, *Arlington, Texas*

Wharton & Lam Architects (dba LBL Architects) 5/87 - 10/92
1106 W Randol Mill Rd # 300
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Healthcare, Religious and Educational facilities

Westmoreland & Quick, Inc. 5/83 - 3/87
Kenwood Homes (dba Northaven Homes) 10/82 - 4/83

Registered Architect, State of Texas, 1988

University of Illinois @ Champaign-Urbana
Bachelor of Science in Architectural Studies – 1982

Speaking
2005, 2006 & 2007 AIA National Conventions
2007 PMKC & TAP Conference
2006 PMKC Fall Conference
2004, 2006 & 2007 Texas Society of Architects Conventions
2007 Dallas Chapter, CSI Professional Practices Seminar
2006 New York City Transit Authority (MTA)
2005 Arkansas AIA Convention

Michael resides in Arlington, Texas with his wife and three children.

2

FIGURE 8.17 Two-page resume.

FIGURE 8.18 Five-page resume.

sections, elevations, and details. Document users must search across various two-dimensional drawings that provide partial depictions of the work themselves and then aggregate the information together to gain a three-dimensional understanding of the whole. Structuring information to instead provide a complete picture or portrayal is an important aspect of good visual communication.

LEVERAGING GRAPHICS AND TEXT FOR INCREASED UNDERSTANDING

Signage consulting has developed into wayfinding, an art and science where creative professionals use signage and graphics to help people understand where they are and how to navigate through a facility or campus they are unfamiliar with. In our flattening world with international teams and projects, it is not uncommon for people from around the globe to either contribute to or use our documents. Graphical information can transcend cultural and language differences to better communicate ideas, instructions, and intent. The design professional's use of graphics, text, and numbers in documents can serve a purpose similar to wayfinding.

PERCEPTION

People perceive information several ways. In Figure 8.19, the same item of information is shown three different ways. Which do you recognize most easily?

FIGURE 8.19 Perception: graphics, text, and numbers. *Source:* Grant A. Simpson, FAIA and Michael F. Czap, AIA

The international symbol for *No trucks* is a graphic that is readily understood, regardless of the country or language spoken. The grouping of letters is comprehended without difficulty by English readers because words are recognized as a whole and not as individual letters. The numbers are meaningless unless you are told that they are used with a telephone keypad to spell *No Trucks*. A secondary mental exercise is necessary to associate the two. Numbers are perceived individually with a few exceptions.

This example provides insight that architects and engineers can use to become better communicators of their ideas and with their deliverables.

Simplicity

IKEA sells a large variety of products across the world, and many items require final assembly by the purchaser. IKEA typically includes one-page instruction sheets that graphically coach the buyer on how to put the item together. Using simple drawings that transcend culture and language, they clearly delineate what is in the package, list what tools are required, and then proceed to illustrate the assembly process step by step. Why do they do this? As a multinational retailer with a global presence, they do not want the purchaser to have to call a telephone number or otherwise increase their cost of business with questions. Our observation is that many architects could turn the one-page instruction sheet into a dozen sheets or more!

WORKING IN CONTEXT

The twenty-first century may well be remembered as the time when global connectivity became the norm, bringing with it a tsunami of information. The Internet provides access to a repository of almost unlimited content that continues to increase. Cellular and Wi-Fi networks extend connectivity almost everywhere. We are bombarded daily with e-mail, text messages, and many forms of media, and our smartphones ping and display notifications from apps clamoring for attention. It requires deliberate effort on our part to discern what is valuable amid the noise created by the sheer volume of data. Design professionals can become unwitting contributors to this problem by the ways we work and how we communicate to the users of our products – estimators, field superintendents, subcontractors, clients, and code officials, to name a few.

> **Working in Context is a process to simplify the preparation of and augment the understanding of drawings. It is based on the premise that the organization and presentation of information is as important as the information itself. It is both analogous to defragmenting construction drawings and to telling a story. It is ensuring that the "whole is greater than the sum of the parts" by combining related drawings to create more understandable groupings of information that are more simply referenced and easier to find. (AIA, 2013, Chapter 10)**

The last 30 years have seen design professionals increasingly focused on keeping up with and incorporating the newest technologies. Somewhere along the way we have forgotten the fundamentals of good visual communication. Too little thought is given as to how to best share information in a manner that is useful by the ultimate document users. It is like *Where's Waldo*, where it is difficult to distinguish what is useful from the visual clutter and graphic density created by superfluous information.

Working in context (WIC) is another term coined by Simpson to describe an approach used extensively in an earlier time by our forebears in the industry. Partly driven by the expense of the drafting media of the day – sheets of linen – draftsmen cleverly created drawings and organized them in simple ways to convey both scope and complexity.

Placing related drawing elements (plans, sections, and elevations) into meaningful groupings together can graphically tell the story of complex areas or entire building assemblies. The drawing shown in Figure 8.20 is from a multistory building that was designed and drawn in the early 1920s.

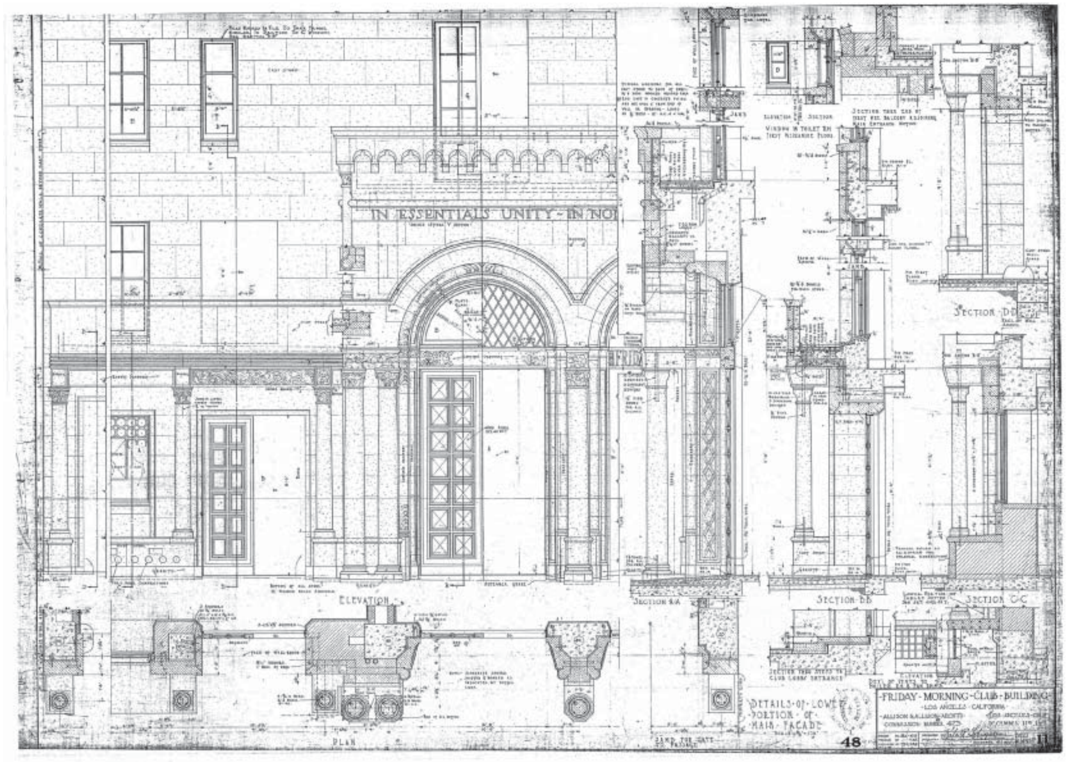


FIGURE 8.20 Friday Morning Club. *Source:* The Internet Archive.

On this sheet a portion of the main entrance façade is drawn. While difficult to read at the scale for publication, the letters A, B, C, and D denote wall section cut locations on the elevation with the corresponding sections placed to the right. Enlarged plan details of the pilasters are located directly below where they occur on the elevation. By colocating related content on the same sheet, it eliminates the need for a referencing system almost completely. Document users do not have to look back and forth across multiple sheets to compare drawings, and the story of this part of the building becomes a little easier to see.

The following headings demonstrate approaches that will help convey information in context.

Intuitive Sheet Organization

It is difficult to Peer Review (or QC Review) a sheet with information scattered about. Here are suggested ways co-locate related content.

- Locate Legends and Schedules on the same sheets where they are referenced. As contrasted to a poor example: Toilet Accessories are listed on the cover sheet and referenced 22 sheets later.
- Locate related information together

- Put Enlarged Plans for Stairs with Sections, and Details together on the same sheet.
- Can the floor plans be almost sufficient to build everything using them – with Plan Details nearby?
- Can RCP's convey virtually all ceiling related info – right there?
- Can Interiors plans, schedules, and legends be co-located together?
- Can Sections and Section details be near each other?
- Can Interior Elevations and Enlarged Plans be intermixed?

Descriptive Titles

Other than the sheet number itself, the drawing number and title are likely the first items that a document user is scanning the sheet for. They should be large enough to be easily read and provide an indication of what the drawing is.

- H/J/S @ DOOR 254 instead of DETAIL
- ELEV @ WORKROOM versus WORKROOM 205-E
- SCUPPER DETAIL instead of DETAIL
- STAIR NO. 3 PLAN versus a generic STAIR PLAN or ENLARGED PLAN

One of the most powerful words used by designers is typical. Adding it to any title indicates that the drawing applies to multiple situations, even when not specifically referenced.

- TYPICAL WALL E.J. COVER
- SECTION @ WARDROBE UNIT - TYPICAL

COLLECTIVE PROCESSES

Processes serve a purpose to bring consistency to our efforts and to leverage knowledge across projects and teams. Like BIM or CAD standards, they can become an end unto themselves and a potential project delivery hindrance. They must be reviewed from time to time with an eye to changing technologies and always asking if there is not a better way. Processes should be *adaptable* to clients and projects. In fact, the very act of process adaption can yield fresh insight into how to do something better and may change the process itself – if we are paying attention.

When every team uses the same or similar processes it brings an advantage in producing the work, the review process, and familiarity for those doing construction administration.

Every Firm Needs a Template

BIM, out of the box, is like starting with a blank sheet of paper, a Leroy lettering kit, or the old plastic circle templates. (If you are unfamiliar with any of these terms, just ask an architect over age 50.)

A customized BIM (or CAD) template allows implementation of basic drafting standards across the company. If it is in the template, most likely staff will use it. (For more on this, see "Defenders of the Old Ways" in Chapter 9.) Many resources cover the topic of templates and implementation, so we will not get into all of that but will focus on some basic philosophies. The main takeaway is that the template is not a trivial item to overlook in Lean delivery.

The ideal starting point for a customized template, in our opinion, includes:

- Linetypes
- Text Styles
- Dimension Styles
- Symbols and Tags
- Prototypical System Sheets such as Partition Types, Door Types, etc., and General Series sheets
- Schedules for items such as: Interior Finishes and Materials, Doors, Equipment, and Toilet Accessories

A firm template allows for new projects to be started with consistency. Without one, there is little likelihood that the project's drawings will look as though they are produced by the same firm.

We have experienced two viewpoints on how much a template should be populated with. It is somewhat dependent on the size of the firm: (1) a lightweight template includes the minimum collateral to start a project, such as the previous list; and (2) a heavyweight template includes the previous list along with prepopulated standard sheets with details and prototypical system sheets.

A smaller firm with a focus on a specific building type, such as residential or light commercial, might choose the heavyweight template as their work is more focused around repetitively used items and adaptable systems. Examples include roofing system details, exterior wall system details, stair details, finish details, toilet room types, waterproofing systems, and kitchen cabinets. Anything not used or needed can be purged from the model, known as a subtractive process.

A medium-size to large firm may be more specialized in nature and focus on a healthcare, office, multifamily, or interiors projects, for example. With this many different project types, a lightweight template will allow for firm standards to be consistent across studios. Practice area specific details and systems can be inserted from a separate BIM source file or container file specific to the practice. Doing this keeps unnecessary collateral out of the model. This is called an additive process.

One thing to look out for is that whatever ends up in a template needs to be agreed to by the firm's documentation standards committee (if one exists) or else it may not be successfully implemented. (For more on this, see "Develop Resources" in Chapter 9.)

PROTOTYPICAL SYSTEM SHEETS

Any intelligent fool can make things bigger and more complex. It takes a touch of genius – and a lot of courage – to move in the opposite direction.

—Albert Einstein

Prototypical system sheets are developed to simplify CD documentation. They can also be issued with conceptual and early design document sets, establishing a level of quality that influences cost estimates. System sheets embed good practice and building systems knowledge into preassembled sheets that are user-friendly and easy to understand and implement. They consist of prearranged and precoordinated 2D drawings and notes and are combined with a workflow to address the majority of conditions found for a given building system and employ a simple tagging nomenclature. There is no value in spending time recreating the same content for each project. It is important to avoid developing overly complex systems that try to cover every possible situation, but instead to utilize separate drawings for complicated or atypical conditions. Architects will still need to think through related project issues but can expect a time savings producing and checking documents.

Objectives

Leverage knowledge across the office by building it into the firm's template. There is no value for multiple teams to research the same building systems and components over time. Conduct the research once, analyze it at a senior level, and build that into a system sheet. You will need to periodically review for industry or product changes.

Also, develop companion workflows for managing repetition. These should be captured in a document such as the systems packets described next. It's important to provide specificity where it counts and be general otherwise and to provide precision and control only where needed.

Visual QC is a goal here, too. This is a form of mistake proofing where simply looking at drawings reveals errors.

Building Systems That Can Be Prototyped

While each building system tends to be unique in its application to a project's design, the systems themselves remain largely the same job to job: partitions, toilet accessory and accessibility clearances, interior finishes, roofs, doors and windows, cabinetry, exterior walls (like partitions), demolition information, RCPs, fire stairs, elevators, metal fabrications, and loading docks and equipment. For example, the partition layout and wall construction itself can vary quite a bit from one project to another due to the type of building, plan layouts, locations of rated partitions, and the types of partitions used. However, the processes to think through and document the partitions is the same, and that is where we can realize efficiencies. Developing a partition types scheduling system is relatively straightforward, and once in place, just like manufacturer's, we can begin to look for ways to further streamline its application. Our goal is to make it as simple as possible for the architects to perform the work of placing walls and annotating and to be readily understandable to code officials performing a review and the contractor who is bidding and constructing.

Plug 'n Play

System sheets help us concentrate on specific areas of documentation, but similar thinking can apply to an entire set of drawings. Prepopulated, insertable prototype sheets offer the prospect to create a baseline set of managed content and common format that are easily deployed through a studio, office,

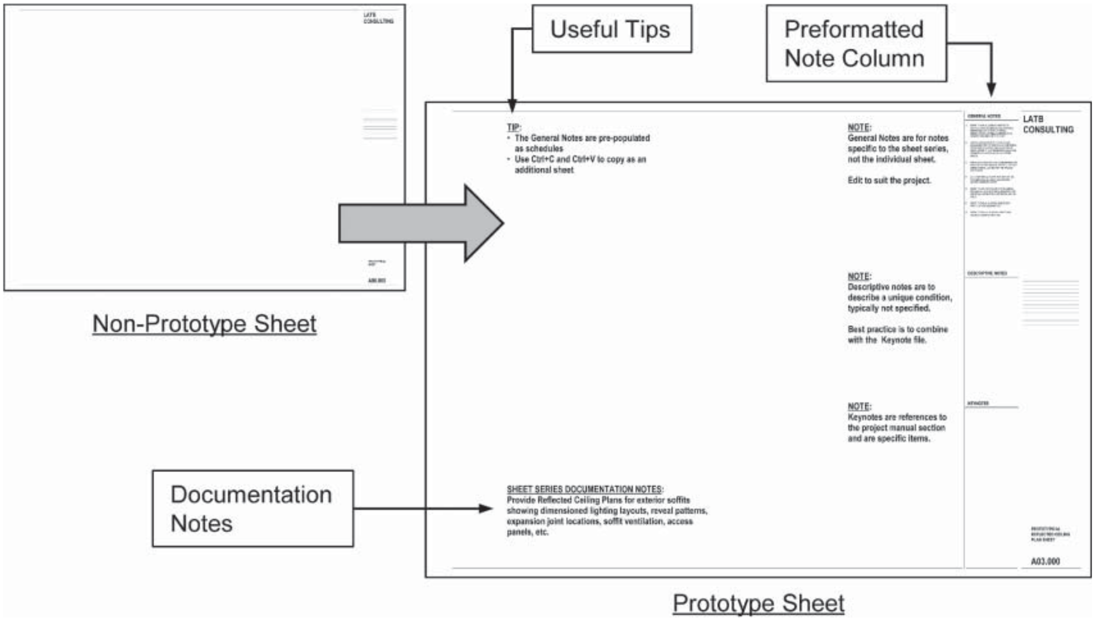


FIGURE 8.21 Plug ‘n play.

or entire firm. Prototype sheets can be part of a heavyweight template or can be maintained as a plug ‘n play resource to be used in conjunction with a lightweight template.

The implementation of prototypes can have the following benefits. First, they provide consistent deliverables by reducing variation among common content. Examples include preformatted sheet titles and numbering as well as common sheet organization of notation. Second, they increase productivity by saving time versus manually creating a sheet with content. Systems sheets may also be included in the prototypes. Third, they allow for knowledge distribution using explanatory notes that provide guidance for less experienced staff and those new to the firm.

Once exposed to the methodology behind the use of these sheets, staff will experience a quicker way to populate their project that follows documentation guidelines. Figure 8.21 illustrates a blank sheet and a developed prototype sheet.

To take this concept a step further, entire prototype sets for various project types and practice areas can be maintained to make it easy to set up unique documentation requirements for different building types.

Example Prototypical System: Plumbing Fixture Types

Following is an in-depth discussion of one prototypical system, plumbing fixture types, to illustrate the thinking behind analyzing a building system and trying to leverage research and knowledge to create a Lean process with the ability to quickly document with accuracy.

Almost every project includes restrooms composed of plumbing fixtures and toilet accessories that need to be documented with close attention to meeting accessibility requirements. In the 30 years since the Americans with Disabilities Act of 1990 (ADA) was signed into law in the United States and officially published as the 1991 ADA Standards for Accessible Design, projects are still issued with errors and inconsistencies that lead to problems with compliance in the field. To compound this, the fixtures and accessories must be usably arranged, scheduled, and dimensioned.

We will consider this a case study to compare how countless architects traditionally address this work and how a Lean process might lead to improvements.

Analysis

- Need: convey toilet room sizes, fixture locations, and accessories to comply with accessibility requirements where applicable
- What does not change: good practice and accessibility criteria
- What changes by project: the room layout and orientation
- Goal: simple referencing on drawings
- Goal: consolidate redundant and typically scattered information onto one sheet

Result

- Solve: what is required for design and layout
- Document: what the contractor needs for bidding, preparation of shop drawings, and construction

Example

Figure 8.22 is a good example of how restrooms are documented by many firms.

Traditional Process

There is some variation, but most projects will do something like this:

- Draw and model correctly.
- Create enlarged toilet plans for each restroom.
  - Dimension overall restroom and tag partitions as needed.
  - Dimension all fixtures horizontally.
  - Tag and dimension horizontally all toilet accessories.
- Create interior elevation of the walls with fixtures or cabinetry.
  - Dimension all fixtures vertically (e.g., water closet seat heights, sink clearance).
  - Tag and dimension vertically all toilet accessories.
- Create the toilet accessibility schedule.
- QA/QC: How do we know that accessibility clearances are correctly documented? Check each instance to verify with ADA, American National Standards Institute (ANSI), or other applicable standard.

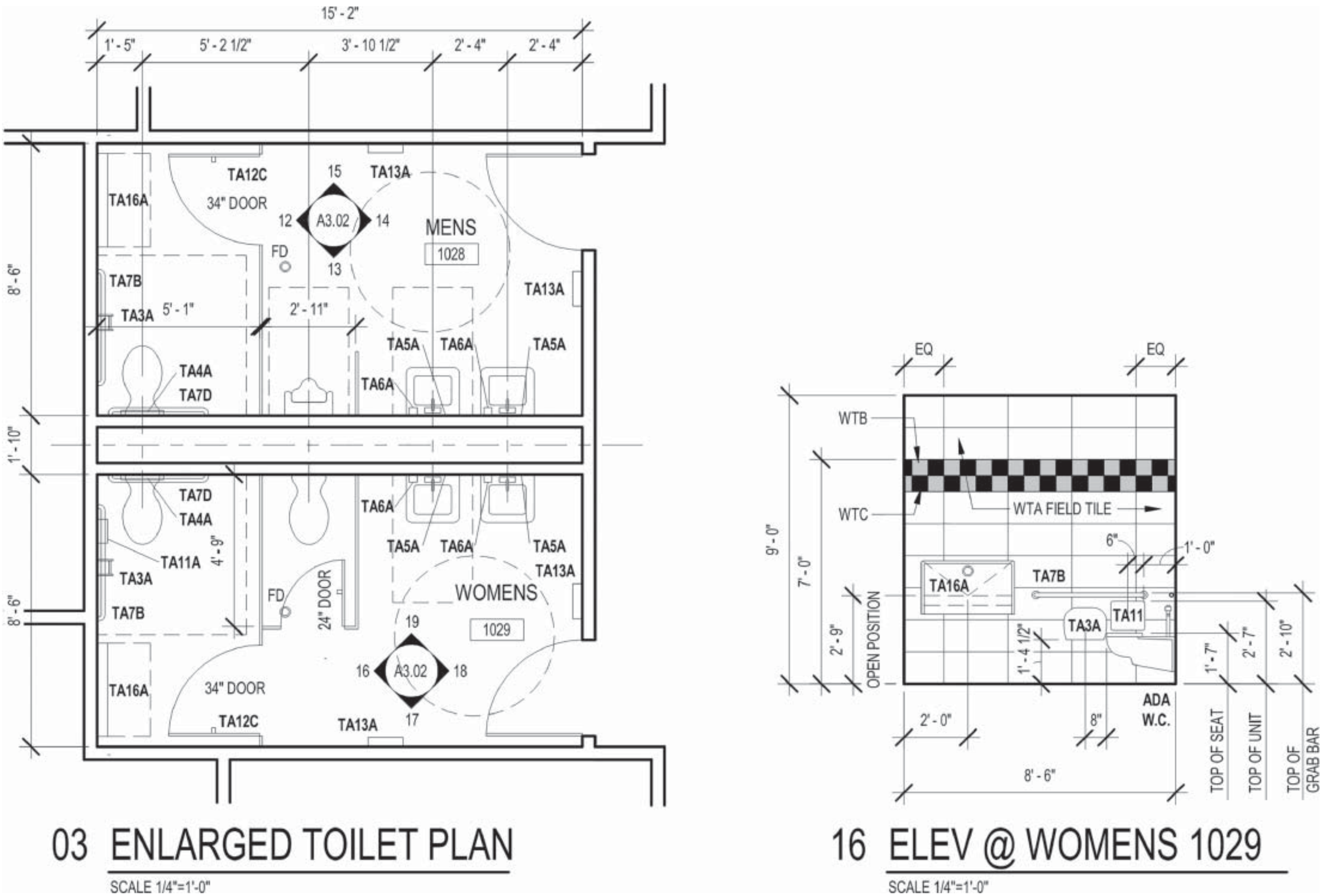


FIGURE 8.22 Toilet room layout: traditional.

Observations

Often, the needed information to bid and do the work is scattered throughout a set of drawings, requiring a contractor to reference multiple sheets to piece together the relevant work. Each plumbing fixture is considered as one of a kind with repetitive tagging and dimensioning of the same elements. The same elements are tagged a second time in elevations, and vertical dimensioning repeats information typically found on the MOUNTING HEIGHTS schedule. This duplication requires time to annotate and review and introduces opportunity for error. Information is located all over the set of documents. For example, mounting heights are located in the G series of sheets; enlarged plans are in the A3 series; interior elevations are in the A8 series; and toilet accessory schedules will be either in the specifications or on another sheet.

Many drawing sets include accessibility compliance sheets that have recreated drawings from the ADA and ANSI guidelines to satisfy AHJ requirements. Exercise caution as these sheets give ranges for heights and clearances and you are asking the contractor to interpret how they apply. Your project's restroom layout and design may need the contractor to install items at specific heights or locations to coordinate with architectural features such as wall tile designs or room layout constraints. For example, the 2010 ADA Standards for Accessible Design states that horizontal grab bars are to be mounted with the top of the gripping surface 33–36" above the finished floor. That 3" range may allow an unsightly result where the grab bars inadvertently straddle the border where differing tile colors meet.

On the PFT sheet (Figure 8.23) are found individual vignette plumbing fixture layouts for accessible and nonaccessible toilets, sinks, showers, and so forth with accessories tagged, fixture and accessory mounting height criteria, required clearances, and dimensions. All of this is located together on one sheet to facilitate ease of use and checking. This information is not repeated anywhere else, does not change, and does not need to be checked. The toilet accessories schedule includes preselected items and should be reviewed with project requirements. Note: this Schedule was created in CAD in 1996 and at the time of writing (2020), over 50% of the accessories remain as originally scheduled. The sheet is instructional to the BIM user as a guide when creating the layouts and for the contractor as to how the system is deployed across the document set.

This approach is not unlike how we create CAD blocks or BIM families that consist of grouped elements to be used over and over.

The system shown in Figures 8.25–8.27 was used on an 11-story, 345 000 f^2 building housing a hospital, corporate offices, and laboratories including more than 150 separate toilet rooms and hundreds of sinks. Only one drawing in the entire set of documents provided the criteria for an accessible water closet: WC1.

Figure 8.27 is a generic, single-occupant toilet room, and the T1 designation can be plugged onto 1/8" scale floor plans – with the overall room sizes dimensioned.

Lean Process – Using Prototypical System Sheet

- Draw and model correctly.
- Create enlarged toilet plans for each unique restroom layout.
  - Add dimensions and tag partitions as needed.
  - Place fixture-type marks onto the floor plans (e.g., ST2, ST3, S1) for each plumbing fixture. Note that this eliminates the need for callouts on the floor plans.

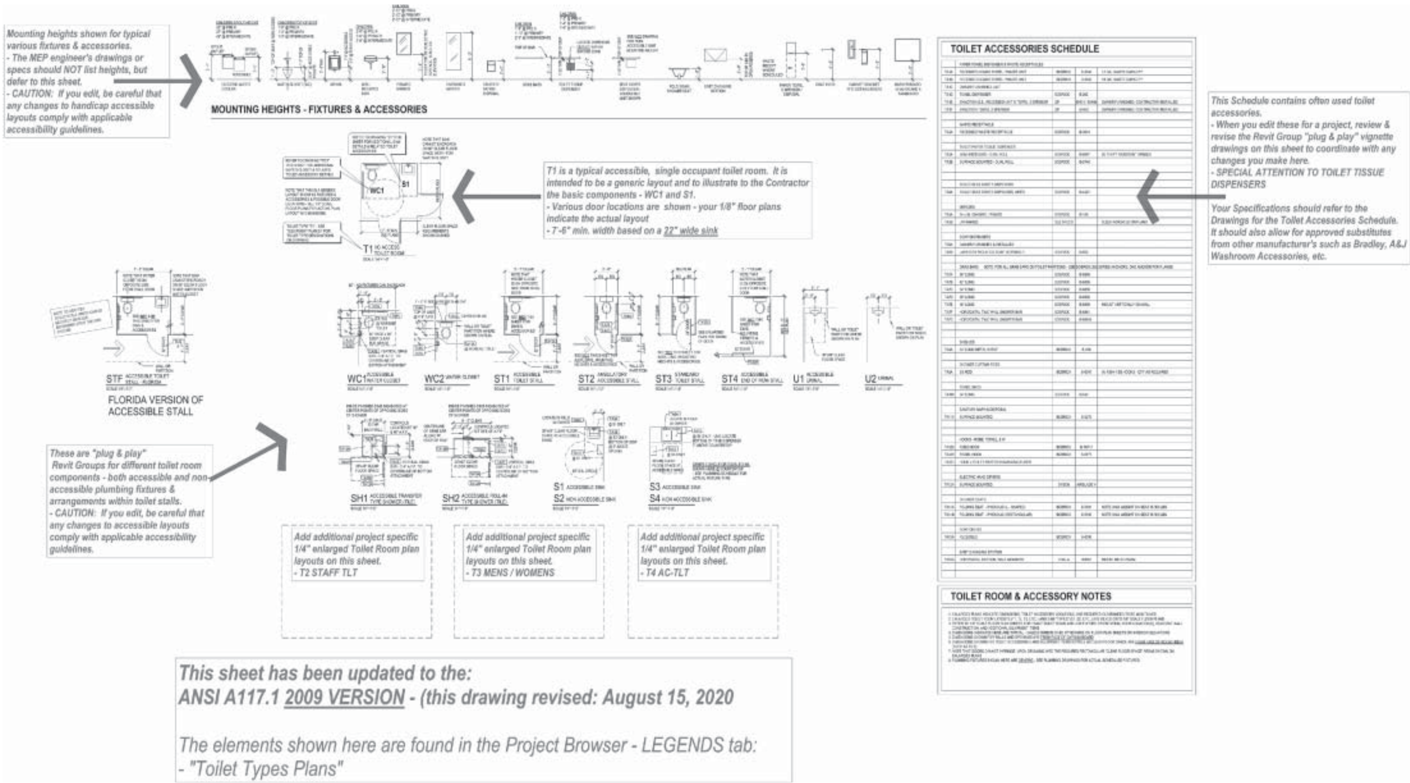


FIGURE 8.23 Plumbing fixture types systems (PFT) sheet.

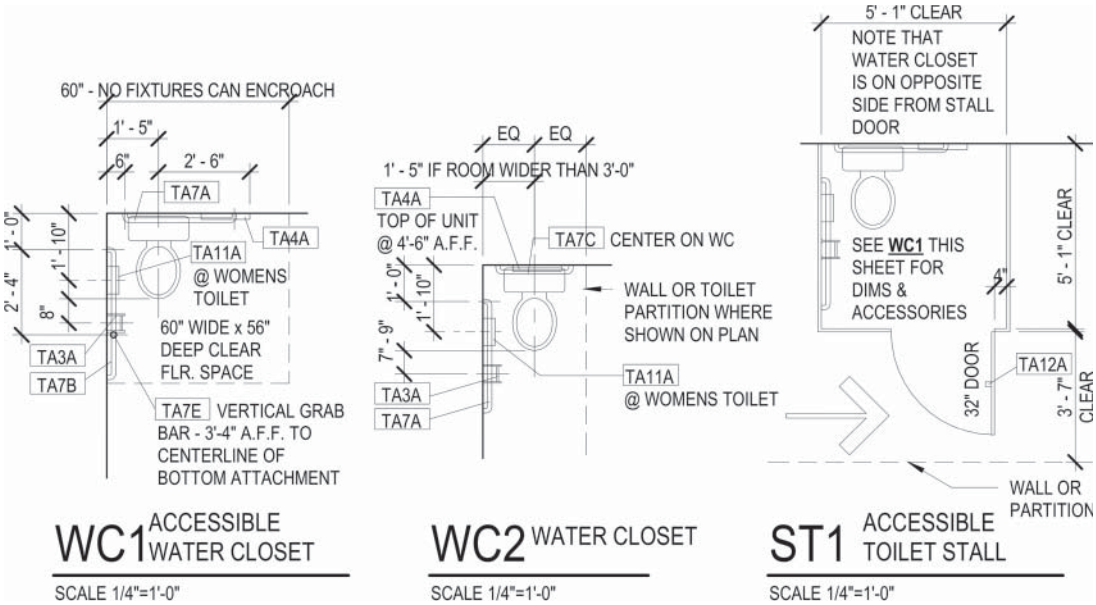


FIGURE 8.24 PFT sheet: plumbing fixture vignettes.

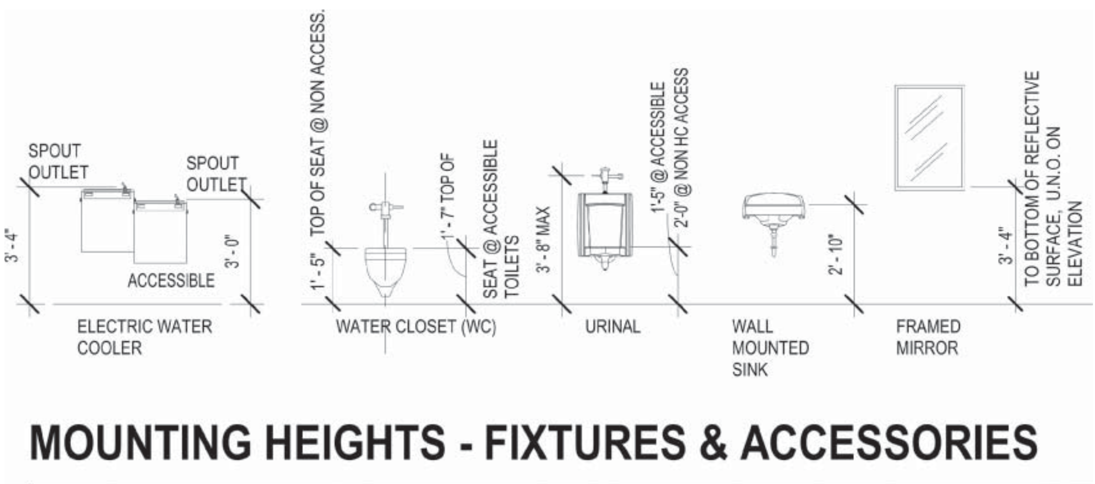


FIGURE 8.25 PFT sheet: typical mounting heights.

- Place toilet room–type marks onto 1/8" floor plans (the T4 mark from the drawing title in Figure 8.28).
- If needed, provide interior elevations for cabinetry or to indicate complex wall tile patterns. Toilet fixture and accessories are preelevated already.

TOILET ACCESSORIES SCHEDULE

	PAPER TOWEL DISPENSER & WASTE RECEPTACLES			
TA1A	RECESSED COMBO TOWEL / WASTE UNIT	BOBRICK	B-3944	12 GAL WASTE CAPACITY
TA1B	RECESSED COMBO TOWEL / WASTE UNIT	BOBRICK	B-3947	18 GAL WASTE CAPACITY
TA1C	OWNER FURNISHED UNIT			
TA1D	TOWEL DISPENSER	BOBRICK	B-262	
TA1E	ENMOTION S.S., RECESSED UNIT & TOWEL DISPENSER	GP	59491 / 59466	OWNER FURNISHED, CONTRACTOR INSTALLED
TA1F	ENMOTION TOWEL DISPENSER	GP	59462	OWNER FURNISHED, CONTRACTOR INSTALLED
	WASTE RECEPTACLE			
TA2A	RECESSED WASTE RECEPTACLE	BOBRICK	B-3644	

FIGURE 8.26 PFT sheet: toilets accessories schedule.

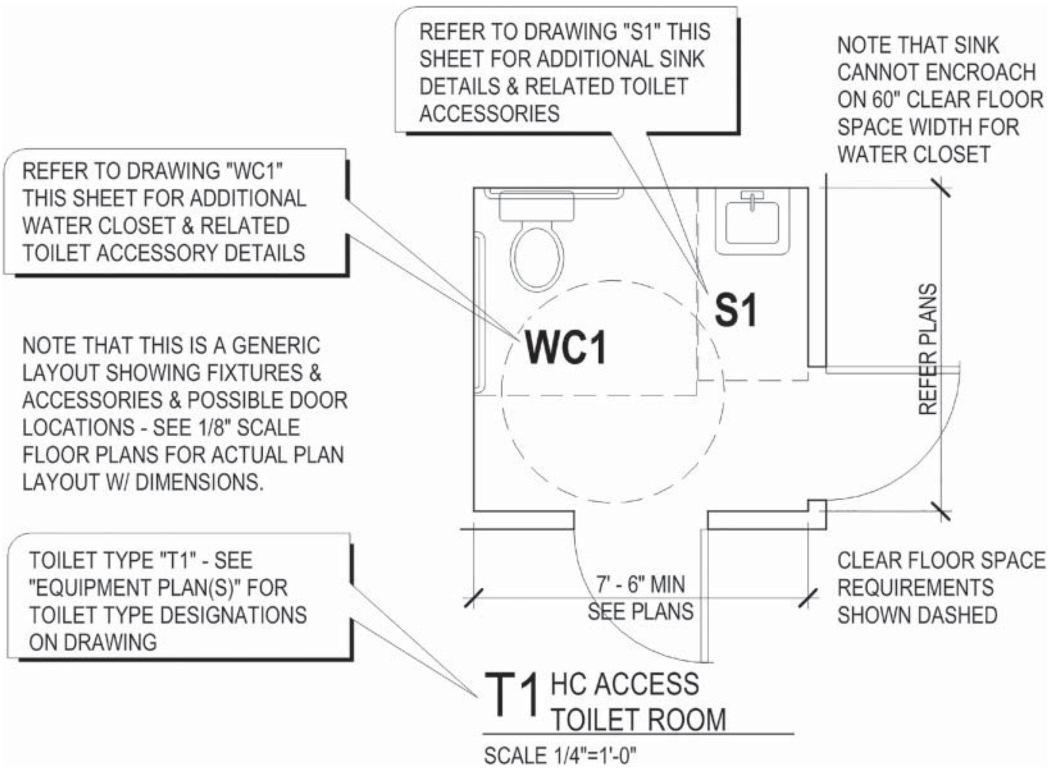


FIGURE 8.27 PFT sheet: T1 instructional layout.

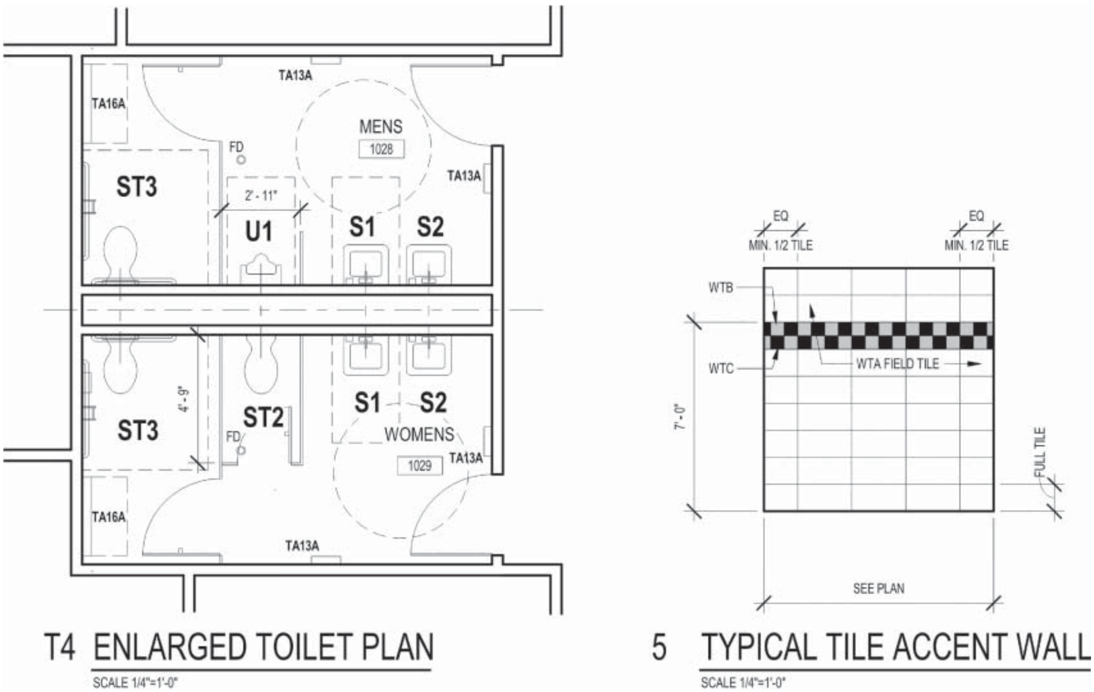


FIGURE 8.28 Streamlined toilet room layout.

All the enlarged plans are located together onto the edited PFT sheet (Figure 8.29). This enables QA/QC to become an integral part of the daily work and less of a separate endeavor as mistakes become easier to spot. In addition, the co-location of content makes it easy to review in the office and for contractor's bidding and installation in the field.

The drawing in Figure 8.30 is relatively uncluttered and easy to understand. Note how the T7 PFT mark uses extra tall and bold text. It is easy to see and it eliminates the need for a drawing callout as all enlarged plans are located together on the PFT sheet (Figure 8.31).

You will recall in the PFT example that we eliminated callouts on the 1/8" scale floor plans for the enlarged toilet rooms. How does the contractor make the connection that the PFT mark indicates where to find the enlarged plan? A floor plan key reference drawing as shown in Figure 8.32 can be included in the G sheets at the front of the set along with drawing and material legends. It is contractor friendly and provides guidance on where to find information.

Summary

Note that while the use of prototypical system sheets is a big idea, trying to use systems such as these without understanding the nuances of how they work or adequately thinking through project issues will result in errors. While it is important to document building systems such as toilet accessories and accessibility requirements correctly, surely our time and attention are better spent elsewhere. The effort invested developing systems like this allows the design professionals time to be better spent solving the

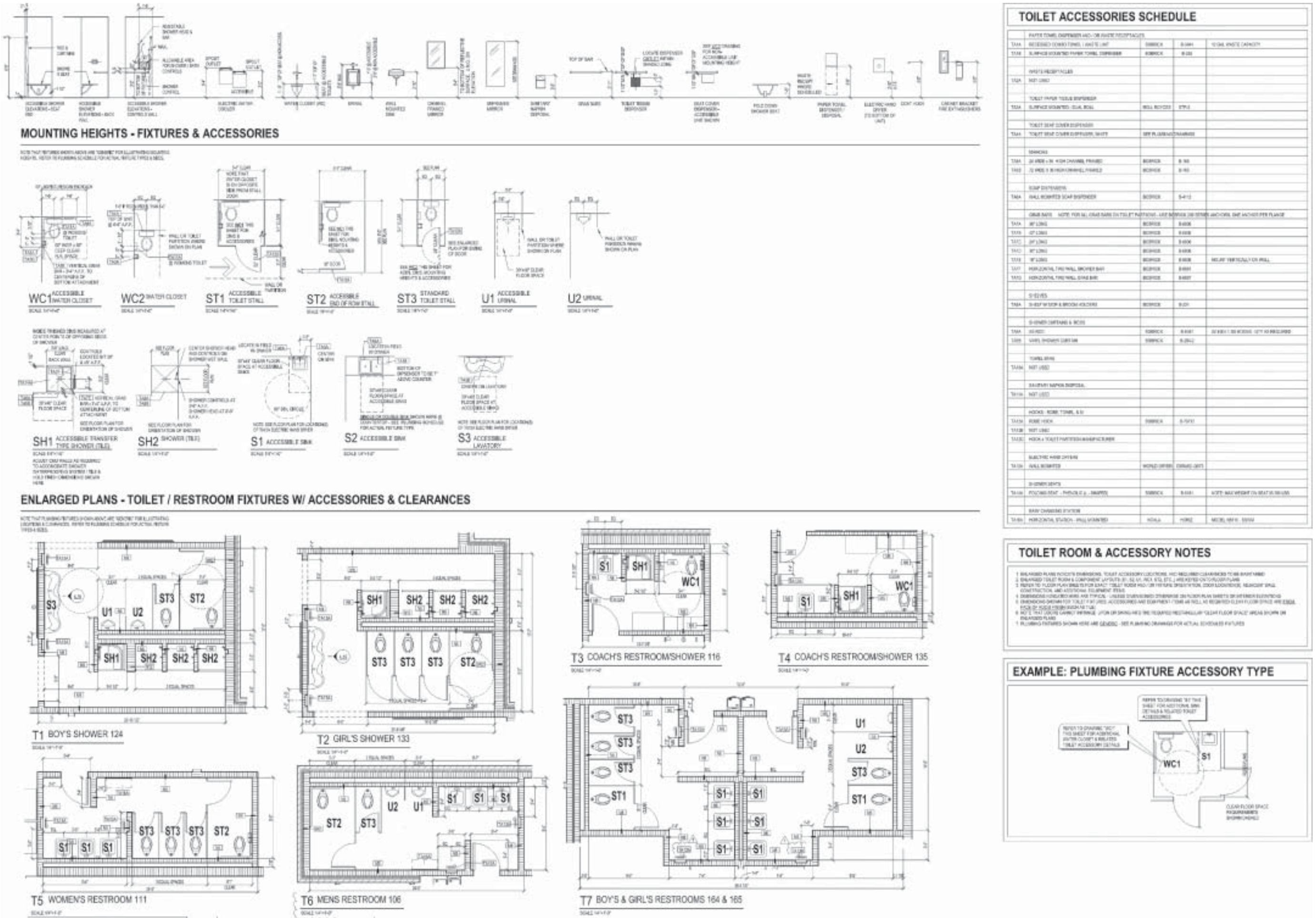


FIGURE 8.29 Finished sheet from a school. *Source:* LBL Architects.

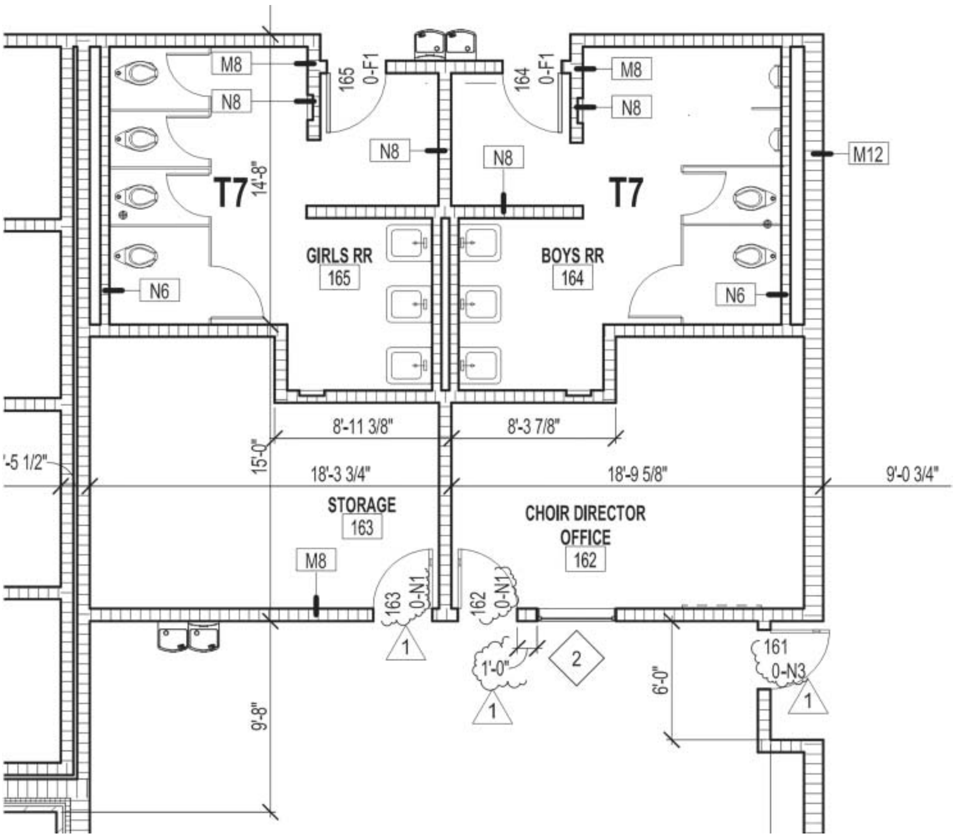


FIGURE 8.30 Portion of 1/8" scale floor plan showing T7 PFT tags. *Source:* LBL Architects.

issues of the project. Make it an objective to research and develop once and then leverage that effort across many projects and for many years.

SYSTEMS PACKETS

Systems packets are a companion write-up of the methodologies used with prototypical system sheets. They are informational documents that describe how to implement a streamlined system and include essential design considerations and a workflow. They are graphical and oriented to recent graduates and new employees. Generally, the more succinct the document is, the better.

Example Systems Packets are included at the end of the chapter for the Plumbing Fixture Types, Partition Types, Door Types, and Cabinetry.

This approach can also be taken to develop building enclosure, building types narratives, and plan sheets that can be developed to capture the knowledge developed by the firm and serve as ready references for how to do work.

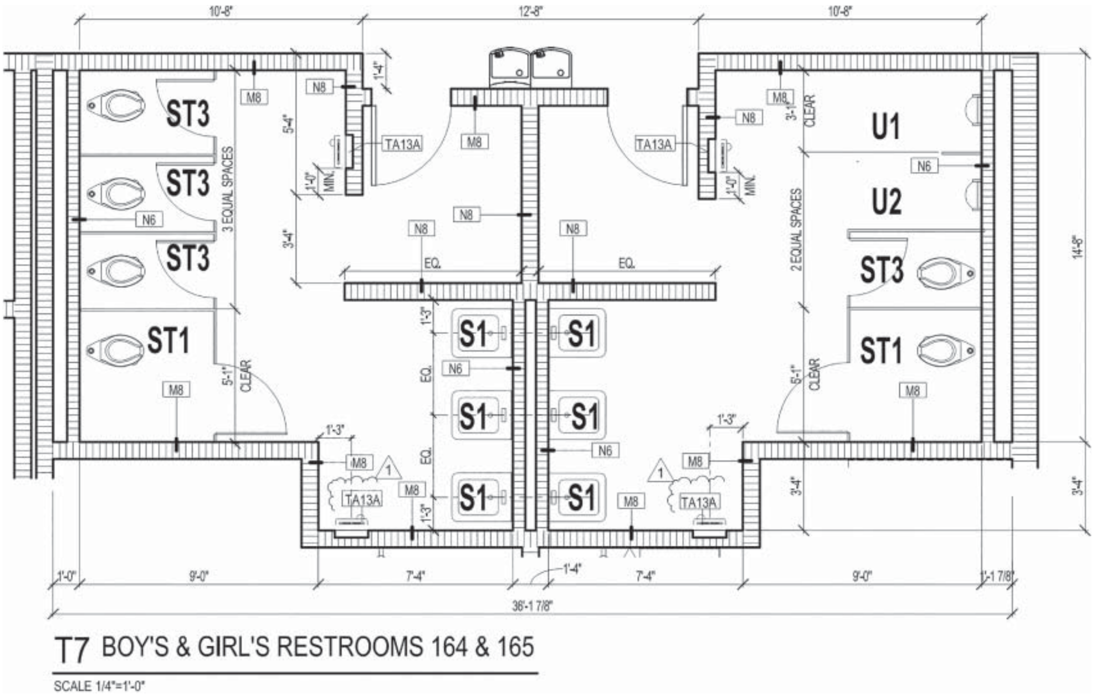


FIGURE 8.31 T7 Streamlined toilet room layout. *Source:* LBL Architects.

Building enclosure narratives can be coordinated with the master specifications and be coupled with reference details sheets that can be incorporated into a model. Examples are: masonry veneer, exterior insulation and finish system, stucco, curtainwall, composite metal panels, and roofs (e.g., modified bitumen, built-up roof, single-ply).

Building types narratives can include (a) manufacturing facilities (e.g., hazardous material piping and process piping), (b) schools (e.g., gymnasium, food service, good classroom practice, security), (c) healthcare (e.g., radiology equipment like PET, CT, MRI), and (d) office (e.g., conference room and workstation layouts).

Plan sheets describe what information is shown on the respective drawings (by project type) – and not replicated elsewhere, including the following types of plans: site, life safety, floor, equipment, RCP, FFE (furniture, fixtures, and equipment), and interiors.

CARTOON SETS – ARE THEY RELEVANT ANYMORE?

It used to be that preparing cartoon sets by hand was a necessary exercise for planning your sheet layouts (Figure 8.34). In recent times, the usefulness of cartoon sets in the traditional sense has diminished, and we are just not seeing them done often any longer. This is not necessarily a bad thing. With digital design tools it is quite easy to lay out, move, and scale plans and details on a sheet as many times as necessary to create your set. However, there is also a tendency to create too many sheets because it

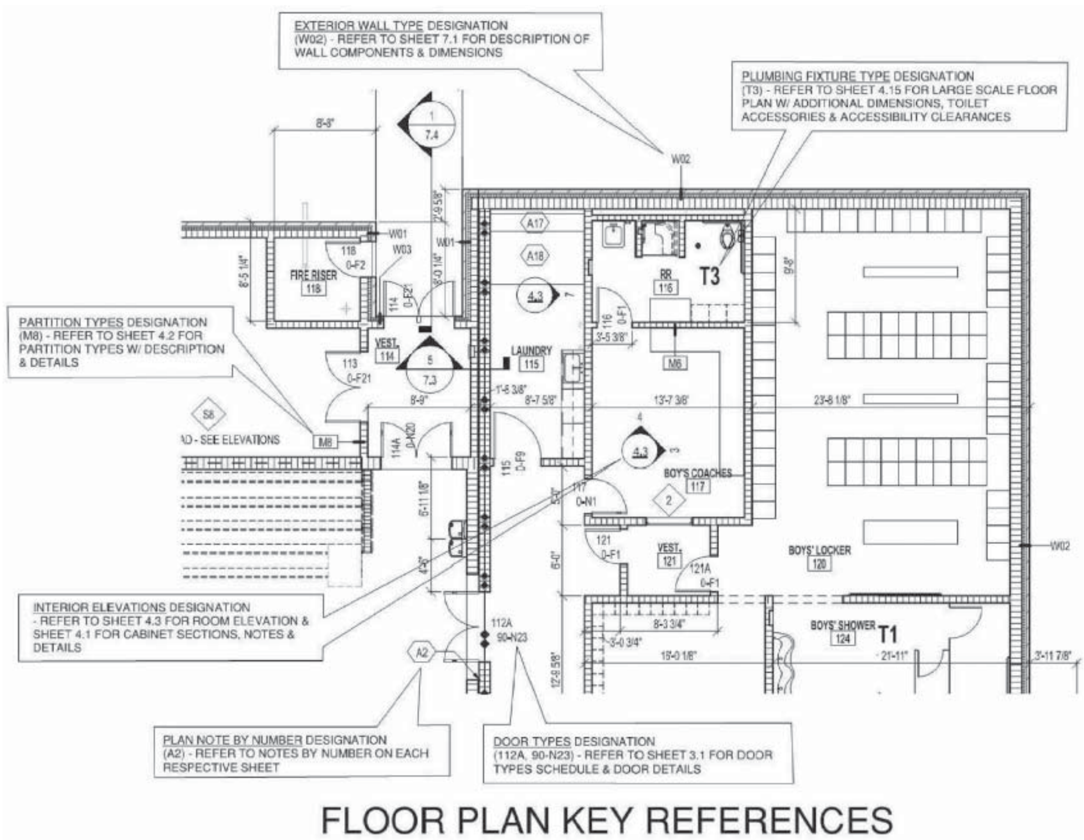


FIGURE 8.32 Floor plan key reference. *Source:* LBL Architects.

is easy to do so. Although not quite the same, the use of a spreadsheet to cartoon a set is just as useful and easier to manage than sketching. Whichever method you choose, we do believe it is important to review sheet setup at regular intervals to minimize wasted effort.

Printing 8 1/2 × 11 or 11 × 17 sets to mark up with section cuts, detail locations, and enlarged plans is still a useful exercise and highly recommended to visualize the amount of work to be completed. While there are inevitably some who will disagree with our opinion that a formal cartoon set is no longer a worthwhile goal, it is still important to know what you are going to be drawing and modeling is relevant. It is also the first step in managing redundancy.

THE PROJECT MANUAL

We have focused much of our discussion on the graphic documentation of a project's construction drawings, but there is also written documentation. The project manual is essential to the success of a project and is equally important as the drawings. In the United States, the standard General Conditions

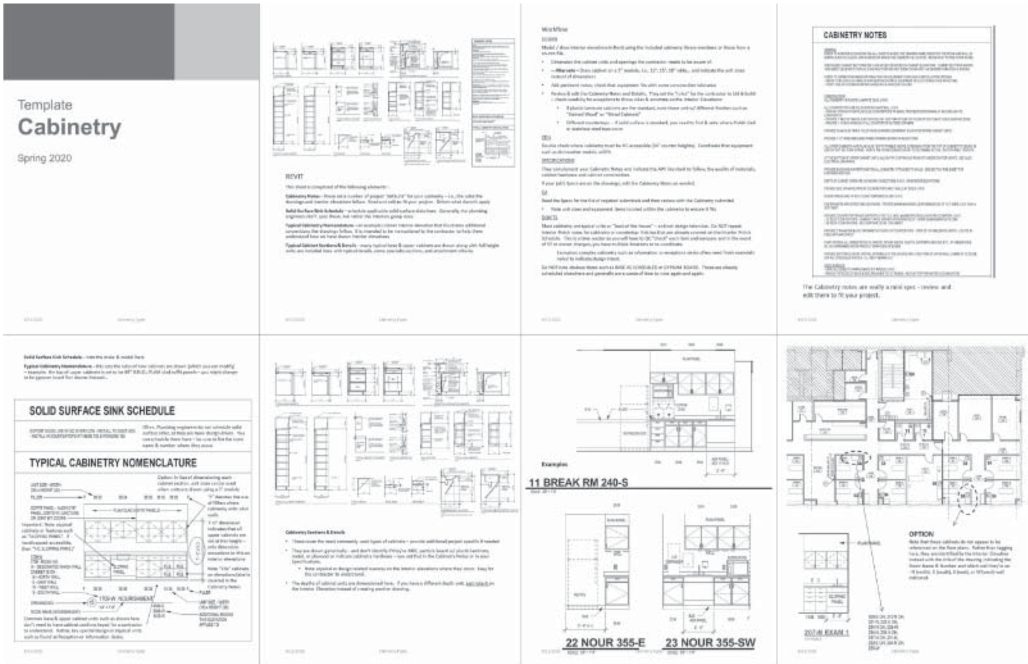


FIGURE 8.33 Example cabinetry system packet.

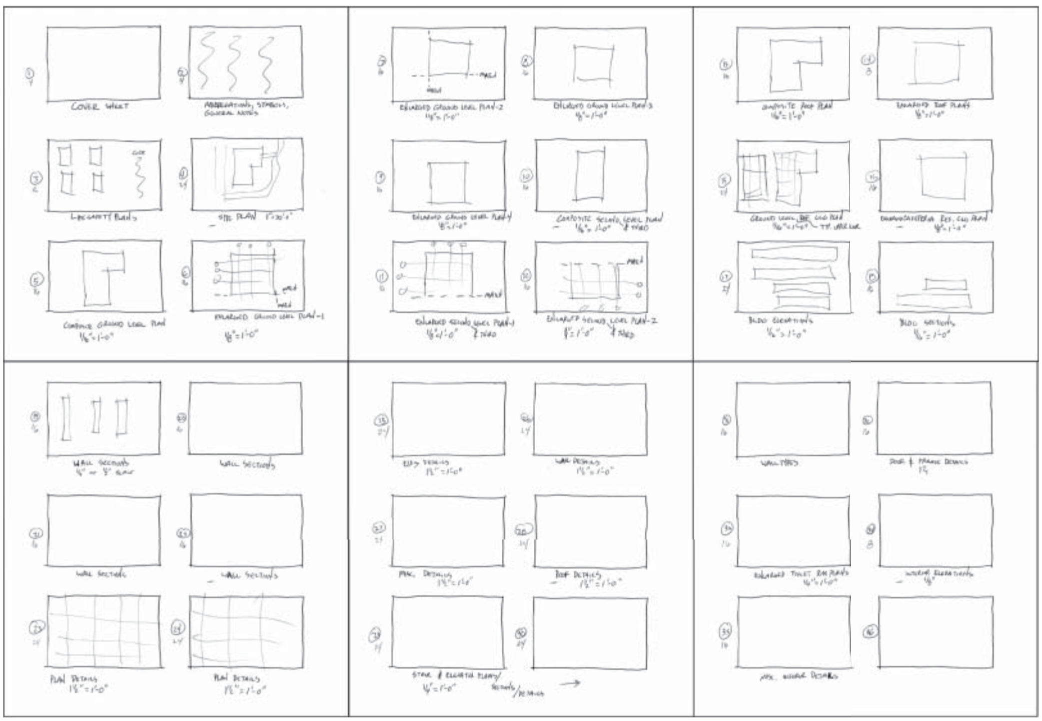


FIGURE 8.34 Cartoon set.

of the Contract for Construction (AIA Document A201) is used by most projects and clearly defines the drawings and specifications and what is part of each.

§ 1.1.5 The Drawings

The drawings are the graphic and pictorial portions of the contract documents showing the design, location, and dimensions of the work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The specifications are that portion of the contract documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the work, and performance of related services.

The A201 goes on further to the define the correlation and intent of the contract documents, of which the drawings and specifications make up the majority.

§ 1.2.1 Correlation and Intent of the Contract Documents

"The Contract Documents are complementary, and what is required by one shall be as binding as if required by all . . . "

This means that the drawings and specifications are to be used in conjunction with one another. What may be in one may not necessarily be in the other, but that does not mean that it shall not be provided. As complementary parts, we as the designer can choose to include specific information in one without the need to replicate the information in the other. This is a misunderstood concept at times which is why there are many perceived conflicts in drawings and specifications. In other words, the project manager or project architect (or both) should be fully be engaged in the development of both parts of the documentation to understand what is included and where. This is especially important when a dedicated team member, commonly referred to as the spec writer, is writing the specifications. If the spec writer is an outside consultant, it is even more important for the project manager or project architect to be involved in the project manual development. We will not delve too deep into this component of project delivery but will offer some advice and observations we have noticed over the years.

- First, determine whether the specifications are to be written by the project team, an in-house specialist, or an outside consultant. Depending on the approach taken, how the spec writer is engaged will be different.
- Second, begin the process early with involvement of the spec writer. Determine a rough outline of what sections will be included. One strategy to use is to use the table of contents from your firm's master specification or the AIA MasterSpec® and identify each section you anticipate will be included. A spreadsheet can be created to help with this checklist approach. This also helps early on by beginning to establish a consistent language between the written and the graphic work.

- Third, if a nonlocal or an outside consultant is used, it is helpful to establish how information will be gathered for materials and building systems and who is responsible. The project team will need to determine and record each option affecting performance, installation, and finishes and then communicate that clearly to the spec consultant. Then determine the specification review process and the way missing data will be addressed. It is all too common for specifications to be issued with yellow highlight or incomplete sentences due to gaps in information.
- Fourth, if keynoting will be used, establish a rough outline early and set the overall approach of what needs to be included in the keynote list and how they will be developed. To maintain consistency, it is also necessary to have an understanding and protocol as to how the project keynote list will be maintained and authored.
- There are additional items to consider as well for what to include in the drawings versus the specifications, such as finishes, door hardware, and glass types.

A well-coordinated set of written and graphical documents is beneficial for the entire project.

CONSTRUCTION ADMINISTRATION

Excellence in project delivery does not end with drawing completion. The project must be built, and our final phase of work is called construction (or sometimes contract) administration (CA). Readers may see a theme here regarding how each part of the work we do is important and related to each other. The CA phase has its own challenges, and some may say that this phase is where the project either succeeds or fails. It certainly forms the client's final impression of the project and it is with this lens that we touch on some items that will help streamline CA. As with the project manual, there is much more to cover and beyond the scope of this book.

Consistency in the administrative aspects of CA is what we would like to highlight the most. In an office environment where multiple staff are involved in CA at any given time, would it not be a positive outcome to have consistent methods of record keeping, forms, processes, and communication? Of course it would, and anything less will result in inefficiencies for your firm. The types of forms we are talking about are internal tracking spreadsheets for logs for requests for information (RFIs), submittals, change orders, sketches, and others. Technology has advanced to a point where it may not be necessary to create your own forms any longer, and there are many useful project management software tools on the market, several of which are cloud based. They allow all of this to be integrated with drawing issuances, e-mail, and so forth. If your firm has not explored the use of the options in the market, it would be worth the time to get a demonstration if you are serious about streamlining.

Procedural efforts are important to consider, and decisions during CA need to be timely. Most, if not all, general requirements of the specifications stipulate a specific number of days for the review times of submittals and RFIs. This can be challenging because there may be internal constraints which do not allow for the response to occur, such as team members that are out of the office due to illness or vacation, or decisions which require a design director to review. These constraints are common, so be aware of these and assign an alternate stand-in to provide guidance when the primary project staff are unavailable.

Good record keeping practices include things such as a consistent naming convention for submittals and RFIs as well as the electronic storage of such items on your network server. Project directories should be consistent from project to project for easy recall of information, and staff need to be familiar and trained where to save files. E-mail protocols need to be understood as well. An e-mail manager may be a good investment to avoid duplicate copies being saved and to facilitate searching. Some project management software has this capability.

Other things to consider are to involve senior construction administrators in constructability reviews prior to the project issue along with the firm's QA/QC efforts. This puts the front-line defenders of the construction documents in a position to prevent problems from happening on future projects and for knowledge to be distributed back to the project teams.

As discussed earlier, it makes sense to see the contractor as a client. Facilitating the flow of CA documentation by timely reviews and quick responses to issues in the field helps the work advance, a benefit to all. While there may be friction and disagreement at times, building a relationship with contractors is worthwhile and bespeaks a long-term view. They are also a tremendous resource for helping architects and engineers understand how work is actually performed and to gain knowledge of constructability.

From the time spent developing the project, the project team is aware of areas of complexity and potential issues such as pinch points for MEP routing, problematic existing conditions, or design-oriented details that require close attention to build well. Keeping a list of such items and proactively intersecting with the contractor during CA to ensure they are done correctly goes a long way to keeping the project on track and preventing problems from developing.

PRACTICAL GOALS FOR DOCUMENTATION

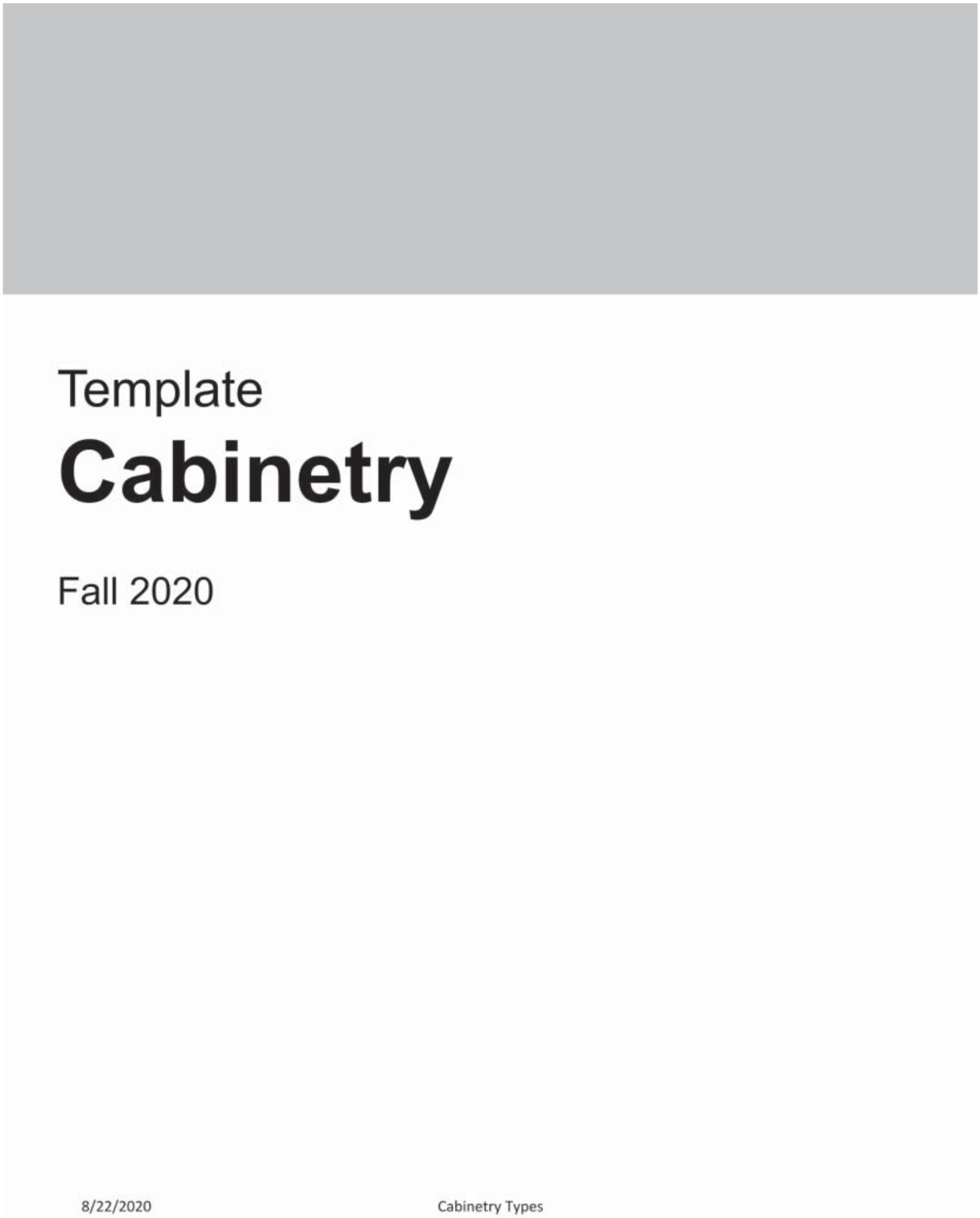
Documenting should become the easiest thing the firm does, and the ways we do the work should be intern friendly to allow staff to quickly learn and become productive. The goal is to convey information to make deliverables easy for AHJs, contractors, and clients to understand.

- Reduce graphic density in drawings and the model.
- Strive for clarity by understanding the primacy of information (i.e., what is most important and must be shown clearly), being careful to eliminate unnecessary graphical information such as symbology, text, or linework that is superfluous or serves to obscure.
- Provide only the information necessary for the contractor to estimate, prepare shop drawings, and construct.
- Reduce or eliminate redundancy.
- Employ a systems documentation approach where components such as partitions, cabinetry, and doors are largely predocumented with an easy-to-implement referencing system.
  - Make your documents instructional to the preparer and end user.
  - Leverage information that is typical by establishing rules to guide the contractor.
  - Schedule and reference by default.
- Plan beforehand what you intend to produce (i.e., begin with the end in mind, as Stephen Covey suggests).
- Think slowly and employ methods to draw or model quickly.

- Draw and model what you know. Holes in drawings or visually incomplete information in a model serve as a graphic indicator that decisions or direction remain outstanding and can be an invaluable indicator of issues needing to be thought through or a lack of specific information.
- Employ visual quality control techniques where documenting methods reveal mistakes by virtue of seeing information in context with other information.
- Beware of the inclusion of placeholder drawing details from the firm's standards or other projects that provide an appearance of document completion but too often result in the inclusion of unrelated and uncoordinated information.

RESOURCE MATERIAL

Figures 8.35 – 8.43: Cabinetry System Packet
Figures 8.44 – 8.52: Door Types System Packet
Figures 8.53 – 8.62: Partitions System Packet
Figures 8.63 – 8.76: Plumbing Fixtures System Packet



Template

Cabinetry

Fall 2020

8/22/2020 Cabinetry Types

FIGURE 8.35 Cabinetry System Packet.

CABINETRY

GOAL

We want to simplify and streamline aspects of the CD documentation process. This System works by addressing a majority of situations found in lieu of a more complex system that covers every possible situation. Atypical, complex and design-oriented features may warrant separate drawings.

There is no time saving in thinking through issues affecting your project, but rather a simplifying or reduction of the documenting effort.

This approach uses two methodologies:

> Default Scheduling – "… employs a methodology to schedule building components such as toilet accessories, doors, partitions, accessibility clearances, cabinetry, sealants, metal fabrications, etc."
>
> - AIA Handbook of Professional Practice, 15th Edition
>
> Instructional Systems – "…drawings and notes that graphically coach the drafter or contractor to an understanding of project conventions such as scheduling or documentation methods."
>
> - AIA Handbook of Professional Practice, 15th Edition © 2013

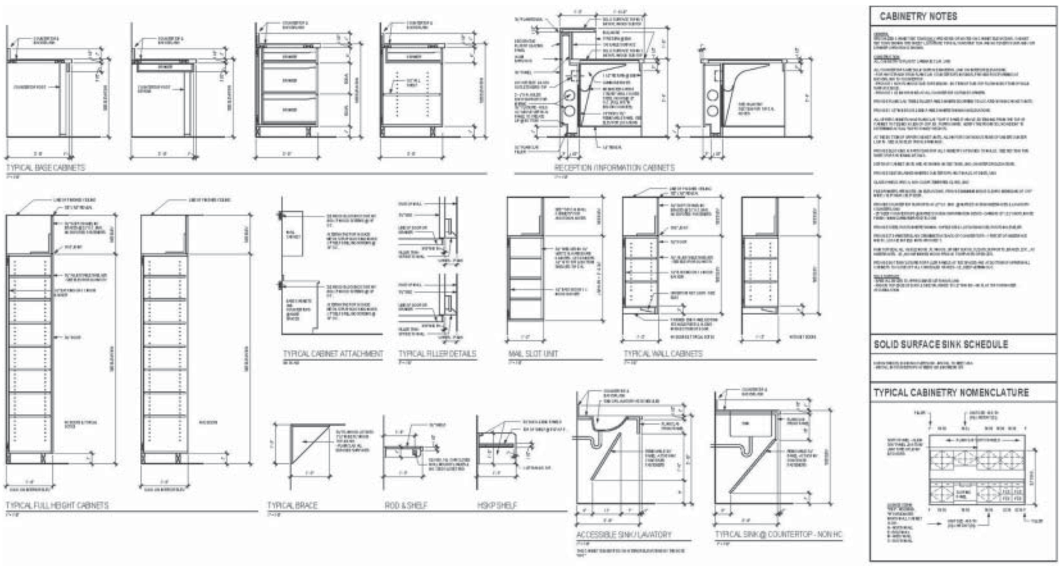
This sheet is setup to require minimal editing, however, to be effective, users must understand the system and how it works. Thinking slowly allows us to work and document more quickly.

Many model elements shown on the resulting construction drawings can be referenced by default without any specific graphical referencing required. The steps are to:

- Each system covers most situations found…
- Set Defaults – graphical "rules"
- Find the exceptions

8/22/2020 Cabinetry Types

FIGURE 8.36 Cabinetry System Packet.



COMPONENTS

This sheet is comprised of the following -

Cabinetry Notes – these set a number of project "defaults" for your cabinetry – i.e., rules the drawings and interior elevations follow. Read and edit to fit your project. Delete what doesn't apply

Solid Surface Sink Schedule – schedule applicable solid surface sinks here. Generally, the plumbing engineers don't spec these, but rather Interiors or the Architect selects.

Typical Cabinetry Nomenclature – this drawing is an example interior elevation that illustrates additional conventions the drawings follow when elevating cabinetry. It is intended to be instructional both to the contractor and the architect to help them understand how they are drawn and how information is conveyed.

Typical Cabinet Sections & Details –typical base & upper cabinets are provided along with full height units along with typical details, some specialty sections, and attachment criteria.

8/22/2020 Cabinetry Types

FIGURE 8.37 Cabinetry System Packet.

WORKFLOW WITH CHECKLISTS

DESIGN

Model / draw interior elevations in BIM using the included cabinetry library members or those from a source file.

❑ Use a a 3" module for all cabinetry, i.e., 12", 15", 18" wide... and indicate the unit sizes instead of dimensioning (i.e., 3036 – a 30" wide x 36" high base cabinet)

❑ ***-- Alternate –*** Dimension the cabinet units and openings the contractor needs to be aware of.

❑ Add notes to identify knee spaces, equipment items, etc.

❑ Check that equipment fits with some construction tolerance.

❑ Review & edit the Cabinetry Notes and Details. They are the "rules" for the contractor to bid & build by – check carefully for exceptions to the rules & specifically note those on the Interior Elevations:

- If plastic laminate cabinets are the standard, note only those unit w/ different finishes such as "Stained Wood" or "Metal Cabinets" on the Interior Elevations.
- Different countertops – if solid surface is standard, you need to find & note where PLAM clad or stainless-steel tops occur.

CONSTRUCTION DRAWINGS

❑ Double check where cabinetry must be accessible (i.e., 34" counter heights). Coordinate that equipment items such as dishwasher models fit and that accessible sinks and garbage disposals, etc., are specified.

SPECIFICATIONS

They complement your Cabinetry Notes and indicate the AWI Standard to follow, the quality of materials, cabinet hardware and cabinet construction.

If your job's Specs are on the drawings, edit the Cabinetry Notes as needed.

CA

Read the Specifications for the list of required submittals and then review with the Cabinetry submittal.

❑ Note unit sizes and equipment items located within the cabinetry to ensure they fit.

DON'TS

Most cabinetry is comprised of typical units and are "back of the house" – they are not design intensive. Do NOT repeat Interior Finish notes for cabinetry or countertop finishes that are already covered on the Interior Finish Schedule. This creates duplicate annotation that must be QC "checked" and each item coordinated, and in the event of VE or owner changes, you have multiple locations to re-coordinate.

Complex cabinetry such as information or receptions desks often need finish materials noted to clearly indicate design intent.

Do NOT note obvious items such as BASE AS SCHEDULED or GYPSUM BOARD. They are already scheduled elsewhere.

Do NOT indicate cabinetry or countertop substrates such as Plywood, MDF, Solid Surface or cabinetry cladding such as "plastic laminate" on cabinet sections. The Cabinetry Notes covers these.

8/22/2020 Cabinetry Types

FIGURE 8.38 Cabinetry System Packet.

CABINETRY NOTES

GENERAL
REFER TO INTERIOR ELEVATIONS ON A6.xx SHEETS WHERE THE DRAWING NAME IDENTIFIES THE ROOM AND WALL (N-NORTH, S-SOUTH, E-EAST, AND W-WEST) ON WHICH THE CABINETRY IS LOCATED. REFER ALSO TO THE FLOOR PLANS.

SPECIALIZED CABINET SECTIONS ONLY ARE KEYED OR NOTED ON CABINET ELEVATIONS. CABINET SECTIONS SHOWN THIS SHEET ILLUSTRATE TYPICAL CONSTRUCTION AND NOT EVERY DOOR AND / OR DRAWER VARIATION IS SHOWN.

REFER TO OWNER FURNISHED INFORMATION FOR EQUIPMENT PURCHASE & INSTALLATION CRITERIA.
- REFER TO FLOOR PLAN SHEETS FOR IDENTIFICATION OF EQUIPMENT W/ LOCATIONS & TAGS OR NOTING
- VERIFY SIZE OF OPENINGS WITHIN CABINETRY & ADJACENT SPACES

CONSTRUCTION
ALL CABINETRY IS PLASTIC LAMINATE CLAD, U.N.O.

ALL COUNTERTOPS ARE SOLID SURFACE MATERIAL, U.N.O.
- FOR ANY STRAIGHT RUN PLAM CLAD COUNTERTOPS W/ SINKS, PROVIDE POSTFORMING AT BACKSPLASH TO COUNTERTOP.
- PROVIDE 1 INCH PLYWOOD SUB-TOPS BELOW - BOTTOM OF SUB-TOP FLUSH W/ BOTTOM OF SOLID SURFACE EDGE.
- PROVIDE 1 1/2 INCH RADIUS AT ALL COUNTERTOP OUTSIDE CORNERS

PROVIDE PLAM CLAD TRIM & FILLER PANELS WHERE EQUIPMENT IS LOCATED WITHIN CABINET UNITS.

PROVIDE 1 1/2" WIDE SIDE & END PANELS WHERE SHOWN ON ELEVATIONS.

ALL UPPER CABINETS HAVE PLAM CLAD "SOFFIT PANELS" ABOVE, EXTENDING FROM THE TOP OF CABINET TO CEILING IN LIEU OF GYP. BD. FURR DOWNS. VERIFY THE ROOM CEILING HEIGHT TO DETERMINE ACTUAL "SOFFIT PANEL" HEIGHTS.

AT THE BOTTOM OF UPPER CABINET UNITS, ALLOW FOR CONTINUOUS RUNS OF UNDERCOUNTER LIGHTS. SEE ALSO ELECTRICAL DRAWINGS.

PROVIDE BLOCKING IN PARTITIONS FOR ALL CABINETRY ATTACHED TO WALLS. SEE SECTION THIS SHEET FOR FASTENING DETAILS.

DEPTH OF CABINET UNITS ARE AS SHOWN ON SECTIONS, U.N.O., ON INTERIOR ELEVATIONS.

PROVIDE SIDE SPLASHES WHERE COUNTERTOPS ABUT WALLS AT SIDES, U.N.O.

GLASS PANELS ARE 1/4 INCH CLEAR TEMPERED GLASS, U.N.O.

FILE DRAWERS ARE NOTED ON ELEVATIONS. PROVIDE MINIMUM INSIDE CLEAR DIMENSIONS OF 13.5" WIDE x 10.5" HIGH x 20.5" DEEP.

PROVIDE COUNTERTOP BRACE SUPPORTS AT 42" O.C. MAX. @ KNEESPACES & LAVATORY COUNTERS, U.N.O.
- 25" DEEP COUNTERTOPS - GAMBAS "LARGE WORKSTATION BRACKETS" - WWW.GAMBASBRACKETS.COM
- 30" DEEP COUNTERTOPS - SEE SUPPORT DETAIL THIS SHEET.

PROVIDE 2" DIAMETER BLACK GROMMETS AT BACK OF COUNTERTOPS - 1 PER 30" OF KNEESPACE WIDTH. LOCATE IN FIELD WITH ARCHITECT.

PAINT OR SEAL ALL VISIBLE WOOD, PLYWOOD, OR MDF BUCKS, CLEATS, SUPPORTS, BRACES, ETC., AT KNEESPACES. I.E., NO UNFINISHED WOOD PRODUCT SURFACES OR EDGES.

PROVIDE BOTTOM CLOSURE FOR FILLER PANELS AT TOE SPACES AND AT BOTTOM OF UPPER WALL CABINETS TO CLOSE OFF ALL CONCEALED SPACES - I.E., KEEP VERMIN OUT.

SOLID SURFACE
- EASE ALL EDGES TO APPROXIMATE 1/8" RADIUS, U.N.O.
- RADIUS TOP EDGE OF BACK & SIDE SPLASHES TO 1/2" RADIUS - NO FLAT TOP FOR WATER ACCUMULATION

The Cabinetry notes are really a mini specification - review and edit them to fit your project.

8/22/2020 Cabinetry Types

FIGURE 8.39 Cabinetry System Packet.

Solid Surface Sink Schedule – note the makes & models here

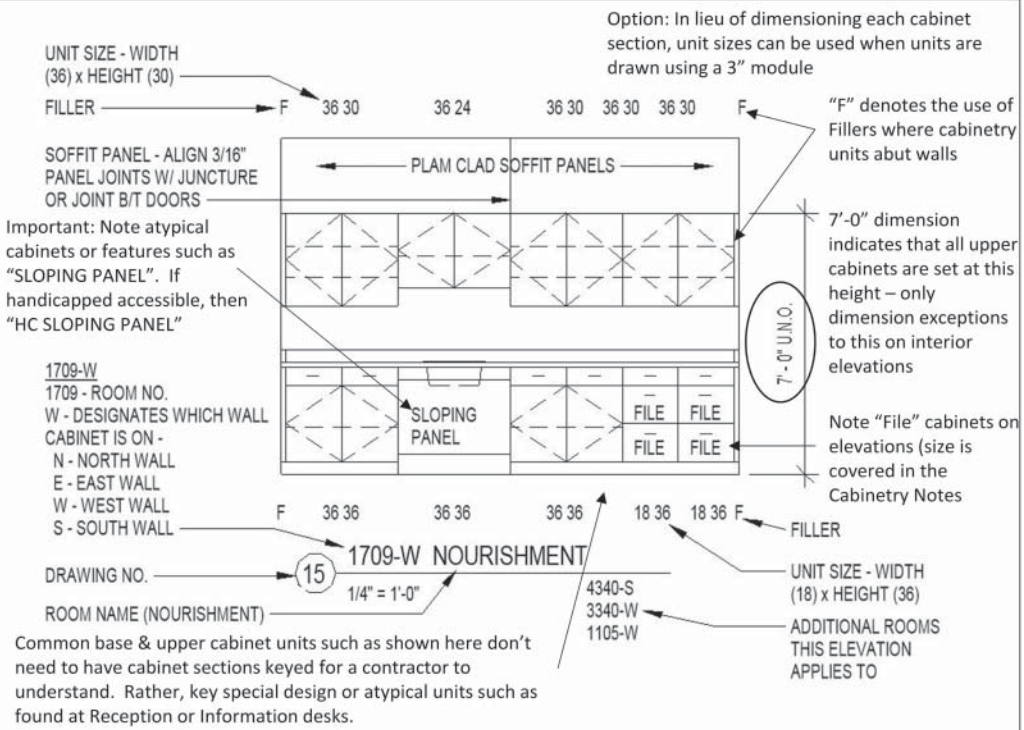
Typical Cabinetry Nomenclature – this sets the rules of how cabinets are drawn (which you can modify) – example: the top of upper cabinets is set to be 7'-0" U.N.O.; PLAM clad soffit panels – you might change to be gypsum board furr downs instead…

SOLID SURFACE SINK SCHEDULE

DUPONT MODEL 816 W/ NO OVERFLOW - INSTALL TO MEET ADA - INSTALL IN COUNTERTOPS AT MENS 103 & WOMENS 155

Often, Plumbing engineers do not schedule solid surface sinks, as they are more design driven. You can schedule them here – be sure to list the room name & number where they occur.

TYPICAL CABINETRY NOMENCLATURE



8/22/2020 Cabinetry Types

FIGURE 8.40 Cabinetry System Packet.

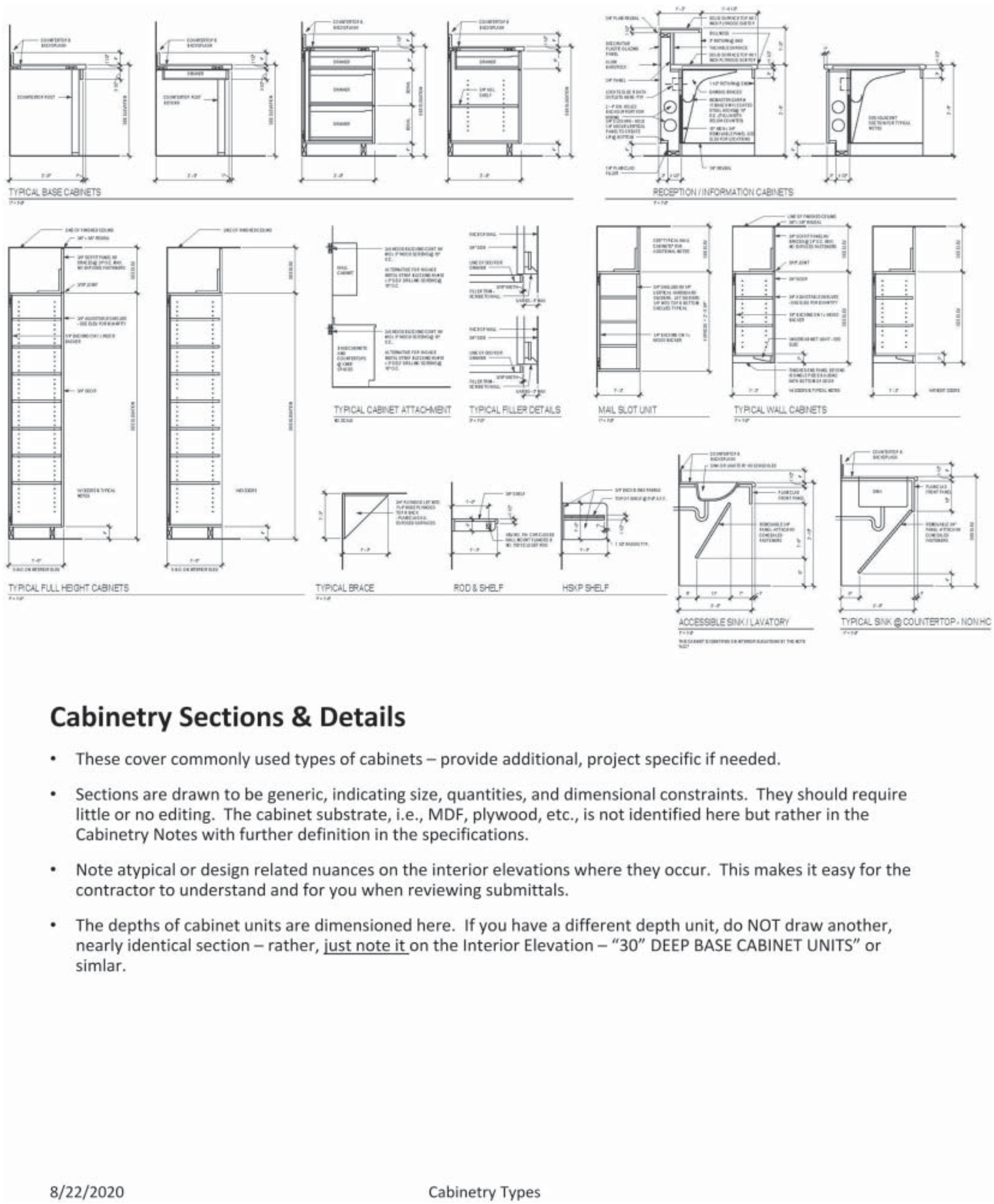


FIGURE 8.41 Cabinetry System Packet.

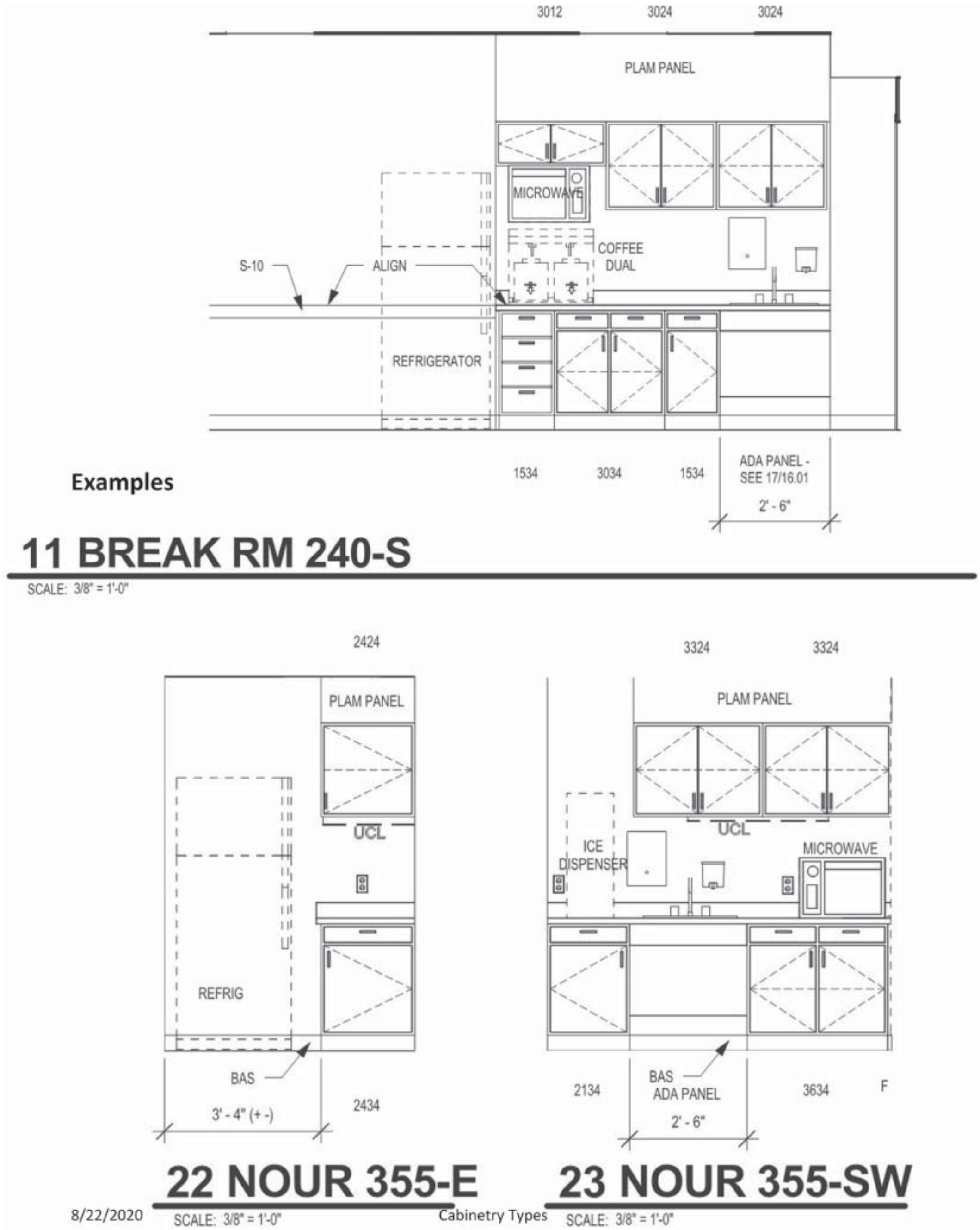


FIGURE 8.42 Cabinetry System Packet.

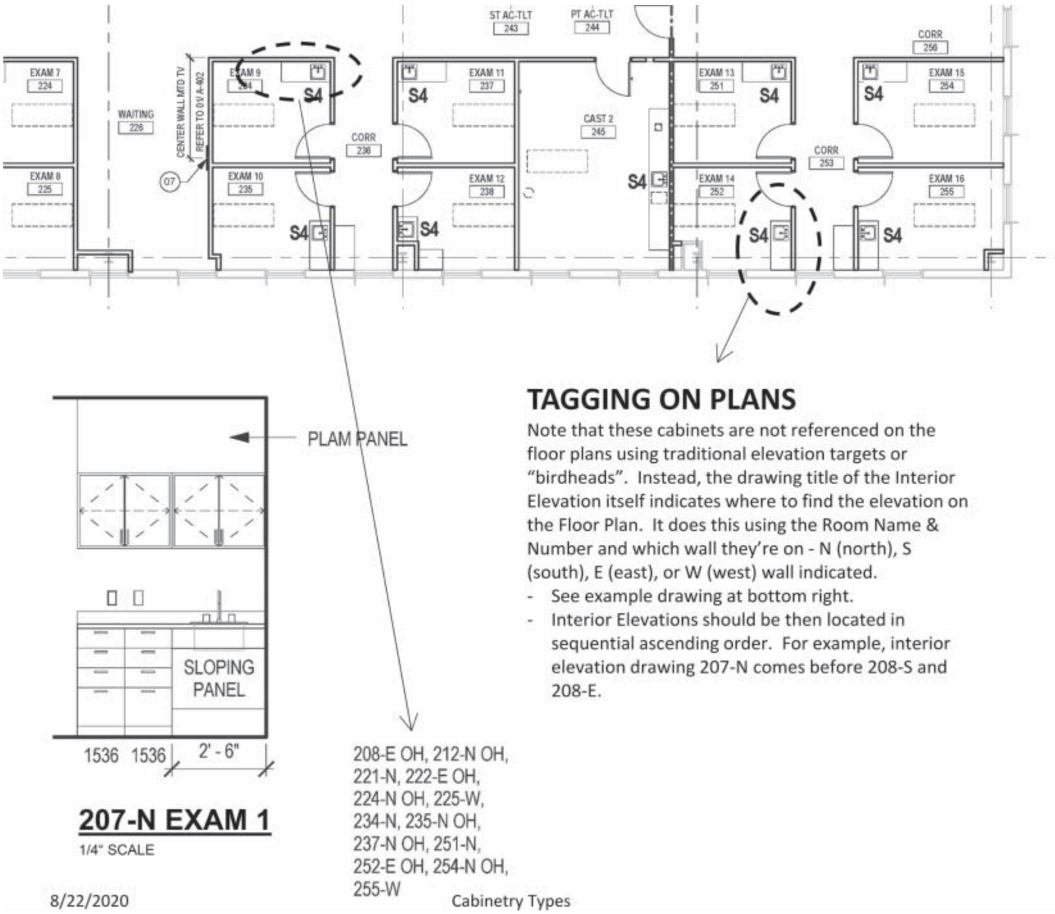


FIGURE 8.43 Cabinetry System Packet.

Template

Door Types

Fall 2020

FIGURE 8.44 Door Types System Packet.

DOOR TYPES

GOAL

We want to simplify and streamline aspects of the CD documentation process. This System works by addressing a majority of situations found in lieu of a more complex system that covers every possible situation. Atypical, complex and design-oriented features may warrant separate drawings.

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This approach uses two methodologies:

> Default Scheduling – "... employs a methodology to schedule building components such as toilet accessories, doors, partitions, accessibility clearances, cabinetry, sealants, metal fabrications, etc."
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>
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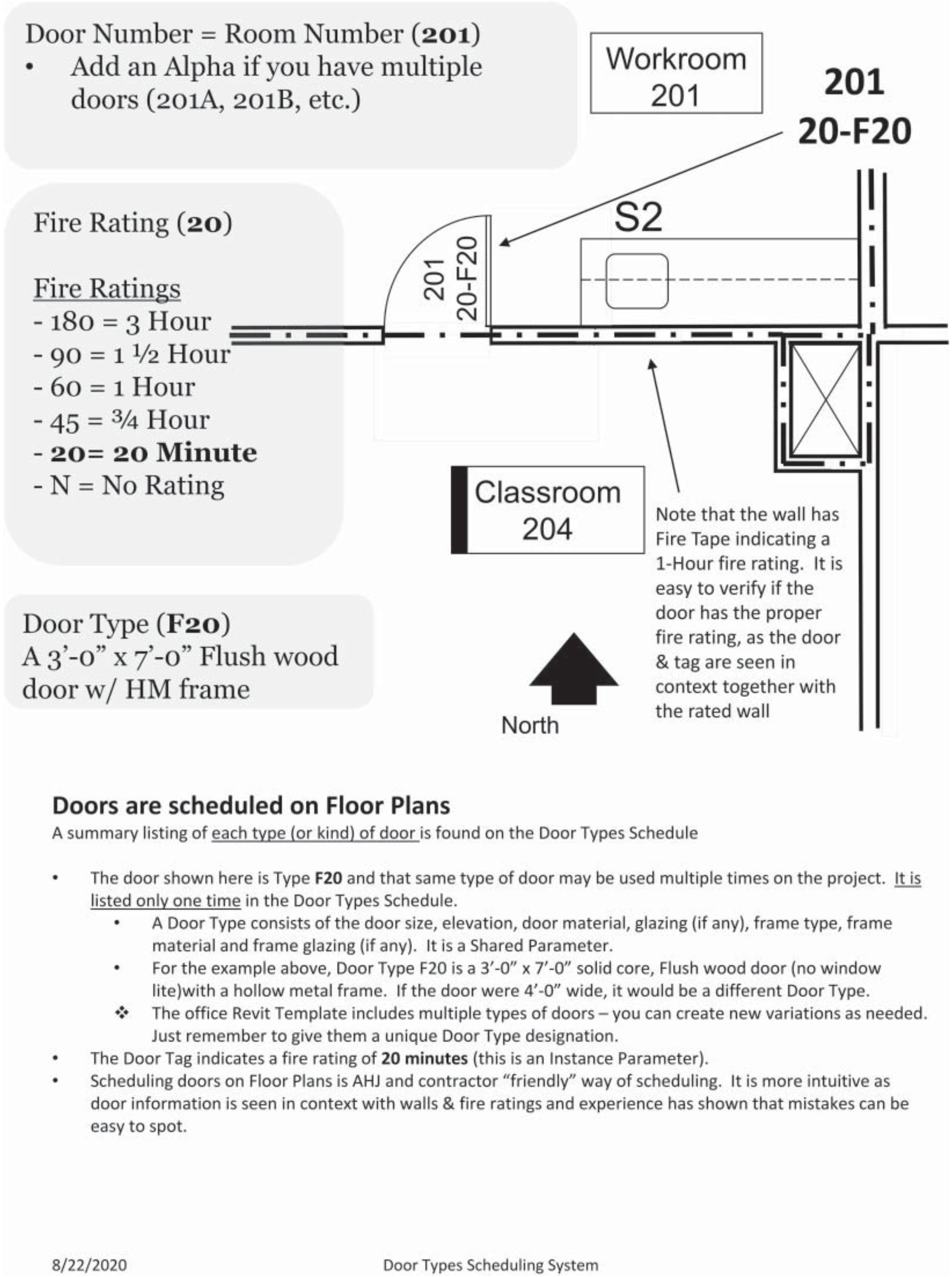
Many model elements shown on the resulting construction drawings can be referenced by default without any specific graphical referencing required. The steps are to:

- Each system covers most situations found...
- Set Defaults – graphical "rules"
- Find the exceptions

8/22/2020 Door Types Scheduling System

FIGURE 8.45 Door Types System Packet.



Door Number = Room Number (**201**)
- Add an Alpha if you have multiple doors (201A, 201B, etc.)

Fire Rating (**20**)

Fire Ratings
- 180 = 3 Hour
- 90 = 1 ½ Hour
- 60 = 1 Hour
- 45 = ¾ Hour
- **20= 20 Minute**
- N = No Rating

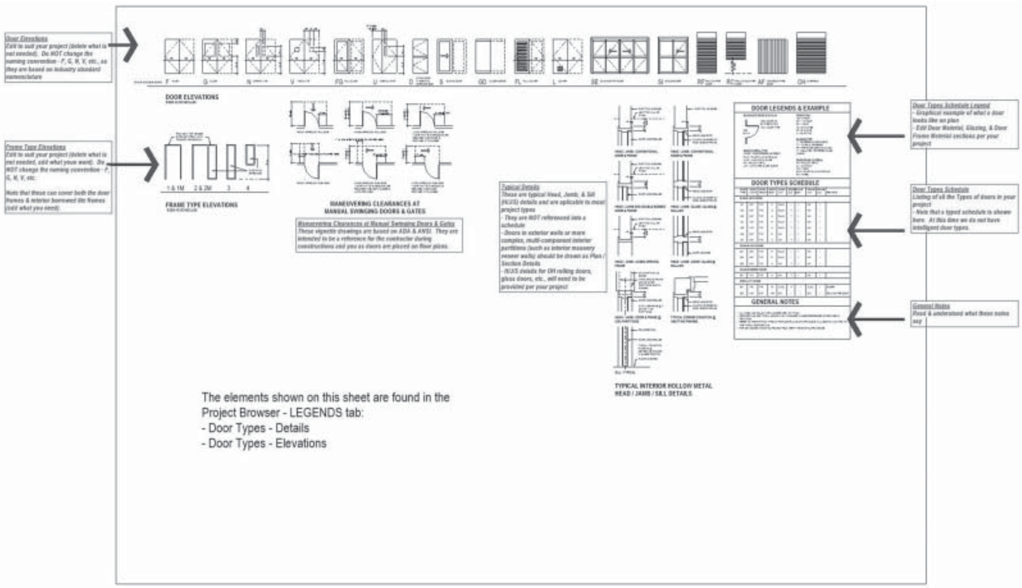
Door Type (**F20**)
A 3'-0" x 7'-0" Flush wood door w/ HM frame

Doors are scheduled on Floor Plans
A summary listing of each type (or kind) of door is found on the Door Types Schedule

- The door shown here is Type **F20** and that same type of door may be used multiple times on the project. It is listed only one time in the Door Types Schedule.
  - A Door Type consists of the door size, elevation, door material, glazing (if any), frame type, frame material and frame glazing (if any). It is a Shared Parameter.
  - For the example above, Door Type F20 is a 3'-0" x 7'-0" solid core, Flush wood door (no window lite)with a hollow metal frame. If the door were 4'-0" wide, it would be a different Door Type.
  - ❖ The office Revit Template includes multiple types of doors – you can create new variations as needed. Just remember to give them a unique Door Type designation.
- The Door Tag indicates a fire rating of **20 minutes** (this is an Instance Parameter).
- Scheduling doors on Floor Plans is AHJ and contractor "friendly" way of scheduling. It is more intuitive as door information is seen in context with walls & fire ratings and experience has shown that mistakes can be easy to spot.

8/22/2020 Door Types Scheduling System

FIGURE 8.46 Door Types System Packet.



COMPONENTS

This sheet is comprised of the following elements –

Door Legends & Example – a graphic of how doors are scheduled on floor plans along with Legends for Door Materials, Glazing, Frames & Fire Ratings.

Door Types Schedule – an editable schedule where each TYPE of door is scheduled once.

General Notes – instructional to the contractor on how the system works

Typical Interior Hollow Metal Head / Jamb / Sill Details –standard Head, Jamb, & Sill details for interior doors.

Door Elevations – follows industry standard naming conventions

Frame Type Elevations – includes those typically used

Maneuvering Clearances at Manual Swinging Doors & Gates – (meeting both ADA & ANSI standards) are included for the contractor's reference – and yours.

8/22/2020 Door Types Scheduling System

FIGURE 8.47 Door Types System Packet.

WORKFLOW WITH CHECKLISTS

DESIGN

- ❑ Populate your Revit model initially using a typical door, such as a 3'-0" x 7'-0" door that is WOOD or HM, with or without glazing (whichever is expected to be the most common door for the project)
- ❑ As design progresses, update those doors which are of a different Door Type due to size, style, door material, glazing panels, etc.
- ❑ Create new Door Types as needed.

CONSTRUCTION DOCUMENTS

- ❑ Tag doors on floor plans
    - The Door Number is the same as the Room number the door swings into (generally); add an A, B, or C suffix if the room has multiple doors
    - Select the Fire Rating in the CD door tag
- ❑ Add Door Tag suffixes only for atypical doors (an Instance Parameter). Examples:
    - B – Ballistics rated
    - L – Lead Lined
    - S – Storm Shelter (ICC-500 rated)
- ❑ Add / edit Notes to indicate door finishes on the DOOR TYPES SCHEDULE NOTES
    - WOOD DOORS HAVE TRANSPARENT FINISH -- or --
    - WOOD DOORS HAVE PLAM FINISH -- or --
    - H.M. DOORS HAVE PAINTED FINISH, etc.
- ❑ Indicate Door finish specifics (laminate(s), paint color(s), etc. on Interiors sheets
- ❑ Edit the FRAME TYPE ELEVATIONS and delete those not applicable.
- ❑ Delete DOOR ELEVATIONS drawings not applicable to the project
- ❑ Delete TYPICAL DETAILS drawings that are not used.
- ❑ Keep the MANEUVERING CLEARANCES AT MANUAL SWINGING DOORS & GATES drawings. They are a reference for you and the contractor.
- ❑ Add Plan and Section Details for doors located in more complex or design intensive interior conditions on the enlarged Detail sheets.
- ❑ Provide separate Plan and Section Details for exterior door H/J/S indicating the materials, flashings, etc. Key them onto the Floor Plans, RCP's and / or Wall Sections.

BIDDING

Draw the bidder's attention to how the Doors are scheduled at the Pre-Bid or review beforehand with the construction manager or design-build contractor.

CONSTRUCTION ADMINISTRATION

- Submittal Review for Doors & Door Frames: using a printed copy of your floor plan (or PDF copy), highlight and mark out the doors as you review them. Keep a copy of this marked up plan for future reference.
    - ❑ Verify the door & frame sizes, materials, glazing (if applicable) & fire ratings
    - ❑ Verify the door frame throat thickness is correct w/ the scheduled partition

- ❑ CA – review how doors are scheduled w/ contractor field superintendent

8/22/2020 Door Types Scheduling System

FIGURE 8.48 Door Types System Packet.

CREATING NEW DOOR TYPES IN REVIT

Multiple Door Types are already in the Revit Template. If you need to create other project specific doors, follow these steps.

- Select a Door Type that is similar to the elevation style of the new one you need – example, a 3′-0″ x 7′-0″ (N) Narrow Lite door if you are creating a new version of a (N) Narrow Lite door.
- Duplicate the Door Type in Revit.
- Give it a unique number – Door Type **N21** (or N31)
    - ❖ The "N" designation used for the Narrow Lite elevation follows industry standard. All of the designations used with the Elevations in the Revit Template follow industry standard.
- Edit the shared parameters as needed changing the size, frame type, etc.
- Save the changes.
- Review that it is correct.

The Door Types Schedule will list the new door type once it is inserted onto the Floor Plan.

8/22/2020 Door Types Scheduling System

FIGURE 8.49 Door Types System Packet.

DOOR LEGENDS & EXAMPLE

EXAMPLE OF DOOR ID ON PLAN

1233 - DOOR NO.
90 - FIRE RATING
101A - DOOR TYPE

DOOR MATERIAL TYPE
WOOD - WOOD SPECIES AS SPEC'D
PLAM - PLASTIC LAMINATE CLAD
AL/GL - ALUMINUM & GLASS
HM - HOLLOW METAL
LAM - LAMINATED GLASS (CLEAR)

FIRE RATING
180 - 3 HOUR
90 - 1 1/2 HOUR
60 - 1 HOUR
45 - 45 MINUTES
20 - 20 MINUTE
N - NO RATING

GLAZING TYPE
T - TEMPERED GLASS (CLEAR)
TT - TINTED & TEMPERED
FR - FIRE RATED CERAMIC GLASS
IT - INSULATED, TEMPERED GLASS (CLEAR)

DOOR FRAME MATERIAL
HM - HOLLOW METAL
AL - ALUMINUM
WD - WOOD
PLAM - PLASTIC LAMINATE CLAD
STL - STEEL

Example of how door is scheduled on the Floor Plans.

Edit to suit your project.

DOOR TYPES SCHEDULE

DOOR TYPE	DOOR WIDTH	DOOR HEIGHT	DOOR ELEV	DOOR MAT	DOOR GLZ	FRAME ELEV	FRAME MAT	FRAME GLZ	REMARKS
SINGLE LEAF DOORS									
101	3'-0"	7'-0"	F	PLAM	-	1	HM	-	
102	3'-0"	7'-0"	G	PLAM	T	1	HM	-	
103	3'-0"	7'-0"	N	PLAM	T	1	HM	-	
104	4'-0"	7'-0"	F	PLAM	-	1	HM	-	
105	4'-0"	7'-0"	N	PLAM	T	1	HM	-	
106	3'-0"	7'-0"	F	HM	-	1	HM	-	
107	3'-0"	7'-0"	N	HM	T	1	HM	-	
DOUBLE LEAF DOORS									
201	5'-0"	7'-0"	F	PLAM	-	1	HM	-	
202	6'-0"	7'-0"	F	PLAM	-	1	HM	-	
203	6'-0"	7'-0"	N	HM	T	1	HM	-	
DOUBLE EGRESS DOORS									
301	7'-4"	7'-0"	N	HM	T	1	HM	-	
SPECIALITY DOORS									
501	7'-6"	7'-6"	SI	AL/GL	IT	-	AL/GL	-	SLIDER
502	4'-6"	8'-0"	RF	STL	-	-	STL	-	ROLLING FIRE DOOR

Doors are sorted by Single Doors, Double Doors, Cased Openings, Double Egress & Specialty

Each Door Type is scheduled here ONE TIME and referenced many times on the Floor Plans

An individual Door Type is comprised of the following:

- **Door Type** – the unique alpha-numeric designation
- **Door Width** & **Door Height** – the door size
- **Door Elevation** – the style of door – (F) Flush, (N) Narrow Lite, (G) Glass, (OH) Overhead door, etc.
- **Door Material** – wood, hollow metal, glass, steel, etc.
- **Door Glazing** – indicates Yes or No
- **Frame Elevation** – the type of frame (some versions include glazing)
- **Frame Material** – hollow metal, wood, aluminum, steel, etc.
- **Frame Glazing** - indicates Yes or No
- **Remarks**

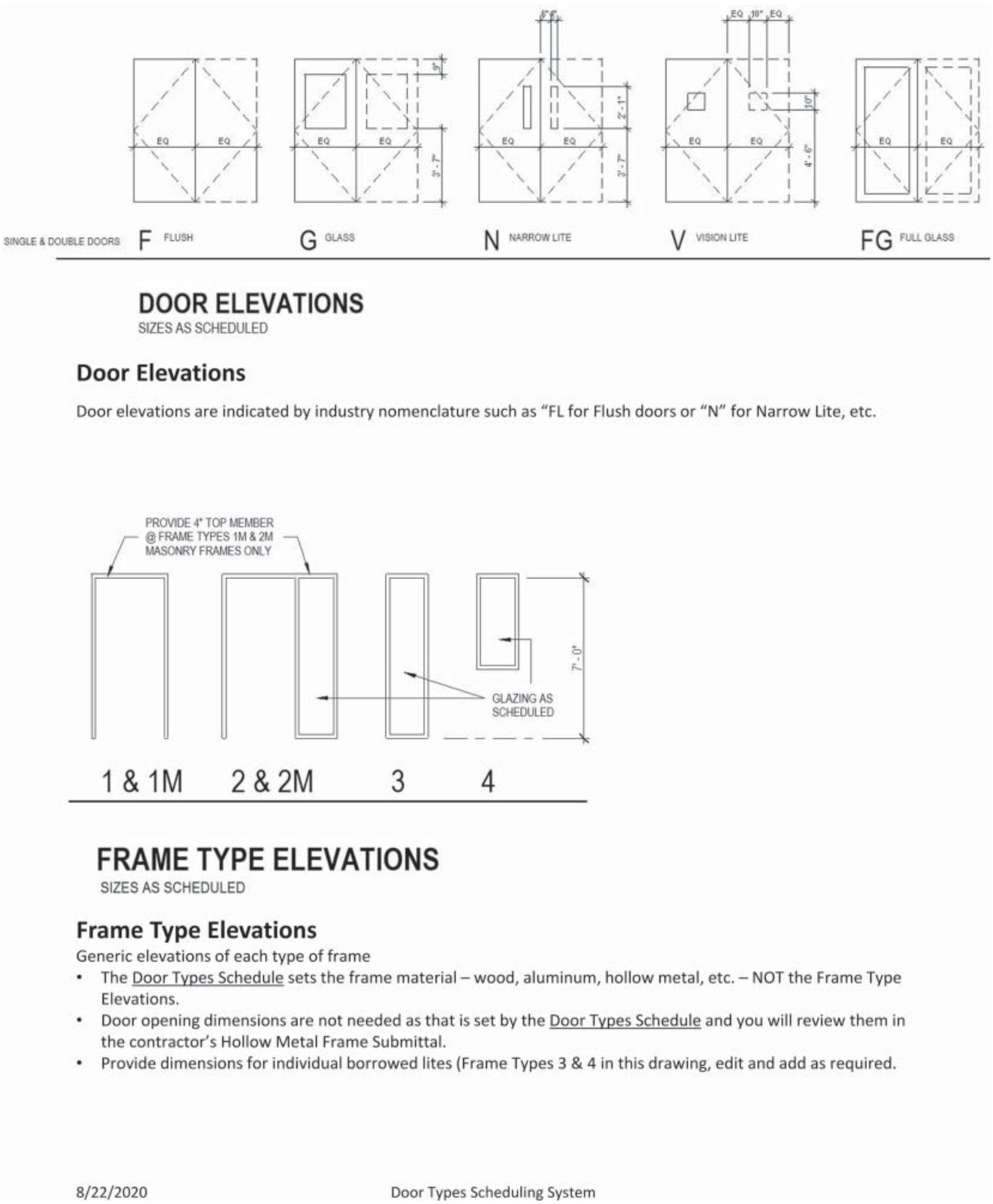
GENERAL NOTES

- ALL WOOD AND HOLLOW METAL DOORS ARE 1 3/4" THICK.
- DOOR DETAILS ARE TYPICAL AS SHOWN ON THIS SHEET UNLESS REFERENCED OTHERWISE ON DRAWINGS.
- REFER TO THE PARTITION TYPE ON THE FLOOR PLAN(S) OR APPLICABLE WALL SECTION AND THEN TO THE TYPICAL DOOR DETAILS.
- FOR NEW DOORS IN EXISTING FRAMES, FIELD VERIFY THE EXISTING FRAME SIZE.

8/22/2020 Door Types Scheduling System

Instructional General Notes above to help the contractor understand the system.

FIGURE 8.50 Door Types System Packet.



DOOR ELEVATIONS
SIZES AS SCHEDULED

Door Elevations

Door elevations are indicated by industry nomenclature such as "FL for Flush doors or "N" for Narrow Lite, etc.

FRAME TYPE ELEVATIONS
SIZES AS SCHEDULED

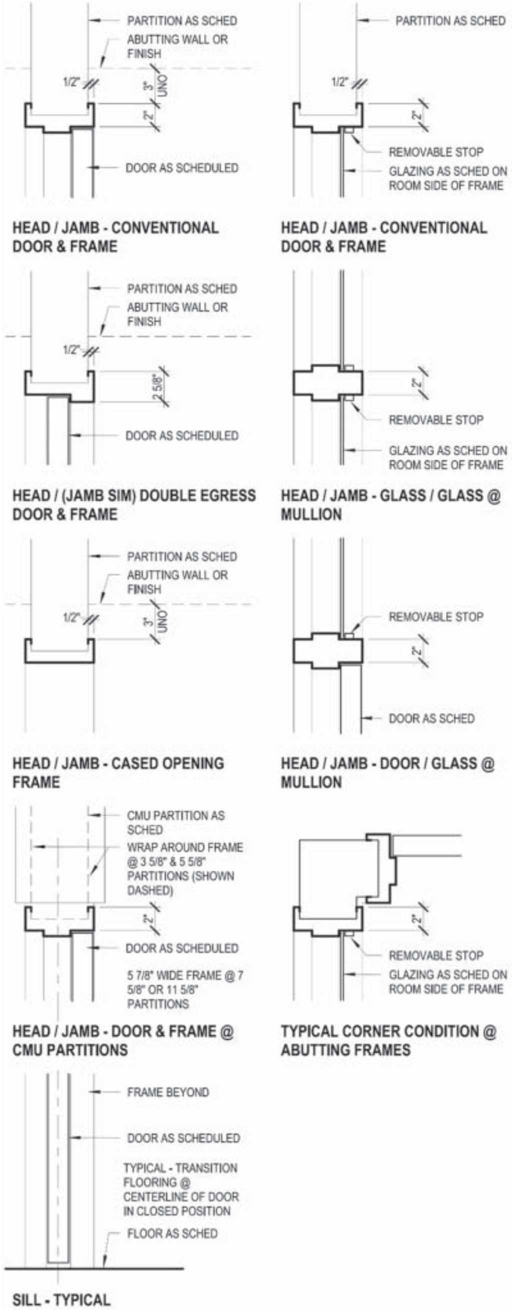
Frame Type Elevations

Generic elevations of each type of frame

- The Door Types Schedule sets the frame material – wood, aluminum, hollow metal, etc. – NOT the Frame Type Elevations.
- Door opening dimensions are not needed as that is set by the Door Types Schedule and you will review them in the contractor's Hollow Metal Frame Submittal.
- Provide dimensions for individual borrowed lites (Frame Types 3 & 4 in this drawing, edit and add as required.

8/22/2020 Door Types Scheduling System

FIGURE 8.51 Door Types System Packet.



Typical Interior Door Details – Head, Jamb,& Sill

These drawings are generic. More complex intersections with multiple building elements are covered using Plan or Section details – and should be located on those sheets.

- Neither the Partition width or type of wall is indicated here (except for Masonry)
- Review the CA phase Hollow Metal Frames submittal, for the door throat dimensions.
- The project Specifications establish criteria for the type of metal door frames – welded, knock-down, etc. as well as common construction practice such as double studs at door jambs, box headers, etc. Nothing else is required here.

8/22/2020 Door Types Scheduling System

FIGURE 8.52 Door Types System Packet.

Revit Template

Partition Types

Fall 2020

FIGURE 8.53 Partitions System Packet.

Partitions

GOAL

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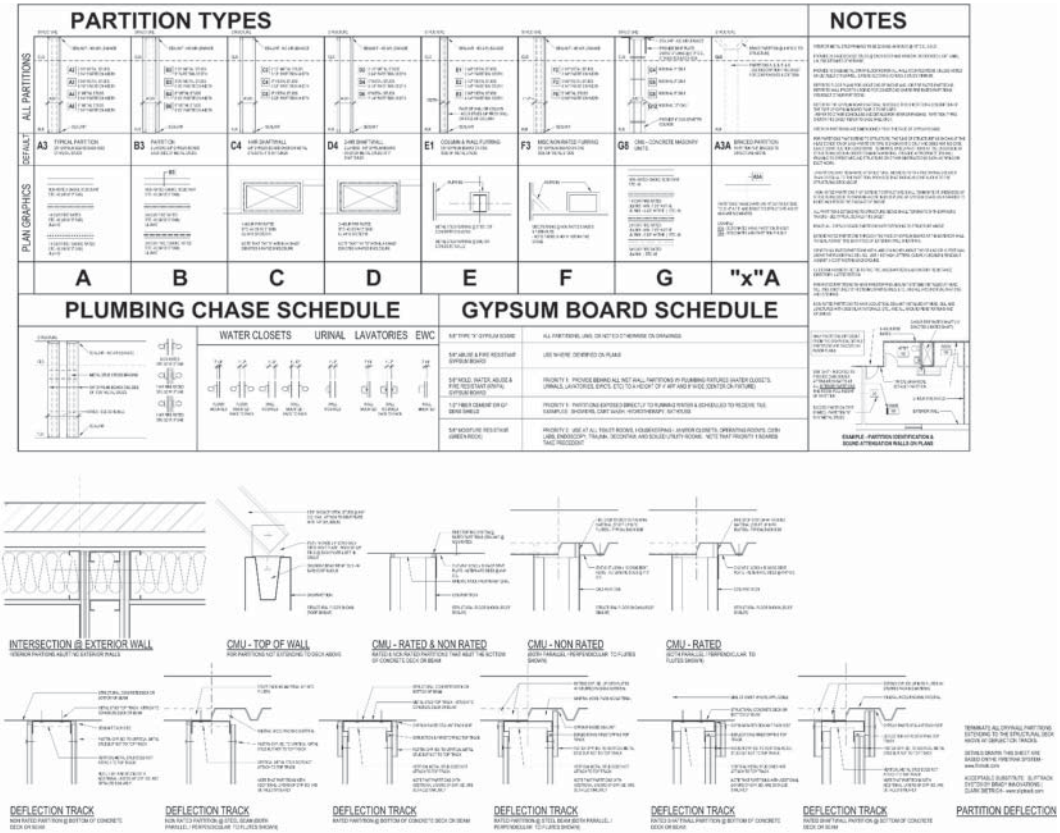
FIGURE 8.54 Partitions System Packet.



COMPONENTS

This sheet is comprised of the following elements –

Partitions – typical partitions are shown by wall type

- Metal studs w/ gypsum board to structure
- Shaftwall
- Metal studs w/ gypsum board extending above ceiling w/ bracing to structure
- CMU
- Metal stud furring around columns
- Metal stud furring for non-rated chases
- And more...

Notes – read, understand, and edit for your project

Plumbing Chase Schedule – indicates fixtures with adjacent partition

Example Floor Plan – intended to be for the contractor's reference

Gypsum Board Schedule – edit to reflect what is used on your project

Typical wall termination details (rated & non-rated) – do NOT reference onto other drawings

FIGURE 8.55 Partitions System Packet.

Partitions

PARTITION BASICS

Partition types cover the base wall only – Room Finishes scheduled elsewhere

Differing types of gypsum board are covered via the Gypsum Board Schedule. Do NOT create new partition types because the type of gypsum is different.

- Other variations such as lead lining (for healthcare projects) can be conveyed by plan notes: Example: PROVIDE 1/16" LEAD LINING ALL WALL PLANES THIS ROOM TO PROVIDE A COMPLETE ROOM ENCLOSURE. or PROVIDE 1/16" LEAD LINING THIS WALL PLANE.

DIMENSIONING

The Revit Template is setup to dimension to the face of gypsum board on one side.

- Question: Why dimension to the face of gypsum board and not the face of metal stud?
- Answer: Usually we are concerned where the face of gypsum board is in relationship to other surfaces and the studs are incidental.

Partitions are organized into 2 categories –

1. ALL PARTITIONS – a listing of all partitions for a given category such as A, B, C, etc. These indicate metal stud or CMU Wythe sizes.

   PLAN GRAPHICS – a graphical indication of how partitions are indicated on floor plans. Understand that most partitions will NOT need to be tagged as they are the "default" condition.

   - Example: Partition Type E, column and wall furring, does NOT need to be tagged in most situations. Defining the E1 partition establishes the stud size and contractor experience will help them understand where it applies.

   2-dimensional representation allows many partitions to graphically identify themselves and often cover 90% or more of those found on a given project – dramatically reducing the amount of tagging required.

REVIT WORKFLOW

DESIGN – for Revit plan development during design select a standard partition such as an A3 wall (3 5/8" metal studs w/ 5/8" gypsum board each side, extending to structural deck above) - whichever is expected to be a common wall for the project.

- As design progresses, change partitions to be different types & thicknesses
- Note that the Fire Tape as drawn on the plans identifies whether a partition is fire rated or not. An A3 partition, for example, can be rated or non-rated – it depends on the Fire Tape

CONSTRUCTION DRAWINGS – delete or add Partitions to Sheet as needed; review & revise Partition Notes

CONSTRUCTION ADMINISTRATION – review gypsum board submittals w/ drawings and specifications

FIGURE 8.56 Partitions System Packet.

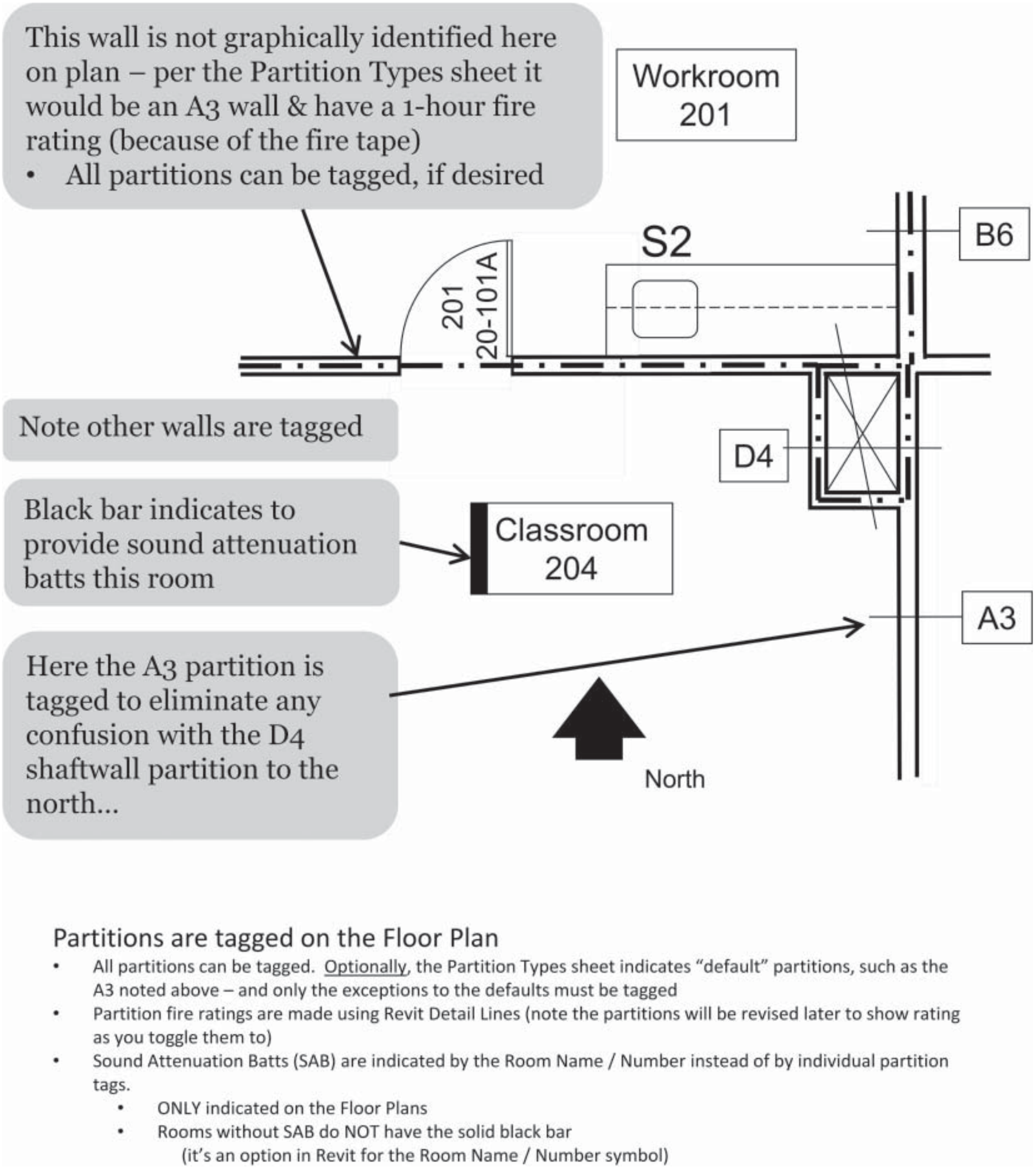


FIGURE 8.57 Partitions System Packet.

NOTES

INTERIOR METAL STUD FRAMING TO BE 22 GAGE (MINIMUM) @ 16" O.C., U.N.O.

PROVIDE 20 GAGE DOUBLE STUDS @ EACH DOOR AND WINDOW / BORROWED LIGHT JAMB, UNLESS DETAILED OTHERWISE.

PROVIDE 16 GAGE METAL STRAP BLOCKING FOR ALL WALL MOUNTED ITEMS, UNLESS NOTED OR DETAILED OTHERWISE. EXTEND BLOCKING ACROSS 3 STUDS MINIMUM.

REFER TO FLOOR PLANS FOR LOCATIONS OF SMOKE AND / OR FIRE RATED PARTITIONS. REFER TO WALL PRIORITIY LEGEND FOR CONDITIONS WHERE FIRE RATED PARTITIONS INTERSECT OTHER PARTITIONS.

REFER TO THE GYPSUM BOARD MATERIAL SCHEDULE THIS SHEET FOR A DESCRIPTION OF THE TYPE OF GYPSUM BOARD PANELS TO BE USED.
- REFER TO OTHER SCHEDULES AND DETAILS FOR INTERIOR FINISHES. PARTITION TYPES SHOWN THIS SHEET REFER TO BASE WALL ONLY.

INTERIOR PARTITIONS ARE DIMENSIONED FROM THE FACE OF GYPSUM BOARD.

FOR PARTITIONS THAT EXTEND TO STRUCTURE, THE "LINE OF STRUCTURE" AS SHOWN AT THE HEAD CONDITION OF EACH PARTITION TYPE IS DIAGRAMATIC ONLY AND DOES NOT INDICATE EXACT CONSTRUCTION CONDITIONS. TERMINATE RATED PARTITIONS AT THE UNDERSIDE OF STRUCTURAL DECK IN ORDER TO MAINTAIN RATING. PROVIDE APPROPRIATE DRYWALL FRAMING TO OFFSET AROUND STRUCTURE OR OTHER OBSTRUCTIONS SUCH AS PIPING OR DUCT WORK.

- PARTITIONS MAY TERMINATE AT STRUCTURAL MEMBERS WITH A FIRE RATING GREATER THAN OR EQUAL TO THE PARTITION, PROVIDED THAT RATING IS CONTINUOUS TO THE STRUCTURAL DECK ABOVE.

- NON-RATED PARTITIONS THAT EXTEND TO STRUCTURE SHALL TERMINATE AT UNDERSIDE OF STRUCTURAL DECK TO MAINTAIN A CONTINUOUS PLANE OF GYPSUM BOARD AS A BARRIER TO NOISE AND RESIST THE PASSAGE OF SMOKE..

ALL PARTITIONS EXTENDING TO STRUCTURE ABOVE SHALL TERMINATE WITH EXPANSIVE TRACKS - SEE TYPICAL DETAILS THIS SHEET.

BRACE ALL GYPSUM BOARD PARTITIONS NOT EXTENDING TO STRUCTURE ABOVE.

EXTEND RATED PARTITIONS THROUGH THE FACE OF GYPSUM BOARD AT THE EXTERIOR WALL TO SEAL AGAINST THE BACK FACE OF EXTERIOR WALL SHEATHING.

IDENTIFY ALL RATED PARTITIONS WITH LABELS 6 INCHES ABOVE THE CEIILNG OR 10 FEET MAX. ABOVE THE FLOOR IF NO CEILING. USE 1 1/2" HIGH LETTERS, CLEARLY LEGIBLE & READABLE AGAINST A CONTRASTING BACKGROUND.

UL DESIGN NUMBERS REFER TO THE FIRE UNDERWRITERS LABORATORY RESISTANCE DIRECTORY, LATEST EDITION.

FIRE RATED PARTITIONS TO HAVE FIRESTOPPING SEALANT SYSTEMS INSTALLED AT HEAD, SILL, AND JUNCTURES WITH DISSIMILAR MATERIALS, ETC., AND ALL AROUND PENETRATIONS AND OPENINGS.

NON-RATED PARTITIONS TO HAVE ACOUSTICAL SEALANT INSTALLED AT HEAD, SILL, AND JUNCTURES WITH DISSIMILAR MATERIALS, ETC., AND ALL AROUND PENETRATIONS AND OPENINGS.

Notes – These establish many of the "rules" for the contractor to bid and build by.

FIGURE 8.58 Partitions System Packet.

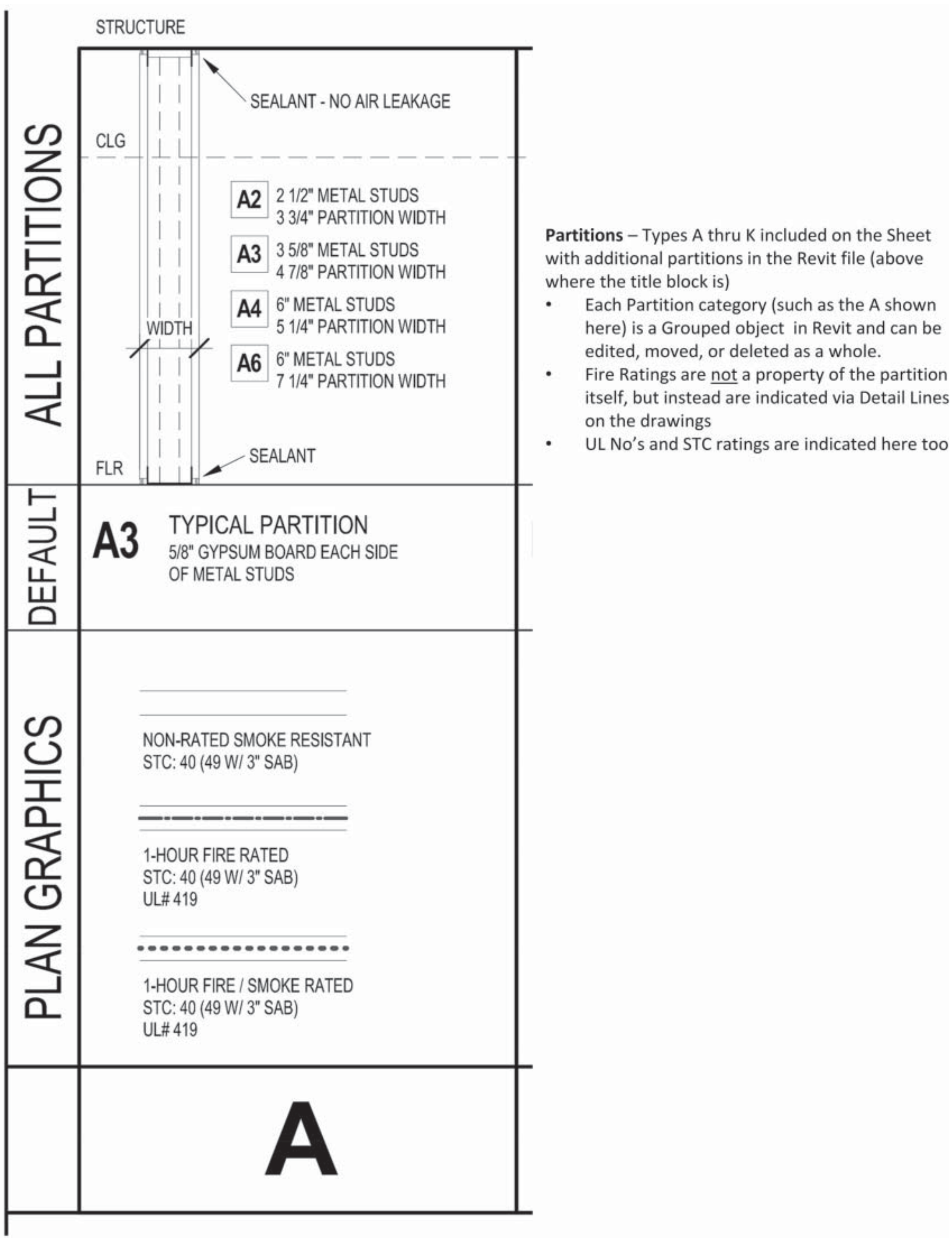
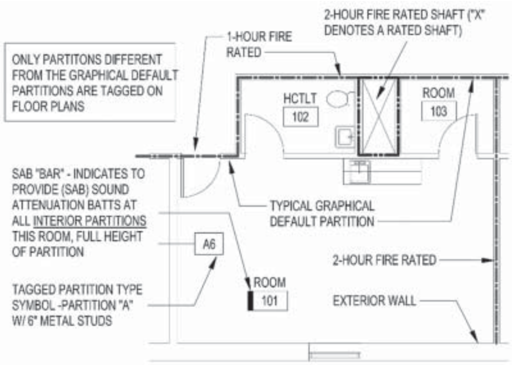


FIGURE 8.59 Partitions System Packet.



EXAMPLE - PARTITION IDENTIFICATION & SOUND ATTENUATION WALLS ON PLANS

Example Plan

Contractor friendly drawing indicating how partitions are shown on floor plans

- Note that sound attenuation batts (SAB) are conveyed by the room tag instead of by individual partitions.

GYPSUM BOARD SCHEDULE

5/8" TYPE "X" GYPSUM BOARD	ALL PARTITIONS, UNO, OR NOTED OTHERWISE ON DRAWINGS
5/8" ABUSE & FIRE RESISTANT GYPSUM BOARD	USE WHERE IDENTIFIED ON PLANS
5/8" MOLD, WATER, ABUSE & FIRE RESISTANT (MWFA) GYPSUM BOARD	PRIORITY 1: PROVIDE BEHIND ALL WET WALL PARTITIONS W/ PLUMBING FIXTURES (WATER CLOSETS, URINALS, LAVATORIES, EWC'S, ETC) TO A HEIGHT OF 4' AFF AND 8' WIDE (CENTER ON FIXTURE)
1/2" FIBER CEMENT OR GP DENS SHIELD	PRIORITY 1: PARTITIONS EXPOSED DIRECTLY TO RUNNING WATER & SCHEDULED TO RECEIVE TILE. EXAMPLES: SHOWERS, CART WASH, HYDROTHERAPY, BATHTUBS
5/8" MOISTURE RESISTANT (GREEN ROCK)	PRIORITY 2: USE AT ALL TOILET ROOMS, HOUSEKEEPING / JANITOR CLOSETS, OPERATING ROOM'S, CATH LABS, ENDOSCOPY, TRAUMA, DECONTAM, AND SOILED UTILITY ROOMS. NOTE THAT PRIORITY 1 BOARDS TAKE PRECEDENT

Gypsum Board Schedule
Edit to suit your project's requirements

FIGURE 8.60 Partitions System Packet.

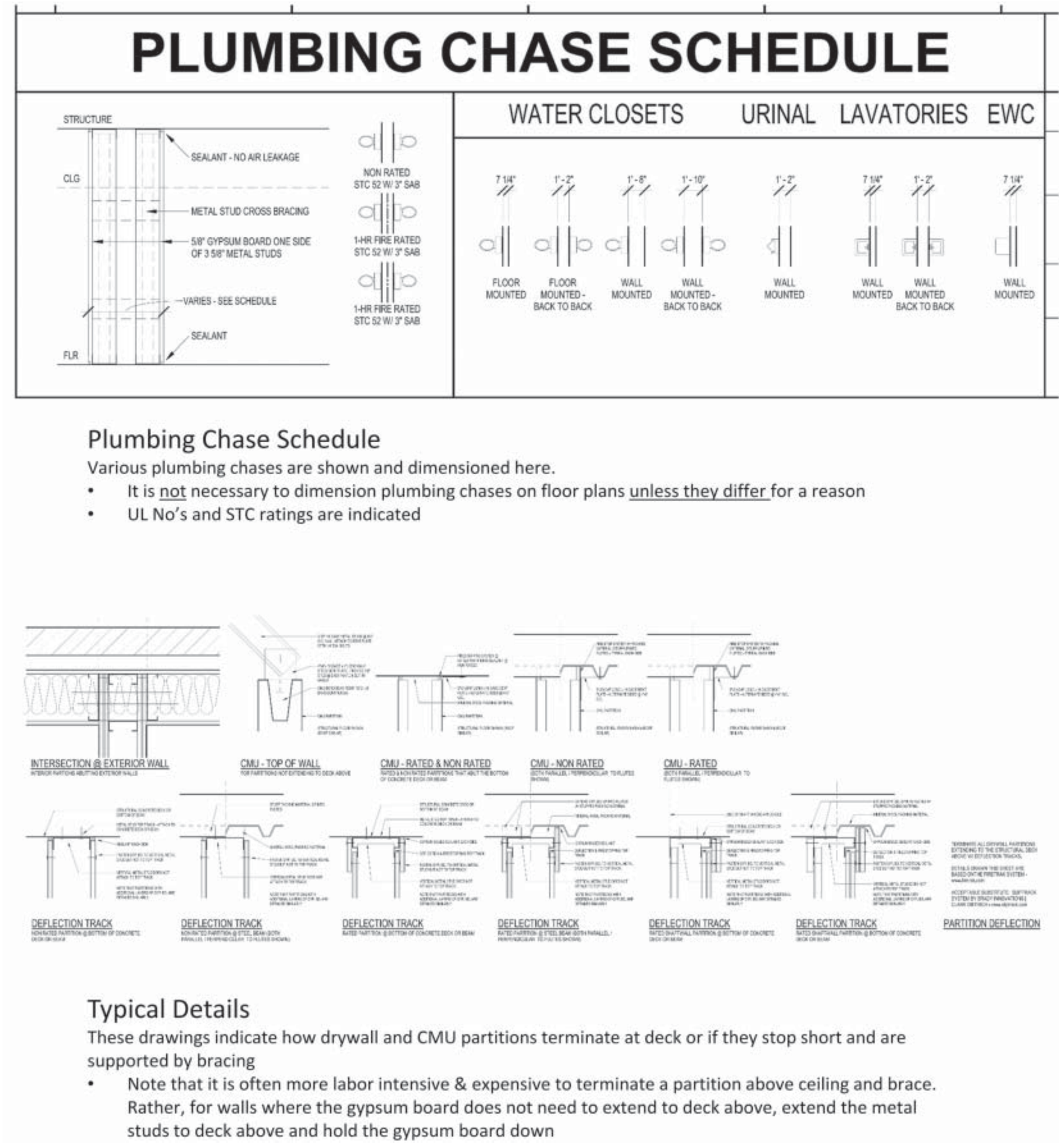


FIGURE 8.61 Partitions System Packet.

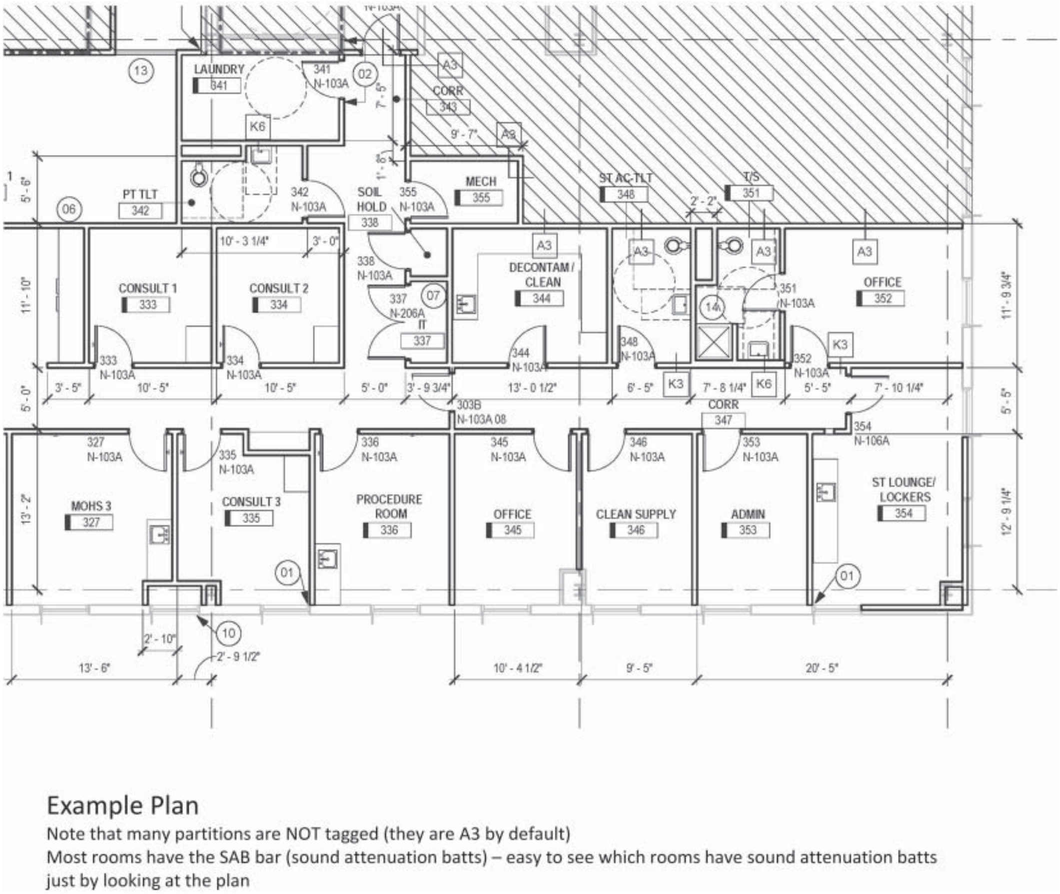


FIGURE 8.62 Partitions System Packet.

Revit Template

Plumbing Fixture Types

Fall 2020

FIGURE 8.63 Plumbing Fixtures System Packet.

TOILET TYPES

GOAL

We want to simplify and streamline aspects of the CD documentation process. This System works by addressing a majority of situations found in lieu of a more complex system that covers every possible situation. Atypical, complex and design-oriented features may warrant separate drawings.

There is no time saving in thinking through issues affecting your project, but rather a simplifying or reduction of the documenting effort.

This approach uses two methodologies:

> Default Scheduling – "... employs a methodology to schedule building components such as toilet accessories, doors, partitions, accessibility clearances, cabinetry, sealants, metal fabrications, etc."
>
> - AIA Handbook of Professional Practice, 15th Edition
>
> Instructional Systems – "...drawings and notes that graphically coach the drafter or contractor to an understanding of project conventions such as scheduling or documentation methods."
>
> - AIA Handbook of Professional Practice, 15th Edition © 2013

This sheet is setup to require minimal editing, however, to be effective, users must understand the system and how it works. Thinking slowly allows us to work and document more quickly.

Many model elements shown on the resulting construction drawings can be referenced by default without any specific graphical referencing required. The steps are to:

- Each system covers most situations found...
- Set Defaults – graphical "rules"
- Find the exceptions

APPLICABLE CODES

This systems has been reviewed with the following:

- 2009 ANSI Guidelines
- 2010 ADA Guidelines
- 2012 Texas Accessibility Standards
- 2014 Florida Accessibility Code
- 2017 ANSI Guidelines (with a separate version of the Revit file for now)

8/22/2020 Toilet Types System

FIGURE 8.64 Plumbing Fixtures System Packet.

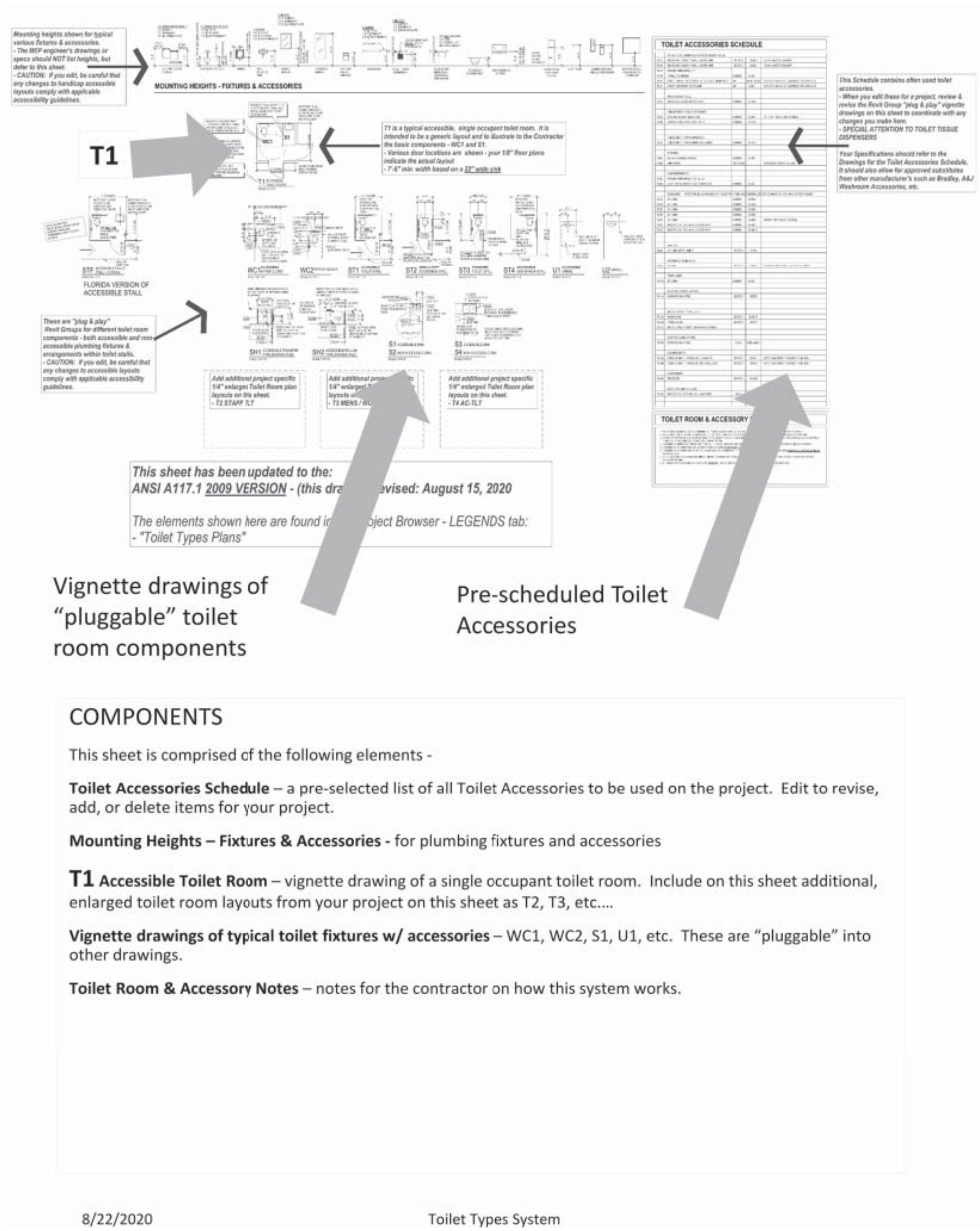


FIGURE 8.65 Plumbing Fixtures System Packet.

WORKFLOW WITH CHECKLISTS

DESIGN

❑ Develop floor plans with toilet room layouts. Model and draw accurately and provide the required accessibility clearances . The vignette drawings on the Plumbing Fixture Types System sheet provide reference information that has been reviewed w/ the current accessibility guidelines (see list on page 2 of this document).

CONSTRUCTION DRAWINGS

❑ Edit the Toilet Accessories Schedule for your project – delete accessories not used, add new ones.

❑ Review & edit the vignette drawings for any toilet accessory changes you make. Some common edits are described below.

Sink vignette drawings tend to change per project.

- On your 1/4" enlarged plans, counters with multiple sinks, such as in large bathrooms, are the place to indicate actual locations for paper towel dispensers. They are still indicated on the S1, S2, etc., vignette drawing and then tagged on the enlarged toilet room plan at the specific location.
- Sometimes it may be better to field locate soap dispensers in the field with the Owner and Contractor during construction than to dimension them on interior elevations. If so, add a note saying this to the S1, S2, etc., vignette drawings accordingly.

❑ Add your project specific enlarged plans onto this sheet and name them T2, T3, etc.

1. "Plug" the applicable vignette drawing designations (**WC1**, **S1**, **S2**, **ST1**, etc.) onto your enlarged plans using **12" BOLD Arial** text (so it stands out).
2. Then, annotate or "plug" the **T1**, **T2**, **T3**, etc., designations onto your 1/8" floor plans.
   - Option: traditional "call-outs" on 1/8" Floor Plans can be used for toilet rooms

For any toilet room Interior Elevations you draw that show toilet fixtures & toilet accessories for context, **do NOT retag the accessories or dimension heights or clearances again (this sheet should be the only place covering that info).**

- It is good practice to elevate bathroom walls ONLY to show atypical tile patterns or other construction complexities.

Shower layouts best utilize the 1/4" enlarged plan that provides the full floor plan context and indicate there the locations of towel bars and robe hooks. Again, the SH-1 or 2 vignette drawings show & tag most of the elements in this case.

SPECIFICATIONS

The Toilet Accessories Schedule is already on the drawings. Your specifications should reference the "Drawings" for the Toilet Accessories Schedule and provide a list of other acceptable manufacturer's.

BIDDING

Draw the contractor's attention to how this scheduling system for Toilet accessories works at the Pre-Bid or review beforehand with a Design-Build partner.

CONSTRUCTION ADMINISTRATION

Review the Toilet Accessories submittal with this sheet & the enlarged floor plans.

8/22/2020 Toilet Types System

FIGURE 8.66 Plumbing Fixtures System Packet.

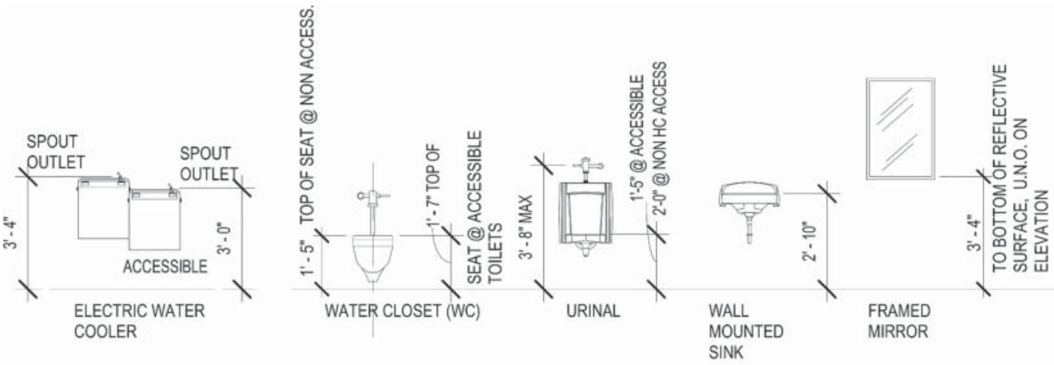
TOILET ACCESSORIES SCHEDULE

	PAPER TOWEL DISPENSER & WASTE RECEPTACLES			
TA1A	RECESSED COMBO TOWEL / WASTE UNIT	BOBRICK	B-3944	12 GAL WASTE CAPACITY
TA1B	RECESSED COMBO TOWEL / WASTE UNIT	BOBRICK	B-3947	18 GAL WASTE CAPACITY
TA1C	OWNER FURNISHED UNIT			
TA1D	TOWEL DISPENSER	BOBRICK	B-262	
TA1E	ENMOTION S.S., RECESSED UNIT & TOWEL DISPENSER	GP	59491 / 59466	OWNER FURNISHED, CONTRACTOR INSTALLED
TA1F	ENMOTION TOWEL DISPENSER	GP	59462	OWNER FURNISHED, CONTRACTOR INSTALLED
	WASTE RECEPTACLE			
TA2A	RECESSED WASTE RECEPTACLE	BOBRICK	B-3644	
	TOILET PAPER TISSUE DISPENSER			
TA3A	SEMI-RECESSED - DUAL ROLL	BOBRICK	B-6997	W/ THEFT RESISTANT SPINDLE
TA3B	SURFACE MOUNTED - DUAL ROLL	BOBRICK	B-2740	
	TOILET SEAT COVER DISPENSER			
TA4A	TOILET SEAT COVER DISPENSER, WHITE	BOBRICK	B-4221	
	MIRRORS			
TA5A	24 x 36 CHANNEL FRAMED	BOBRICK	B-165	
TA5B	UNFRAMED	SEE SPECS		SIZES INDICATED ON PLANS
	SOAP DISPENSERS			
TA6A	OWNER FURNISHED & INSTALLED			
TA6B	LAVATORY MOUNTED SOAP DISPENSER	BOBRICK	B-822	
	GRAB BARS NOTE: FOR ALL GRAB BARS ON TOILET PARTIIONS - USE BOBRICK 258 SERIES ANCHORS, ONE ANCHOR PER FLANGE			
TA7A	36" LONG	BOBRICK	B-6806	
TA7B	42" LONG	BOBRICK	B-6806	
TA7C	24" LONG	BOBRICK	B-6806	
TA7D	30" LONG	BOBRICK	B-6806	
TA7E	18" LONG	BOBRICK	B-6806	MOUNT VERTICALLY ON WALL
TA7F	HORIZONTAL TWO WALL SHOWER BAR	BOBRICK	B-6861	
TA7G	HORIZONTAL TWO WALL SHOWER BAR	BOBRICK	B-68616	

Toilet Accessories Schedule - edit for your project
- Don't change a category - example: TA**7** series should always be grab bars
- Delete unused items

8/22/2020 Toilet Types System

FIGURE 8.67 Plumbing Fixtures System Packet.



MOUNTING HEIGHTS - FIXTURES & ACCESSORIES

Mounting Heights – Fixtures & Accessories

Both accessible & non-accessible components are shown here w/ vertical mounting height criteria.

Delete any other instances in the Specifications and Arch or Plumbing drawings indicating mounting heights – this is the ONLY location to find that information.

Do not repeat dimensions for fixtures and accessories if they are shown on other drawings such as interior elevations.

Example: It is common when elevating bathroom walls that indicate complex tile patterns to also show the toilet accessories that are on the walls for context.

Your model will accurately show all items but if we re-dimension the mounting criteria there again, it is one more thing to coordinate and worse yet, we may conflict w/ the information shown on this sheet.

Simplify the contractor's job and let them rely on this sheet alone for all dimensional criteria related to mounting.

8/22/2020 Toilet Types System

FIGURE 8.68 Plumbing Fixtures System Packet.

TOILET ROOM & ACCESSORY NOTES

1. ENLARGED PLANS INDICATE DIMENSIONS, TOILET ACCESSORY LOCATIONS, AND REQUIRED CLEARANCES TO BE MAINTAINED.
2. ENLARGED TOILET ROOM LAYOUTS (T1, T2, T3, ETC.,) AND SINK "TYPES" (S1, S2, ETC.,) ARE KEYED ONTO 1/8" SCALE FLOOR PLANS.
3. REFER TO 1/8" SCALE FLOOR PLAN SHEETS FOR EXACT TOILET ROOM AND / OR FIXTURE ORIENTATION, DOOR LOCATION(S), ADJACENT WALL CONSTRUCTION, AND ADDITIONAL EQUIPMENT ITEMS.
4. DIMENSIONS INDICATED HERE ARE TYPICAL, UNLESS DIMENSIONED OTHERWISE ON FLOOR PLAN SHEETS OR INTERIOR ELEVATIONS.
5. DIMENSIONS SHOWN FOR WALLS AND OPENINGS ARE FROM FACE OF GYPSUM BOARD.
6. DIMENSIONS SHOWN FOR TOILET ACCESSORIES AND EQUIPMENT ITEMS AS WELL AS CLEAR FLOOR SPACE ARE FROM FACE OF ROOM FINISH (SUCH AS TILE).
7. NOTE THAT DOORS CANNOT INFRINGE UPON OR SWING INTO THE REQUIRED RECTANGULAR "CLEAR FLOOR SPACE" AREAS SHOWN ON ENLARGED PLANS.
8. PLUMBING FIXTURES SHOWN HERE ARE GENERIC - SEE PLUMBING DRAWINGS FOR ACTUAL SCHEDULED FIXTURES.

Toilet Room & Accessory Notes

- These notes are Instructional for both the architect and contractor
- Note the distinctions for dimensions and what we're telling the contractor here.
- Also, remember, the plumbing fixtures we show graphically are generic (actual fixtures will be scheduled on Plumbing drawings)

8/22/2020 Toilet Types System

FIGURE 8.69 Plumbing Fixtures System Packet.

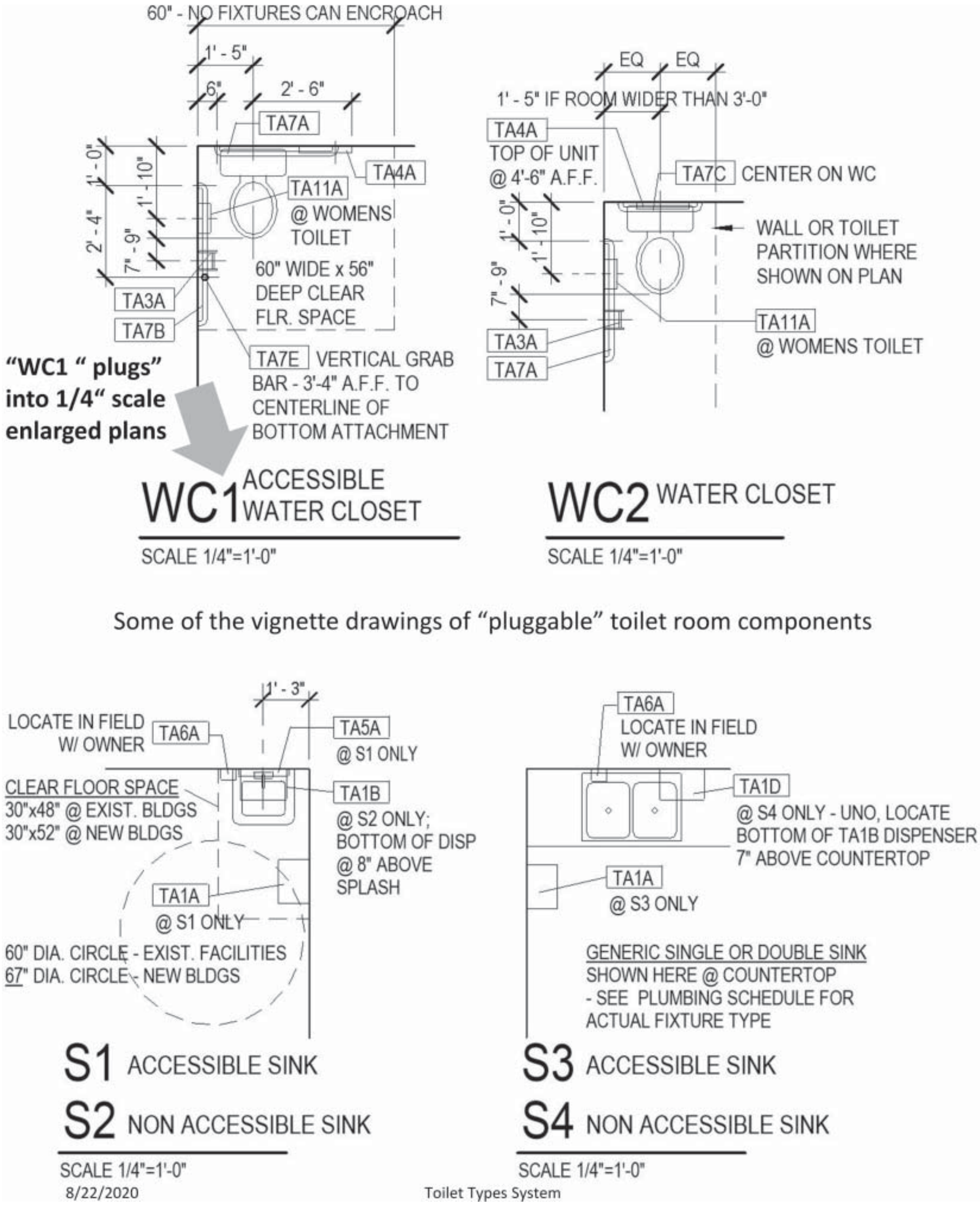
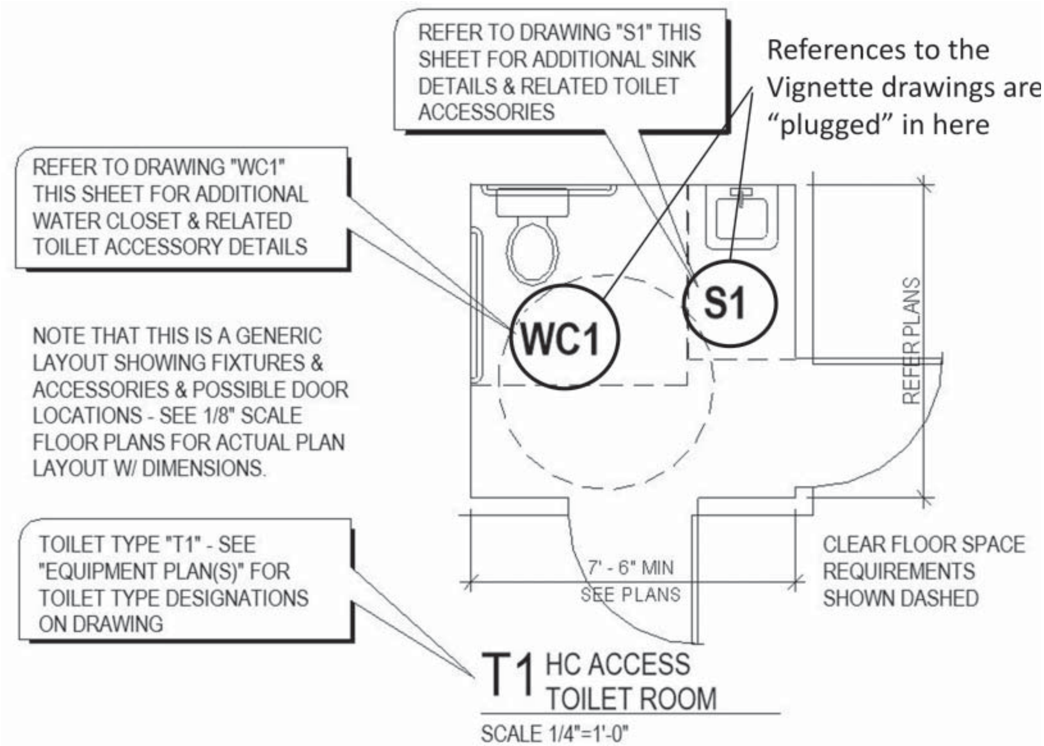


FIGURE 8.70 Plumbing Fixtures System Packet.



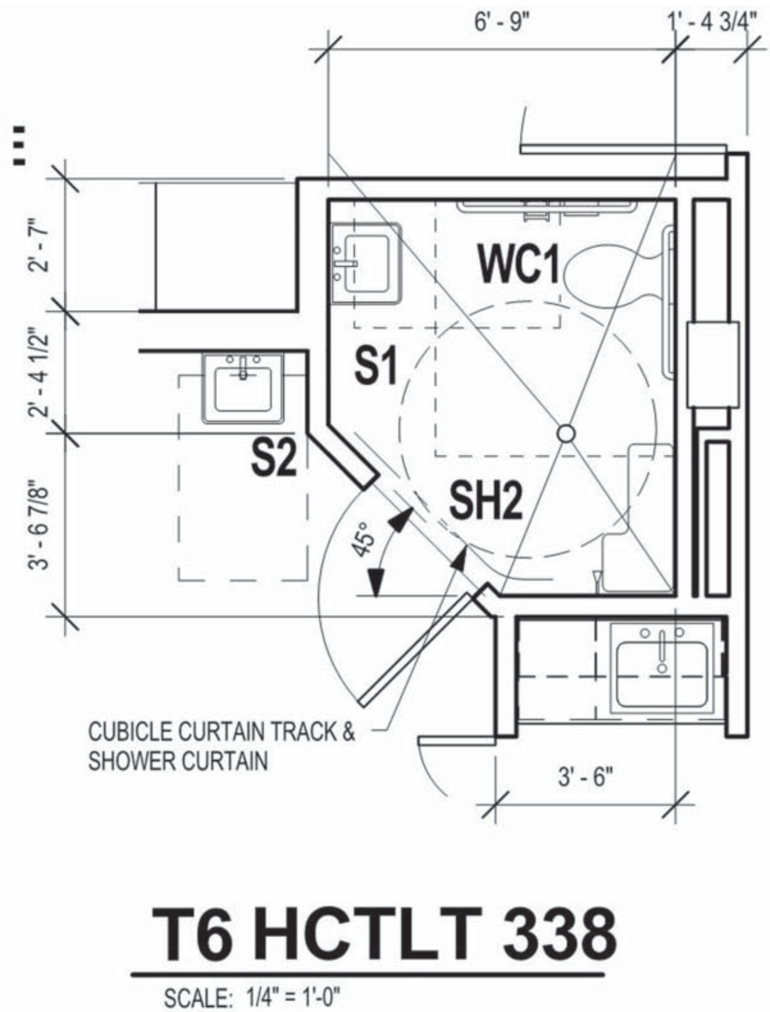
T1 HC ACCESSIBLE TOILET ROOM

This is a generic, single occupant toilet room and it does NOT require editing.

- Overall room dimensions are to be shown on 1/8" floor plans – not here.
- The **T1** tag is placed onto the 1/8" floor plan in lieu of a bubbled plan "callout"

8/22/2020 Toilet Types System

FIGURE 8.71 Plumbing Fixtures System Packet.



EXAMPLE 1/4" ENLARGED PLAN

This is a project specific layout with vignette components shown (S1, SH2, etc.)

- Plan dimensions are shown here
- Note that Toilet accessories are not tagged again here
- The **T6** designation is shown on the 1/8" floor plan in lieu of a plan "callout"

8/22/2020 Toilet Types System

FIGURE 8.72 Plumbing Fixtures System Packet.

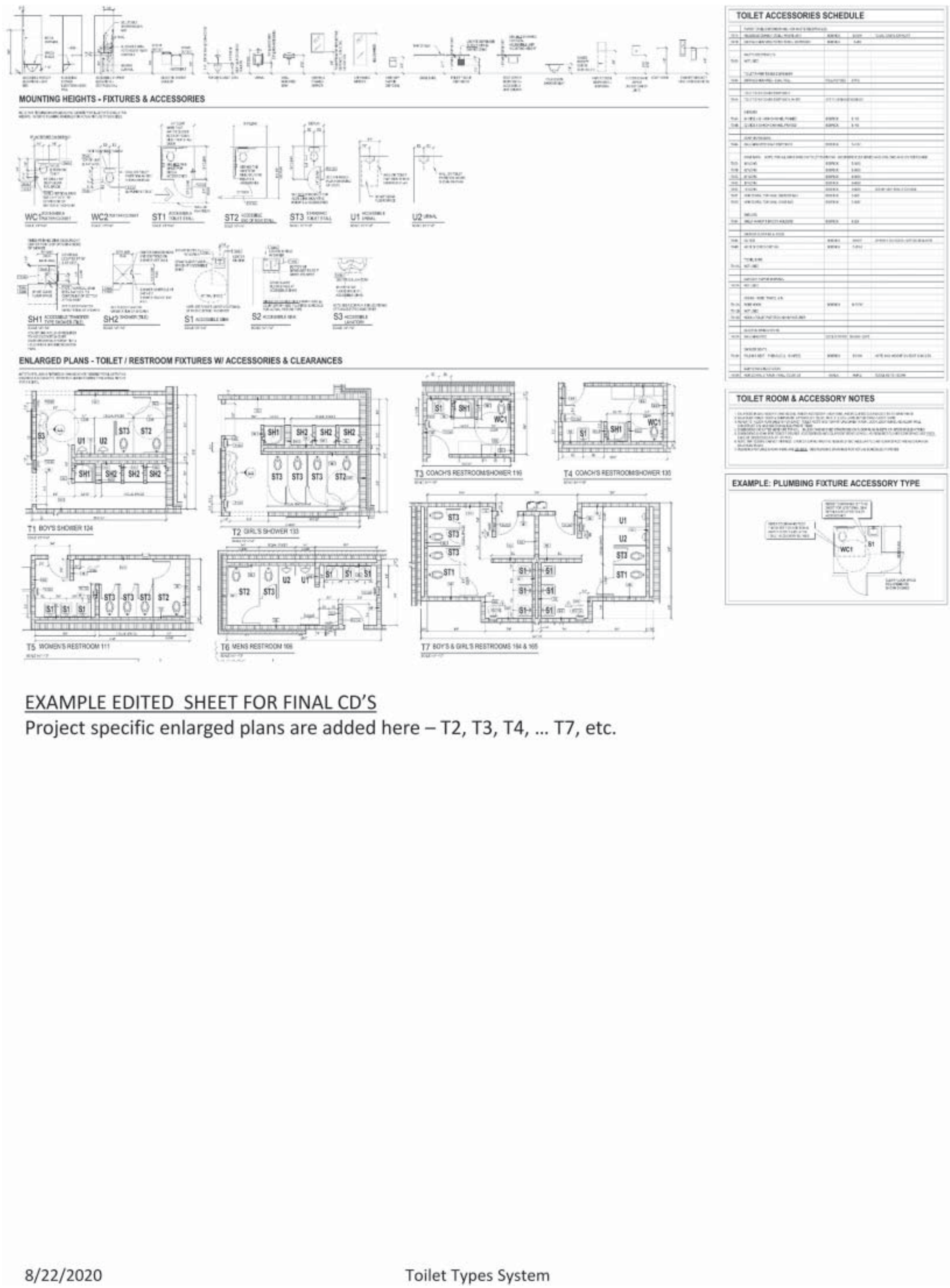
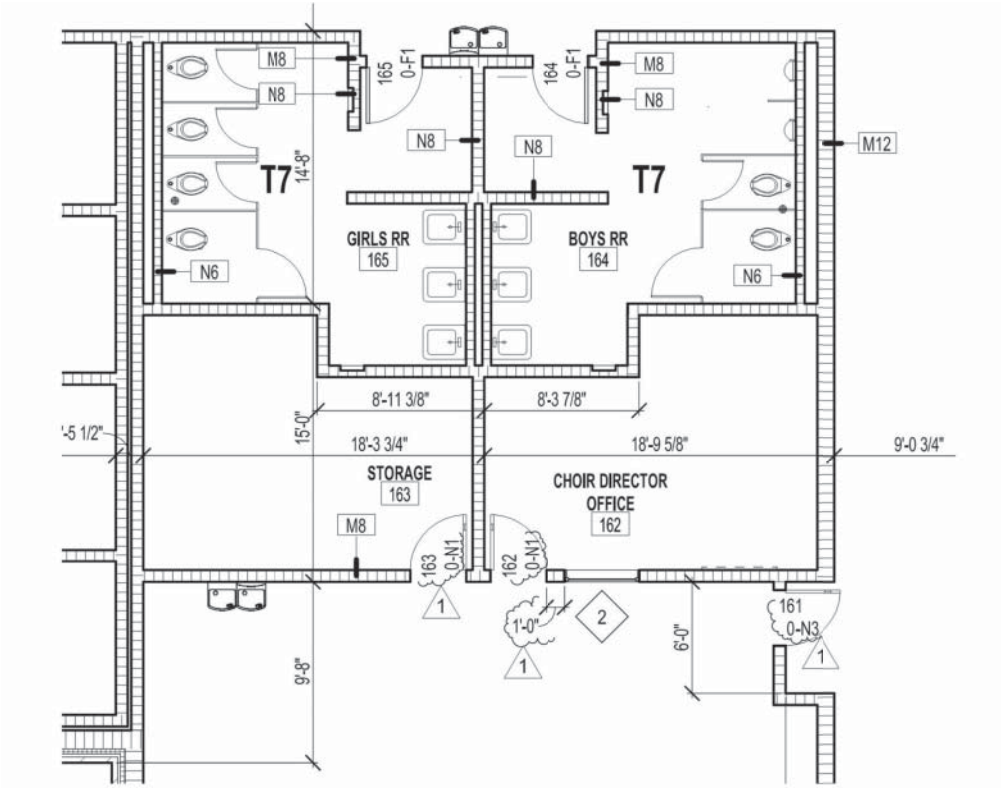


FIGURE 8.73 Plumbing Fixtures System Packet.



EXAMPLE FROM 1/8" FLOOR PLAN

Note how the **T7** designation is placed within the Boys and Girls toilet rooms and references back to the enlarged plan layout. No callout required on the floor plan

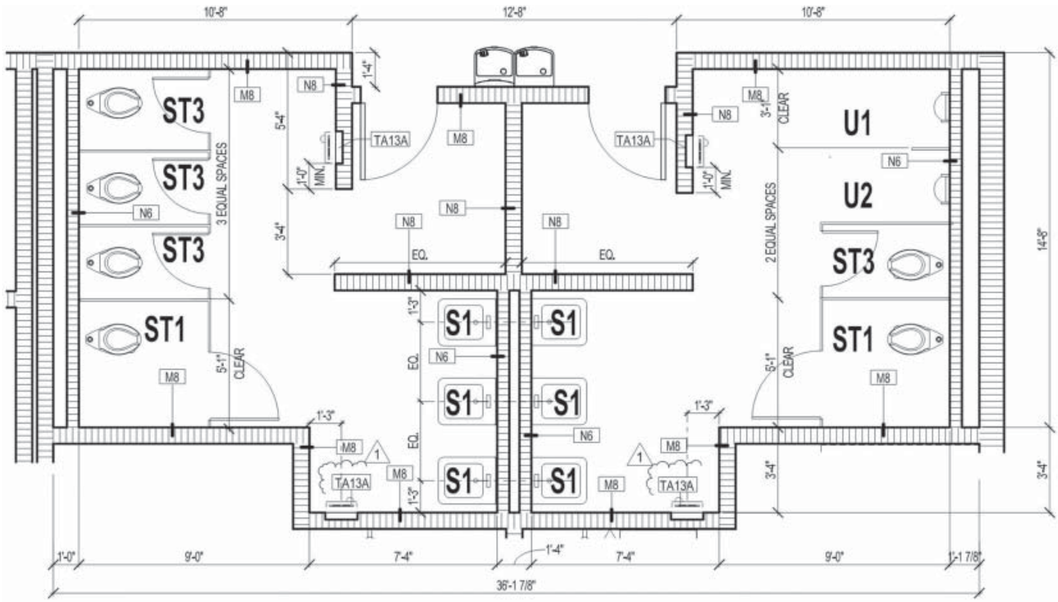
The **T7** designations are 12" high, bold text (i.e., it is not an intelligent BIM reference). It is intended to visually stand out graphically and be easy to see by the contractor.

- Even at this scale, it is easy to read and understand!

This method of referencing reduces the drawings graphic density on the floor plan and is easy to see & follow. Alternatively, traditional plan "call outs" could be used to reference to the enlarged plans.

8/22/2020 Toilet Types System

FIGURE 8.74 Plumbing Fixtures System Packet.



T7 BOY'S & GIRL'S RESTROOMS 164 & 165

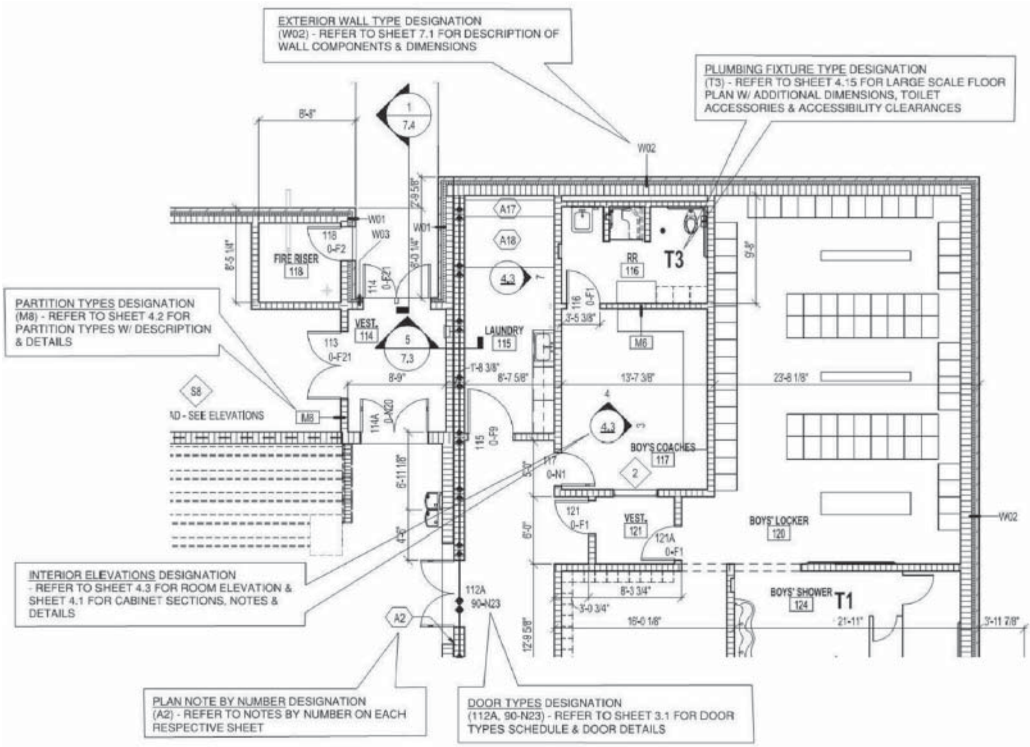
SCALE 1/4"=1'-0"

ENLARGED PLAN FROM EXAMPLE EDITED SHEET FOR FINAL CD'S

Vignette enlarged plans for individual plumbing fixtures are added here – ST1, ST3, S1, etc. Note how the "pluggable" references eliminate the need to re-tag and re-dimension everywhere.

8/22/2020 Toilet Types System

FIGURE 8.75 Plumbing Fixtures System Packet.



FLOOR PLAN KEY REFERENCES

WAYFINDING FOR THE CONTRACTOR

If we are using progressive documenting systems that differ from traditional methods, a simple drawings like this on the Cover Sheet or near the front of the set provides an easy to understand reference for the contractor as to how we are showing information – and where to find it in the set.

8/22/2020 Toilet Types System

FIGURE 8.76 Plumbing Fixtures System Packet.

PART III

Implementing Lean

CHAPTER 9

Rethinking Your Firm

In Parts I and II of the book we addressed the building blocks for understanding Lean and process management in general, with application to design practice components and Lean management, respectively. In Part III, we address (a) what it means to change and why it may be difficult, reasonable expectations, and the need to think long-term; (c) how to identify candidates for change; (d) implementation; (e) steps for small, medium-size, and large firms; and (f) how to develop tools and resources.

CHANGE

Change is not easy. If it were, giving a Microsoft PowerPoint or other similar software presentation could solve myriad problems! Unfortunately, creating change requires much more and can involve a daunting set of tasks. Within a design firm, implementing new ideas and making structural modifications may seem nearly impossible at the outset. Achieving real and lasting change requires a clear understanding of what is to be accomplished, the costs, and a timeframe, all of which should be well-defined with the firm's leadership.

Recognizing the need for change may be difficult, especially when times are good. An essential question to ask is, *What makes a firm want to or need to change?* The desire for improvement may come from many places (Table 9.1).

Whichever the influence, project challenges, major changes in the firm, and the economy are often the catalyst for deciding to make improvements.

Pride and Other Things

Several years ago, while researching for a speaking engagement, we came across the results of a survey published by the American Institute of Architects (AIA). It was included as part of the Architecture Billings Index (ABI) monthly report, which is an economic indicator that forecasts nonresidential construction for the next several months. The index shared the top five concerns by firms for the

TABLE 9.1 Internal and External Motivators for Improvement

Internal factors	External factors
• Increase profitability • Boost productivity • Improve firm culture • Improve quality of work	• Competition • Ability to deliver work faster • Contractual obligations • Litigation • Economic changes • New opportunities

coming year: (1) coping with an unpredictable economy; (2) negotiating appropriate project fees; (3) identifying new clients and new markets; (4) dealing with competition from other architecture firms and design professionals; and (5) managing rising costs of running a firm.

While the list was not surprising and each item is relevant, the obvious question to us was whether firms were giving serious attention to improving how they work. This seemed logical as processes that improve the firm's bottom line directly impact two of the five concerns, in our opinion. Efforts at self-improvement are also under our control, unlike an unpredictable economy, which is not. Ultimately, we referenced the ABI's results to ask the question: if other industries use process management approaches such as Lean, to provide better products and services and to do so at a lower cost, why do most design firms not? The answer to the question is influenced by many factors, but one to consider is that of pride. Many design firms are rightfully proud of their history, their organization, and ways of working. However, pride, just like tradition, can be a hindrance to seeing the need to make meaningful change. Other factors include viewing the effort involved as an overhead expense only instead of an investment or simply being too busy or uninterested. Some consider the profession to be primarily about aesthetic design and place little value on how the work is done.

Introspection

In addition to solving long-standing issues or gaining an understanding of the constraints that hinder effective project delivery, we must ask some basic questions: (1) Have we assessed our project delivery capabilities and know our strengths and weaknesses? (2) Do we have well-thought-out firm practices that are documented and taught across the offices? (3) Are we leveraging today's technologies to great effect? (4) Can clients, contractors, and other users of our services attest to their sufficiency and usefulness? (5) When problems occur, do we identify what went wrong and work out solutions so it does not happen again?

Recognizing what prevents us from doing good work and making an honest assessment of what it will take to effectively change are significant first steps toward excellence in project delivery.

Anyone Can Cook

If you have seen the 2007 Walt Disney Pictures and Pixar Animation Studios movie *Ratatouille*, the premise is that anyone can cook, even a rat. The main character, Remy, is a rat who desires to become a chef, and the movie chronicles his adventures achieving his goal. Thinking about this ridiculous premise long enough or watching the movie over and over with your children, it just might inspire a revelation. One of the essential tasks architects and designers must perform well is to meaningfully communicate using drawings, models, narrative text, specifications, e-mail, and so on. Thinking back to the movie, a similar premise can be made that anyone can learn to communicate well. Or take drawing, for example: anyone *can* draw, as it is one of the most basic things we do as humans. To draw well, though, takes time, learning some technique, and a lot of practice. Provide a young child with a crayon, and they will create a drawing – maybe not considered art by most standards but an artistic masterpiece by the parent to display on the refrigerator door or on a desk at the office for sure! Provide that same child art lessons, and you may have equipped them with the tools to become a professional artist.

We believe any firm can become Lean.

A RECIPE FOR SUCCESS

In any recipe, multiple variables can affect the outcome in a good or bad way. Accidentally substituting salt for sugar can lead to quite a shock when taking the first bite. So care is required as you prepare your firm for a new recipe. In our experience, the necessary ingredients are (a) *clear definition of goals* of what we want to accomplish; (b) *commitment* from the firm's senior leadership to the defined goals; (c) *agreement* of what success looks like; (d) *freedom* to experiment and test new ideas; (e) *authority* to implement change by designated staff; (f) *communication* to all of what we are trying to achieve and why; (g) *resources and time* to develop processes, tools, and training; and (h) *patience* to understand that change may happen slowly.

When making cookies from scratch, you may find it takes many adjustments to the ingredients to get the perfect flavor and texture, so some experimentation is in order. The same will hold true for developing and implementing new and improved workflows. Persistent and ongoing efforts are required as we allow teams to implement new tools and create improvements to get that perfect balance. It is important to note that we often find the suggestions or changes made by the teams implementing new processes provide valuable insights into making them work better.

Return on Investment

It is unwise to think that becoming Lean happens magically without investment. Most things of value, whether intangible or substantive cost something, and require concerted effort along with time and resources (think money). We do not hesitate in the pursuit of new work, yet marketing and business development can obtain an *opportunity* only to get what we are really interested in - profit. So why not invest in how we perform the work to maximize the profit?

In the effort to increase profitability, firms monitor and seek to minimize overhead expenses. Services such as accounting, human resources, administrative, and business development are all accepted as necessary business operating costs. But how do you measure the time and fee saved through working smarter? What is the value of preventing a project from going into litigation? Bottom-line value is not only generated through monies earned, but through dollars not spent or wasted, and by repeat business. Improving your work processes can increase profit, but the idea of spending profit to invest in future profit is a catch-22. Think about this!

Implementing Lean will require investment over time, but if you recognize the value proposition it may enable your firm to operate at a higher level.

Time

Time is both an ally and a constraint. It is the space within which to develop ideas and new workflows and at the same instance the pressure that prods us into making decisions decisively. It works against us as the longer we take to effect change the greater the cost to the firm. A balance must be maintained to ensure that we receive a return on the investment.

There is a saying that Rome wasn't built in a day. Patience is not a popular term in the twenty-first century, where everything seems to move at high speed and *better, faster, cheaper* is a mantra. But patience is a tool to help us obtain something – in this case, meaningful change. Returning to the analogy of a recipe, preparing a meal requires a set amount of time in the oven for the ingredients to cook and combine to produce just the right flavor. Likewise, we must have realistic expectations and allow sufficient time to effect change, but not so much we might ruin the meal.

Walk Before You Run

New methodologies should be rolled out slowly with a focus on what is to be accomplished. The time frame can range from weeks to months or even years, depending on the significance and complexity of what is to be implemented. First, updated versions of software with new capabilities may alter the direction and implementation, and a willingness to learn and adapt to changing technologies without losing sight of the goal is required. Second, make connections with the people affected by new processes. You must reinforce the supporting ideas along with the new approaches and techniques to staff to facilitate understanding and a level of familiarity and comfort. Third, ongoing time and effort will be needed to maintain the resources and collateral created so the work is not obsolete within a short period. The second law of thermodynamics postulates that any system left to itself will move toward disorder, and this certainly holds true for the systems you develop for your firm!

MAINTENANCE REQUIRED

Most firms have general information sheets as part of their building information modeling (BIM) templates, which will become part of the construction drawing sets. These include information such as drawing symbols and abbreviations, mounting heights of accessories and devices, and accessibility criteria. They can quickly get out of date if the author of the material is no longer with the firm or changes position. This creates risk as the accuracy of the information is important and teams tend to presume that what comes from the template is correct. Standardized sheets such as these provide great value but must be maintained.

FIGURE 9.1 Slow down. *Source:* Publicdomainpictures.net.

And finally, do not bite off more than you can chew. We have seen or been part of failures from trying to do too much too early or having too broad of an effort. Starting small and going slow at the beginning allows change to occur in increments, and improvements that can be seen have a way of engendering trust and fostering consensus. Moving too quickly or trying too hard can fail due to lack of focus and dilution of effort. Think of the proverbial turtle crossing the road: it takes perseverance to get to the other side; however, there is still a reason to attempt the journey, and the effort required to get there is worth the trip (Figure 9.1).

LEAN IN DAILY PRACTICE

Lean can take many shapes and be any size. It is not necessarily a new thought or process either. Our workday is full of what can be considered wasteful practices that we take for granted and are candidates for applying Lean concepts. One such example are unnecessary and unproductive meetings. For some reason, design firms think that the number of meetings held in a day is a metric of success! Of course, this is sarcasm, however, eliminating wasteful meetings can help projects or tasks actually progress faster. What if our meetings were minimized or reduced in duration or number of participants involved? Doing so is one way of applying Lean to daily practice.

Obvious constraints can also be candidates for improvement by Lean thinking. Time is one example we all deal with every day – there never seems to be enough. If we think of instances in the context of a firm, a principal or manager can frequently be a bottleneck. How is it that our leaders can be constraints, you ask? Well, they often hinder the work by late communications that cause delays or rework by the project team. On the other hand, maybe they provide us incomplete information. Remember playing the game of Pass the Message as a child: how often did the message get to the last person exactly as it was originally communicated? On very few occasions did it get passed along without some mistakes. The same goes for information passed along from project leadership. Their recollection may not include all pertinent information.

Consider the scenario of working on a project from a remote office other than where the project manager is located. If a critical design decision is made that affects your work but is not communicated to you afterward, your work will likely be uncoordinated. Such a scenario leads to rework, aggravation, and perhaps a very long night at the office. Out of sight often equates to out of mind. This is a common occurrence on projects that share staff across multiple offices and can happen in firms of all sizes.

It is a worse outcome if this occurs in the same office because it leads to animosity and a feeling of lower self-worth to not be included, leading to internal conflicts. By centralizing decision-making to an individual (the constraint) and not allowing others to participate can have a stifling effect. Including others and spreading out authority and responsibility to multiple team members can alleviate these concerns. To have decisions flow through a single entity creates hindrances to work by withholding context when needed. Decisions are influenced by context. Lack of context in decisions leads to both individual and team frustration. Our observation is that eliminating this type of constraint may be difficult in a firm due to personalities. Realizing the constraints, however, will help to address them.

READY ACCESS TO RESOURCES

How many of you are in an office where the code books are kept by the senior architect in the office? You are all laughing because it is true! In most firms there are one or two sets of hard-copy books in an office controlled by the code guy or technical leader. It is typically out of necessity since this staff member is constantly being asked technical questions and needs instant access within arm's reach of the book in order to research the question.

Reference books are considered overhead expenses by a lot of firms and limited funds are generally available to have multiple copies floating around since they change every several years – not to mention the different versions enforced in different jurisdictions. The model building codes are free to view online, but access to a physical book can be the best way to do research on a topic (Figure 9.2).

To eliminate a bottleneck such as described can be accomplished through the purchase of electronic copies and placing them in an easily accessible location on your firm's network. Electronic copies have licensing agreements, so be sure to check if sharing on a network location is part of the agreement. Some licenses also allow the use on a network. In recent years, some subscription-based code reference websites on the market allow a number of licenses to be purchased and shared in a single location or multiple locations. Whatever you choose, the purchase of a physical book may still be the best solution, and it may be best to locate these in a more shared location in the office than someone's desk to eliminate the constraint.

FIGURE 9.2 Reference books.

RESISTANCE

In your journey to rethink your firm, you will undoubtedly encounter resistance. This is natural and should be anticipated and planned for. It usually comes from those who dislike change, who are comfortable with how they are currently working, or those that are just skeptical. Whatever the reason, it is helpful to understand the psychology of how people encounter and ultimately accept change.

In “Challenging ‘Resistance to Change,’” Eric B. Dent and Susan Galloway Goldberg (1999) dispute the historical concept that people resist change. The thesis of this research paper “examines the origins of one of the most widely accepted mental models that drives organizational behavior: the idea that there is resistance to change and that managers must overcome it.” (pg. 25) The widely held notion that people resist is a barrier itself to creating change. It puts the employee in conflict with management, creating a personal issue instead of a business improvement issue. Dent and Goldberg question the conventional wisdom and suggest that “people do not resist change, per se.” But rather, “People may resist the loss of status, loss of pay, or loss of comfort, but these are not the same as resisting change.” (pg. 26) “Employees may resist the unknown, being dictated to, or management ideas that do not seem feasible from the employees’ standpoint.” (pg. 26) The authors finish with the conclusion that "Making changes effectively in organizations requires specific, targeted action." (pg. 40) Change requires effort to learn new ways of working along with the admission that there may be a better way.

Delgado (2020) outlines 10 things that could hold people back from being open to change: (1) not understanding that they need to change; (2) fearing the unknown; (3) lacking expertise and fearing failure; (4) being attached to habits; (5) imposition; (6) being exhausted and saturated; (7) cognitive dissonance; (8) being poorly motivated; (9) the wrong timing; and (10) being personally predisposed to resist change.

It is plausible that each of us has experienced every one of these factors in our own personal or professional lives when encountering change. This is important to comprehend as we attempt to enable change in our work processes. Every person deals with change in their own way. However, experiencing success is often effective at winning people over regardless of their coping mechanisms. Sometimes what is obvious to one is not to another and can be understood only by doing. Using processes that streamline work and save time may be the most effective persuasion.

Defenders of the Old Ways

Many firms employ *defenders of the old ways* (Figure 9.3). These antagonists are generally older, experienced architects or leaders with strong opinions rooted in the past about how work should be done, and they see what they are currently doing as the "right way." These defenders can be very resistant to change and span the generational gap. While their numbers are dwindling, they still exist and must be considered in any change management program. They share several characteristics: a) pointing out problems but not offering realistic solutions; (b) preferring a list of rules in lieu of guiding principles; (c) finding complicated ways to do simple things; and (4) disagreeing regardless of an idea's merit.

One strategy to earn trust with a defender is to listen to their viewpoint, ask them to explain why they like their current methodology, explain and demonstrate to them an alternative, and ask that they consider it. Often, a different method incorporating their concerns will be agreeable. It may be helpful to include them in the change process itself, being careful not to let them dominate and defeat the efforts. Another way may be as simple as asking them to try the alternative and provide feedback.

FIGURE 9.3 Defenders. *Source:* Adobe Stock.

Alternative paths also exist to help overcome them. Begin developing and implementing changes with staff who are open to new approaches. Those newer to the profession are more likely to accept different approaches because they do not carry the baggage from years of practice and have less to unlearn. Also consider this: *If it is in the template, the staff will use it*. This is analogous to the famous line from the 1989 Universal Pictures movie *Field of Dreams*: "*If you build it, he will come*." In the context of a firm using a BIM platform, if new methodologies and workflows can be integrated into the firm's template, users will assume they are part of an approved standard for daily use. This strategy is useful for graphic standards and the like that may be fundamental to producing work in a BIM environment. The opposite can happen if the BIM template is not managed by those who are current architectural practitioners. Many firms have BIM implementers who maintain the template but do not have their finger on the pulse of the practice or do not understand what is necessary to produce work efficiently. The defenders in this case may be more concerned with the upkeep of the template and not open to improvement.

Success also has a way of quieting skeptics and easing the difficulties of transition to new workflows.

Backgrounder 9.1 Can Design Process Be Lean?

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THE QUESTION

It's an age-old question in the architecture, engineering, and construction (AEC) industry: Why do designers go in circles? Why must we be perpetually late, incomplete, over scope, and over budget? These and other similar queries from contractors and owners have probed the mysteries of design process for centuries. For two fine examples read *Brunelleschi's Dome* by Ross King and *Assembling the Architect* by George Barnett Johnston. The former recounts tales of value engineering and rework occurring during the design of the Duomo in Florence during the Renaissance. The latter offers historical research into the early challenges of the profession. Things haven't changed much in 500 years. Perhaps the nature of design process is an invariant?

The easy answer – particularly from those who practice the art of design – is no. Those who initiate architectural form will quickly tell you that design is messy. You begin the journey without knowing your destination. There is no right answer. With homage to T. S. Eliot, you might even go in a circle to discover you were in the right place all along. To bring efficiency, linearity, and logical sequence to such an unknown, divergent, explorative process is sheer folly, designers argue.

To a large extent these designers are correct. But the question persists. In current project delivery forms with multiple parties, conflicting agendas, and shorter schedules, there is an ever growing need to streamline design process. To accomplish such a feat, we must not only understand it but also make creative process leaps to transform it or, at a minimum, optimize what is admittedly an unpredictable undertaking.

In my 50-year career as an architect, I had the opportunity to serve as lead designer on many projects. All were subject to the same forces discussed in this book. All were over budget. All suffered from inefficiency. Eventually, they all got built. For the most part, they realized the design vision we fought so hard for. A good number were recognized by the industry: Progressive Architecture design award citations, AIA Honor awards, and a host of other accolades gave testament to the fact that we were practicing architecture at the highest levels as recognized by our peers. And the end of every one of them we woke up the next day and said, *There's got to be a better way*. To serve those who still ask that question, let's dive deep to understand if – and how – design process can be made lean.

To be clear, in this investigation I'm not speaking to project delivery forms, completion of construction documents, or construction administration. I will not elucidate Lean principles such as pull planning, work in progress, Kanban events, and percent complete. Rather, I speak directly to the process of genesis, conception, synthesis – what we know in the industry as the creative act of form making in architecture. In old-fashioned phase terms, the activities traditionally driven by the lead designer or design team during concept design, schematic design, and design development (or whatever names the industry has assigned to these phases in the blurring that began at the dawn of CM-at-risk, fast-track projects, and accelerated design as far back as in the 1940s.

Why Is Design Messy?

As an art, design of a building admits subjectivity as a key element of its process. This is in distinct contrast to building, an objective, executing process that can be planned, sequenced, resourced, and scheduled. Design is different. By its nature, design is multivalent, multidisciplinary, and contextual.

Education, Culture, and Legacy

In architecture school, design studio students are taught to noodle with a design, play with it, study it, and explore multiple iterations, as if aesthetics were the primary factor. In the reality of business and practice, the issues of how much and by when become major design determinants in almost every case. *But good design takes time*, designers argue. *Don't rush me. Long after the building is completed on time, the quality of the building will still stand*, designers tell us. They're right. But we still need them to be more efficient. How?

COPING MECHANISMS

After 5 decades of limited success in trying to optimize the unmanageable process we know as design, here are my coping mechanisms for making the best of it.

Program and Project Definition Come First

How in the world can any designer attempt to solve a puzzle without all the pieces? Answer: They can't! Yet they attempt it all over the globe daily. Why don't they have all the pieces? Because owners don't (or can't) know what they want anymore. Rather than provide their design team the fixed, approved program of requirements, our contracts and processes assume (and are based upon), owners increasingly turn to us: *You tell me what I need. you're the expert. I don't know. The technology is* *changing. The business climate – and the world – are uncertain. Now, more than ever, we need criteria and a building and that are adaptable and flexible.*

What's more, because they are designers (and not puzzle-piece collectors or programmers), many designers are unable to discipline themselves to program and define problems before design begins. As lost-in-design-lovestruck artists, they leap headlong into design, wrongly thinking (just as so many were educated) that form alone is king. Unable to balance a complete problem definition with their addictive love of design, they begin. Little do they know, the very form they worked so hard to conceive may be dealt a death knell by the appearance of just one new jigsaw piece, a scope change, a program revision, or (humans forbid) a change in mind or heart by the owner – or the designer themselves.

Budget Rules

We always have a budget. It's what we do with it that matters. Too often, it's treated as a necessary evil by too many. Understanding budgets and how to live within them is a basic business tenet for every businessperson on earth – except for architects. In modern practice, budget is a major driver of design. Ignore it at your peril.

How can architects so inclined to disregard budgets, better understand and manage costs? They are not educated or practiced in issues such as bonds, insurance, contingency, mobilization, hoisting, materials, labor, crew size, and market conditions- elements that are the everyday currency of contractors. Simple. Ask a contractor. Or ask a trade contractor.

Manufacturers, the architect's traditional source for early design phase budget feedback, can offer only a limited view of what their products cost. They don't install them. Architects and manufacturers need to ally with an installer to provide such needed cost advice early – lest the building system in question become the added piece that undoes the puzzle. Only by actively seeking key input and accelerating key decisions can we understand where we stand financially.

Scope Is the Secret

The biggest reason projects go over budget is that scope is omitted or duplicated. There's just too much stuff in the project. A frequent malady is the designer who doesn't take the time to consider what they need to design, that is, the scope of work. Does this project include the low-voltage cabling? The equipment? Does it have horizontal waterproofing? Lead designers – as the determiners of project intent and extent – must advance this knowledge by pushing it forward in the design process. In many projects, I advocated and used a process called scope documents to convey the full complement of project scope with great success – in small, diagrammatic form – even during schematic design. All it took was a CSI MasterFormat checklist to remind me. Caped designers who complain, *I don't know; I'm only in schematic design*, deserve to be over budget. To know what's in your project, do scope documents.

> *I was at CIFE in Stanford a few years back. An industrial systems engineer described design as "isolating the variables and using repeat processes." I said, "Design's not like that." He argued, "Every building has a roof, doesn't it? Footings? Floors? Walls?" He was trying to get us to use checklists. I agreed. Designers do too much intuitively. We get sets of drawings with no mention of half the scope or systems. "We're only in schematic design or design*

> *development," they say. "Fine, but if you can't tell me what kind of roof you're thinking about, how can I estimate it?" I'm a proponent of industry checklists, like CSI, not to constrain creativity but to augment our brains for the rote parts and to add rigor.*
>
> (LeFevre, 2019)

Design Lean Pull Planning Schedule

To do a good design schedule, you need to care about everybody's activities, not just your own. Allow time for option studies, key cost input, review, and approval. Failure to include all tasks will lead to team failure. Even if you get it wrong – which you will – you're better off to have tried. Something's bound to change. And you can't know or predict all of everyone's activities. In that case, when you fail or miss a target, you'll just miss on an interim or smaller one, not the entire project. Designers who disdain design scheduling because it's beneath them or it's not perfectly calculable are irresponsible.

Document Planning

As the primary means for designers to communicate to builders and estimators, design documents hold great power. But confusion comes when designers become too self-focused. In truth, documents are done for myriad purposes and audiences. Studies, visualization, scope depiction, coordination, concept development, permitting, budgeting, purchasing, coordination, and finally, construction documents serve owners, users, financers, insurers, manufacturers, code officials, energy analysts, and countless others. Firms that produce documents without a project-unique document strategy miss the chance to apply design thinking to their documentation process and product. And firms that plan documents without the benefit of input from contractor partners embed waste and miss the mark.

Project Design Controls These five coping mechanisms form the core tangible measurable aspects of project design controls (LeFevre 2019). Together with 20 other factors such as communication, trust, project planning and change management, and leadership they form a dynamic framework that can be used to manage – and make Leaner – the crazy, circuitous, personal, and perilous process we know as design. Good luck!

A Place for Craft, Experience, and Humans

Despite my attempts to share tools and apply intelligence to a seemingly unmanageable process, I admit architectural design will never be fully Lean. In fact, I hope it never is. Simply because a piece of software can design a system or a machine can apply artificial intelligence, immersive design, or intelligent automation to generate form doesn't mean it has good judgment, experience, or taste. Humans offer that. Despite seers like Suskind and Suskind (2015) predicting the atomization of the profession into discrete routinized sequences, I think we humans will always have a place in architecture.

I just hope we get a little better at trying to speak the language of our teammates and employing a leaner, more efficient design process, mindful of key bits of information at the right time.

If we can do that, we'll have found the secret. We'll be almost Lean.

END OF BACKGROUNDER

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IMPLEMENTATION

We have addressed many aspects of effecting change in previous chapters but will discuss it more directly here to look at the broader picture. We do not propose a singular answer or approach; what we do want to provide is a series of ideas and examples, which together may help you craft your own path to improvement in your firm. Although not discussed here, example documents for a Lean Design Kickoff and Project Review meetings are included at the end of the chapter.

Approach implementation slowly. Doing many things too quickly can backfire by diluting your effort and eroding the company's goodwill. Take small steps and make incremental improvements to earn the trust of your people. As ideas and strategies are adopted and improvements can be seen and experienced, an understanding of the goals and results of Lean thinking will become more evident.

We find that many of the best ideas on how to deliver projects extremely well come from the middle of the firm – individuals with 5–15 years of experience, the ones who are familiar with how the work is being done and the technologies and tools being used. Implementing Lean can require stepping on toes at times as you eliminate tradition; sacred cows must be contested, and conventional thinking should be challenged. The staff doing the work should be intimately involved, which leads to the next point: individual projects and their teams are a necessary testing ground for the development of new processes and workflows. Letting employees work through and experience a new approach tends to create by experience, an innate understanding of what works better and why.

To effect change, it is also quite often a matter of breaking the rules and showing that better ways are possible. Managers may be reluctant having staff make changes on their projects, but methodologies and workflows developed in the milieu of a project tend to be streamlined and more effective than those created in the vacuum of a committee.

Lean approaches can be applied to most any type of project. The matrix in Figure 9.4 provides an overview of project types and a weighting of areas where Lean practices can be applied.

Size Matters

The 2018 American Institute of Architects (AIA) firm survey grouped firms by size using the following percentages: (a) 1–9 employees, 75.8%; (b) 10–49 employees, 18%; and (c) 50 or more, 6.3%.

Their research indicates that the firms with greater than 50 employees earn over 56% of total architectural billings. This disparity is dramatic, with large firms clearly dominating the professional services being provided. The breakdown by size is interesting for understanding fees, but for our purposes here we want to realign firm sizes along the following criteria: (a) small firms, 1–24 employees; (b) medium firms, 25–100 employees; (c) large firms, 101–1000 employees; and (d) super-large firms, 1001+ employees.

Small Firms (1–24 Employees)

Characteristics

- Requires the active support of senior leadership to effect lasting change.
- Challenges allocating overhead dollars and staff for development efforts.
- On-the-fly development preferable.

Lean Matrix x Market Sector

	Pull Planning	Strategic Modeling	Streamline Docs	Targeted Reviews	CA Processes
Aviation	■■■	■■■	●●	■■■	■■■
Commercial	■■■	■■■	■■■	■■■	■■■
Education K-12	■■■	■■■	●●	■■■	■■■
Entertainment	■■■	●●	■■■	●●	■■■
Faith Based	■■■	■■■	■■■	■■■	■■■
Government	■■■	■■■	■■■	■■■	■■■
Healthcare / Research	■■■	■■■	■■■	■■■	■■■
Higher Education	■■■	■■■	■■■	■■■	■■■
Hospitality	■■■	■■■	■■■	■■■	■■■
Manufacturing	■■■	■■■	●●	■■■	■■■
Residential (Large)	■■■	■■■	■■■	■■■	■■■
Sports	■■■	■■■	●●	■■■	■■■
Time & Material	■■■	●●	◆	■■■	●●

LEGEND

Limited application	◆
Selected application	●●
Significant application	■■■

FIGURE 9.4 Lean matrix by market sector.

- Smaller projects + rapid delivery = more opportunity to iterate new approaches.
- New processes and knowledge are easily shared using on-the-job training and mentoring.

With small firms comprising the majority of architectural businesses, the challenge of implementing change at firms of this size is readily achievable. This assumes there is sufficient depth of project experience by the principals, practical know-how for identifying and developing new practices, and a willingness to develop and record them for use by all. Small firms are less likely to be in a position to allocate overhead expenses to ongoing strategic investments. However, informal mentoring and training are easily done using informal communication. Another advantage is that projects tend to move quickly with staff performing a variety of roles. The shortened time frames let staff gain a broad perspective of the whole of project delivery and see the impacts of improvements in workflows.

Medium Firms (2–100 Employees)

Characteristics

- Requires the active support of senior leadership to effect lasting change.
- One or two offices with breadth and depth.

- Flatter organization, less politics.
- Able to allocate staff time with some dollars for development efforts.
- On-the-fly development works well.
- New processes and knowledge are easily shared using on-the-job training and mentoring.
- Can utilize formal instruction with development of an intranet-based knowledge management platform.

Medium-size firms are also an easy place to enact broad change as they are usually composed of one or two offices with breadth and depth of experience and knowledge. With a flatter organization and less internal politics to overcome, these firms also tend to have resources available to invest back into the company.

Large and Super-Large Firms (101+ and Multioffice Employees)

Characteristics

- Requires the active support of senior leadership to effect lasting change.
- Can have firms within a firm, independent personalities with authority.
- Significant inertia, resistant to change.
- Resources often squandered on firm-wide initiatives.
- Large firms require buy-in from multiple stakeholders or committees.
- Super-large firms can either be centralized or decentralized in their approach:
  - Centralized firms can be compared with the hub-and-spoke model used by airlines, where major decisions occur at the main office and are disseminated to the local offices.
  - Decentralized firms may have multiple offices working together and sharing resources but, due to regional differences in the ways of working, develop office specific approaches to the work.
- Development by committee watered down by least-common-denominator practices.
- New processes and knowledge are most effectively shared using formal instruction with on-the-job training and mentoring.
- Development of an intranet-based knowledge management platform allows multioffice firms to broadly share resources.

We are combining the large and super-large firms as they have much in common and much to gain from improved project delivery practices. We acknowledge that differences in these firms will exist owing to market sector and practice area focus as well as due to regional locations. Super-large, multinational practices may have multiple business and design philosophies that vary by location and tend to create more disparate approaches to doing the work.

While generally well organized, these large-scale firms can consist of multiple mini firms within the firm, separated by geography, personalities, politics, and established processes. They can be very resistant to change, and company resources are frequently squandered on firm-wide initiatives. While there may be room for individual endeavors that test ideas and methodologies, deliberate, centralized efforts are the most effective in establishing common methodologies.

FOUR STEPS AT A MEDIUM SIZED FIRM

As said before, the effort to make lasting impact will take time, and it is good practice to gradually implement change. Figure 9.5 is the framework used successfully with a rapidly growing, medium-sized firm to streamline documentation practices for construction drawings over an approximately 3-year period. It served a dual purpose: to introduce new systems to existing teams and new employees; and to peer review the projects. Once everyone was onboard with the new approach, steps 3 and 4 continued as part of a quality assurance (QA) review process that had evolved from this initiative.

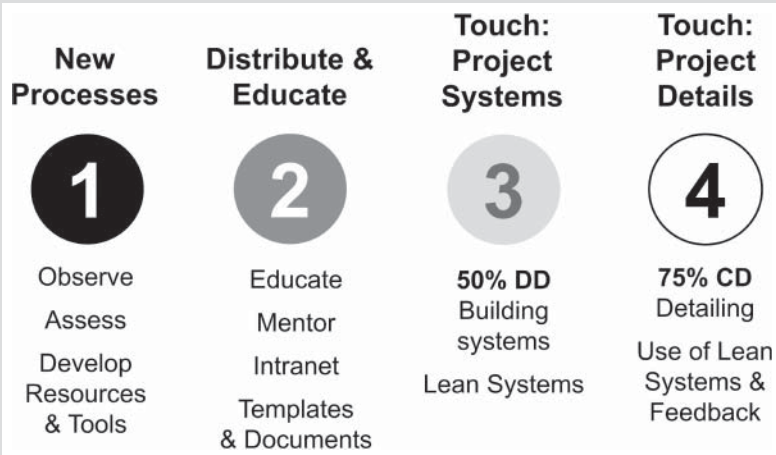

FIGURE 9.5 Four steps of implementation.

1. Step 1: New Processes

   You may already know areas and processes that need improvement and an assessment of where you currently stand is usually what precipitates making change in the first place. Many problems are obvious, while others become apparent due to project pressures and the need to get the work done more quickly.

   Looking at how we work, we can ask questions like:

   - How are we performing now?
   - Where are we stymied and why?
   - What mistakes or issues repeat across our projects or teams?
   - What could we do differently to deliver work more quickly and consistently?

   Senior leadership often knows what the problems are but tend to lose touch with technology and how work is performed daily. Involving those that do the work in creating the solutions not only garners their buy-in but also makes it more likely that the processes will be practical. It is also valuable to actively monitor teams and projects for new ideas that are worthy of becoming part of the firm's broader practice.

Create instructional materials that are graphical and succinct. They should address the why and include relevant examples and clearly document the new workflow. Video is another way to record and memorialize teaching.

2. Step 2: Distribute and Educate

   To effectively implement the new workflows and tools, staff and teams need to understand how to use them and have ready access to the materials you develop.

   - Intranets are relatively simple to set up and maintain and are becoming the go-to portal in many firms for accessing current, firm-approved resources.
   - People are more likely to be receptive and retain the information when training is provided at the point of need.

3. Step 3: Touch Building Systems

   Meeting with teams midway through design development offers opportunity to review the building systems they intend to use (e.g., masonry veneer, roofing, partitions, interior finishes) and to check that the right questions are being asked and that the systems are being developed correctly. Mistakes and errors uncovered at this juncture can be corrected. This is also a good time to introduce the team to new documenting systems, review the instructional materials, and discuss how they are implemented. If you take time to make sure they understand the building system itself, the process to document it will make more sense.

   - Intersecting with teams creates a sense of accountability and expectation for a high-quality delivery product.
   - It is effective at catching issues with building systems before they become embedded into the BIM and documents.
   - Going slowly by reviewing new processes and workflows together and filling in gaps in understanding will allow teams to go faster later.

4. Step 4: Touch Building Details

   Later in the construction drawings phase, meet again with the project team to look at construction detailing. This is the time to check that the new documenting systems are being applied correctly. Again, doing this in the midst of work pressures tends to embed the new practices. It is interesting to note that we have made many improvements to the documenting workflows themselves by seeing the wrong ways teams have implemented them. We liked their approach better!

   - It is still not too late to find and address problems with the detailing and building systems integration.
   - There is also opportunity for constructive feedback from the teams.

DEVELOPING RESOURCES

For ideas to take root and eventually bloom, ongoing and persistent effort must be made to propagate your thoughts and creations. Documentation is critical, and we consider it mandatory for medium- and larger-sized firms to document their processes and workflows, the guidelines, and standards, be they procedures for request for proposal preparation, human resources support, BIM, drawing and specification standards, or construction administration procedures. In other words, there may as well not be guidelines and standards without documentation or helpful user guides (see also "Systems Packets" in Chapter 8). How will staff know how to do work in the firm's way if it is not communicated? Step-by-step directions remove anxiety or reluctance to attempt a new method and also can eliminate much of the one-on-one training that may have been necessary previously. You may also find it helpful to provide a detailed backstory or commentary with the documentation as to why the process was created so others may understand the intent of the process and what is trying to be accomplished. There is little value in creating processes that no one understands how or why to use.

To enhance your firm's adoption, resources must be easy to understand and follow. No one wants to read a thesis on partition types. The use of bullet points and graphics are generally the easiest to understand. Consider engaging your marketing or graphic designers to help with the branding of internal documentation so that it is consistent. Branding conveys the message that it is official. Consider how to write documentation from the user's standpoint. Sometimes those who are knowledgeable skip steps and make logical leaps that others cannot due to less experience or familiarity. So begin with the basics of the process, and fill in the gaps to add clarity. For nonnegotiable processes, consider making the investment in face-to-face training. Avoid the habit of relying on individual or peer-to-peer training as it leads to individualized enhancements or miscommunication.

A problem with many resources is that the information is obsolete the day it is published. Processes change, software is updated, and new features emerge, so it should be in a format that allows for easy updating by designated staff.

Open-source documentation (think wiki format) may have a place as well. End-user tips and tricks can be beneficial along with sharing shortcuts or observations from having adapted the process to a unique situation. Experimenting and knowing your staff are important to understanding how to maintain good resources.

Case Studies at Large Firms

When firms merge or grow organically, it can quickly become apparent that, especially in the case of a merger, there are multiple ways of doing the same things. In the case of expansion across the country, some regional approaches may be considered. Two examples of developing firm-wide documentation standards and guidelines at large firms follow.

FIRM A

Firm A is a good example of both the merger and eventual growth model. In the move away from multiple independent companies within an umbrella corporation to a centralized operation consisting of a firm-wide headquarters with hub offices. It was an opportunity to get each office working the same since they were more connected in their work pursuits and delivery. The initial effort occurred during the computer-aided design (CAD) era and was an effort to standardize graphics and a documentation philosophy throughout the firm. Individuals from previously independent offices came together to define how the firm should do this. It was a successful effort resulting in a written guidelines manual. However, it was never completed due to changing world economic events that refocused resources elsewhere in the firm. The guidelines were rolled out to all the offices and did create some positive and negative commentary.

The guidelines were adopted fully in some offices and semiadopted in others, yet the effort remained incomplete. It was not until about 5 years later, with the firm-wide adoption of BIM, that an endeavor to finish the manual was restarted. This was an opportunity not just to complete the earlier effort but also to update the guidelines to reflect the different workflow in BIM.

Once the final updates were completed in a traditional printed format, there was a roadshow to present to each office. The effort was again seen as successful, yet the written manuals once again landed on a shelf. It was time to rethink how to share the knowledge. The firm developed an intranet site that was accessible to all, was user-friendly, and that allowed for customization by discipline. Guideline content could be accessed through hyperlinked documents that were easily updated. Goodbye to the old printed manuals at last! Even though the new intranet-hosted documents were easy to find, they were still dumb and awkward to use, and links to graphic examples were ineffective. As thinking further evolved and BIM became the de facto firm documentation software, it became clear that to maintain the legacy of the previous work, the manual would transition to guidelines that were incorporated into the BIM template itself, now accessible without leaving the software platform. The combination of the two was exactly what was needed.

Key Observations

- It took several years and multiple attempts to find the best solution.
- New technologies and methods of working influenced the need to be flexible and innovative.
- Resources used in combination (e.g., intranet, BIM template) offered the greatest flexibility to most users.
- Committee-based solutions can help overcome reluctance to new guidelines and practices.

FIRM B

Firm B followed the organic model growing exponentially as the global economy expanded. However, rapid growth reveals complex issues that are compounded by the scale of the firm. With an increased staff count and development of a studio-based practice, the task of onboarding new staff to the essential methodologies was increasingly difficult. This was exacerbated by the need to share staff across offices. Greater consistency among drawings was not the ultimate goal; it was more the need for exposure to the overall documentation philosophies and framework that were important to convey. Developing this documentation was much more difficult and time-consuming as there was not a firm-wide documentation manual available as a starting point. Many of the offices had customized methodologies, but they had been developed independently from each other.

Collecting and consolidating the many similar documents into a singular source required a champion to own and drive the effort forward; it was not a designated committee like firm A but was a volunteer effort. Its success would entail organizing groups to take on an agreed upon topic and drive toward a deadline. Many topics were chosen to focus on. The topic of a dimensioning methodology was handled by a small group spread among several offices. Their task was to examine existing documentation and synthesize the content into a concise one- or two-page document. Each of the remaining groups were responsible with a similar strategy for a different topic. The effort lasted approximately 12 months. Final graphics and high-level approvals took an extended amount of time. The final document was formally released nearly 2 1/2 years after the initial idea was brought forward.

Key Observations

- A committee-based approach was not effective in such a growing and studio-based firm.
- A small leadership group was employed to drive to an approved direction.
- Being a framework of documentation methods still allows for unique approaches that makes streamlining more difficult to accomplish across the firm.
- Creating a framework is a basis for future standards and guidelines.

Committees can be an effective if they have authority to make change. However, there is a tendency for them to become self-focused, where the goal is to meet and discuss and ultimately make only recommendations. Many committees are better employed as short-lived SWAT teams, put together to solve a specific problem within a limited time frame and with the authority to act. This makes them action oriented with clear expectations for results.

Case Studies at Small and Medium-Sized Firms

Small and medium-sized firms have different dynamics and challenges. Management structure tends to be flatter, but the ability to innovate and the flow of ideas and information may be hindered by the principal's desire to manage clients as well as the broader office. Established small firms can be insular and beholden to past processes and ways of working.

FIRM C

Firm C is a small firm where the principals desired to make change but were not able to dedicate their time or staff. A key hire brought in a senior architect who, after getting to know the firm, proposed several documentation changes. Five systems were reviewed with the principals to garner their approval and make modifications specific to the firm's client requirements and the principal's preference.

Four of the systems had been developed previously by the senior architect, and, working with a savvy BIM manager, the principals quickly modified the BIM template and developed the fifth system. The cooperative efforts spent building them into the office template embedded the why of the Lean documenting ideas with the BIM manager. Training material was adapted from that previously developed by the senior architect, and together with the BIM manager they held lunch meetings with staff to review each system in detail and began using on projects.

Key Observations

- Bringing in experienced staff from the outside can rapidly inject new ideas and approaches.
- The support of the firm principals is key to effecting change.
- The availability of previously developed, ready-to-go templates and training materials allow for rapid change.
- Projects can be the incubator to test place previously developed systems, illustrating how they work in detail as staff are trained in their use.
- Small projects usually occur over shorter time frames and allow more project iterations for staff to learn new approaches.

FIRM D

Firm D was a young, medium-sized firm that was growing both in the size and project complexity. No documented office standard existed, and there was a variety of methods used to produce work, largely based on standards from the last firm the project architect worked at. The chief executive officer (CEO) stated that they were making promises to clients and focusing on ways to grow the firm, and it would be the task of middle management to figure out how to keep the promises and deliver the work well.

One project team inadvertently developed new workflows as a result of a difficult project that were ultimately adopted firm-wide. The project was the largest undertaken by the firm at the time, and the team was small and inexperienced. Due to the fast-track project delivery approach, they initially focused on working through the design to resolve how all building systems integrated together to set the building dimensionally and facilitate the flow of information to structural and civil engineers, who were developing the first document packages to be released.

Understanding the team's inexperience, the project architect developed documenting approaches that were easy to understand, implement, and check. During construction, each new system was reviewed with the contractor's field superintendent for feedback. A senior manager was briefed on the systems and the advantages they had brought the team, and he facilitated their acceptance by firm leadership – no discussion or committee involvement.

The documenting systems were integrated into the office template and training materials developed. Key to their incorporation and ongoing use was introducing them to the project teams during design development and checking for their correct usage later during the construction drawings phase. Over an approximate 3-year time frame, all projects and teams moved to the new systems. Originally developed for CAD they were migrated to BIM several years later with enhancements to workflow and data attributes.

Key Observations

- Lack of firm standards and tradition can make it easier to overcome resistance to new practices.
- Difficulty can create an opportunity for change to occur out of necessity.
- Projects are an invaluable test bed to develop new ideas and workflows.

- New workflows are more easily learned and retained when shared during a project. This includes resolving the design and how by building a systems interface first a systems approach can allow for rapid documentation.
- Understanding how contractors estimate, bid, and construct work is helpful for designing effective documenting systems that relate only the information that is actually needed.
- Teaching staff how a building system (such as cabinetry) is fabricated and installed engenders quality in modeling and detailing and increasing the speed of documentation.
- Recognizing who is performing the work affects the complexity of workflows.
- Firms can learn from other firms.
- Senior management buy-in and support is necessary for adoption by the firm.

While these case studies describe firm documentation standards development, the underlying approach to identify problems and persistently work through the issues and ultimately determine what to do applies to most any improvement effort you will undertake.

DEVELOPING AND SHARING KNOWLEDGE

Taking from the examples of developing standards, developing resources can be a challenging task. Communicating and sharing these are also vital to any implementation of Lean practice. It can be said that the days of a printed three-ring binder are a relic of the past, but how many still have copies lingering on dusty shelves? A common problem with the traditional book-type standards is that they were printed and often never updated again. It is nearly impossible to update all the copies because binders go missing, pages are removed, and additional bootleg copies have been made. The digital revolution has made it easier to maintain office or firm standards, but this age-old challenge still remains: how do you update and inform staff of revised information, and what medium is best used to convey that information?

Sharing information in the digital age is almost too easy. It is not unlike all the ways we can communicate – talking, texting, posting, blogging, and so forth – but with more opportunity for information to be copied without the context of why the information was shared to begin with. One method of sharing a document is to create a PDF and place it on the firm's computer network in an easy-to-find location. However, instead of referring to the network version (which may have changed), staff copy the document to their desktop or personal folders as their own easy-to-find resource. When a colleague asks for the document, the individual will send their personal version instead of directing the colleague to the network location. The cycle never stops as the PDF goes from person to person, and we end up with multiple copies of an out-of-date document in circulation. At this point the digital version is just about as worthless as the old printed three-ring binder versions. Who says that a paperless office is going to save resources? Think of all the bad information circulating in an office or firm that is being misused and that can potentially cause a risk issue.

To alleviate the anxiety of misinformation floating around uncontrollably in your firm, consider the following examples of ways firm standards, guidelines, and other information critical to your practice can be shared successfully: (1) development and use of a company-wide intranet to post official resources and on-demand video training that can exist in HTML or similar Web-based formats and not as PDFs or other document file types; and (2) in-place documentation in the firm's BIM template or prototype sheets as described earlier.

Variations and combinations of these may all be successful methods for any knowledge sharing as there is no one-size-fits-all answer to this problem. It depends on your firm culture and how comfortable your staff is with each method. It may take some experimentation to find which way is the most effective. Once the methods for sharing are determined, the task of maintaining the existing and creating the new collateral information will follow suit.

Backgrounder 9.2 Knowledge Management

About the Author
Christopher Parsons is founder and chief executive officer of Knowledge Architecture (knowledge-architecture.com), the developer of the intranet platform *Synthesis: A Social Intranet for Architecture and Engineering Firms*. Knowledge Architecture holds an annual conference broadly addressing the topic of knowledge in the architecture and engineering industry. This interview took place in June 2020.

What Is Knowledge Management?

There are many definitions of knowledge management, but one that is remarkably simple is the enabling of companies to make the best use of their knowledge. If you begin to unpack that, it is profound. Architecture and engineering (AE) firms are in the knowledge business, and the majority do not own intellectual property or patents or produce or sell widgets. Rather, they bring incredible knowledge, expertise, and processes to bear for clients. It is often said that our biggest asset is our people; what is generally meant by this is the knowledge the people must apply to winning and delivering projects – and to do that well. And by well, we can mean profitable, well-coordinated, sustainable, well-designed, and many others.

Architects and engineers do complicated work and it all changes quickly; the half-life of knowledge continues to shrink; architects and engineers used to deal with an increasing number of building systems, with software that changes every year. Today's hard-won knowledge is being updated and replaced with new knowledge and information quickly. For these reasons and many others, it is truer now than before that we are in a knowledge industry.

Every AE firm is doing knowledge management; they may just not call it that. Everyone wants to get better, to pass the knowledge and expertise of the firm down to the next generation. Knowledge management is about having an intentional approach to the management of that knowledge as opposed to being reactionary, ad hoc, or doing nothing at all.

I became aware of knowledge management in the mid-2000s while working as an information technology (IT) director for a 100-person architecture firm. At that time, the only available information and best practices about knowledge management concerned large multinational corporations and

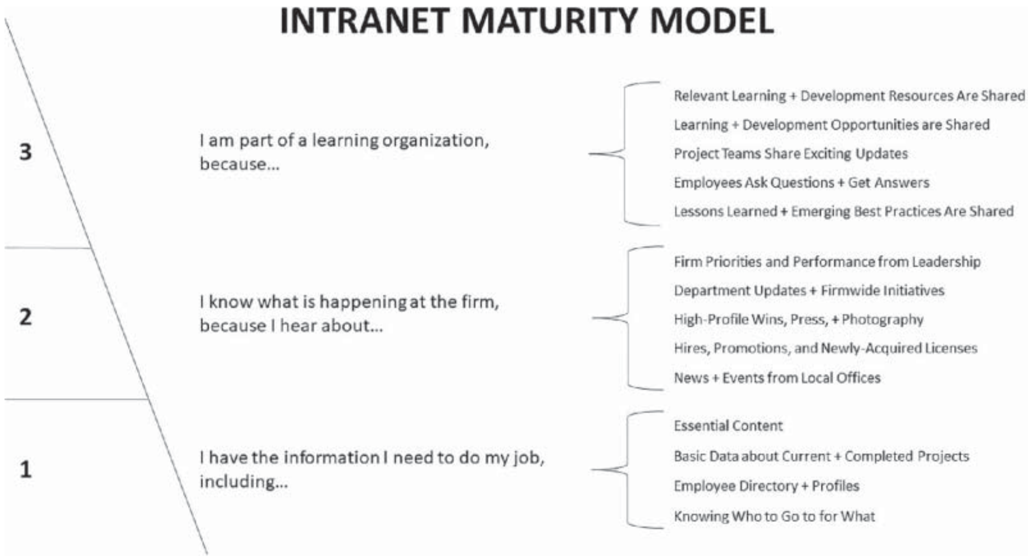

FIGURE 9B.1 Intranet maturity model. *Source:* © Knowledge Architecture.

organizations such as the World Bank, NASA, and the military. As I read about those efforts, I realized this was exactly what I had been doing at my architecture firm; I just did not know it had a name. No one was speaking, writing, or developing software approaches for professional services firms, let alone small and mid-size architecture and engineering firms.

I've since spent 15 years trying to understand the approaches, techniques, the best use of software, and the culture of knowledge management for AE firms to help them make the best use of their knowledge.

What Benefits Come from Making Knowledge Accessible in Firms?

There are several ways to look at this. Knowledge management is a set of tools encompassing technology, firm processes, getting and doing work, and running the business. You can look at a firm and where its heart beats – Knowledge management can help do it better and serve as an accelerator and a catalyst to fan into a flame what you are already doing, only better (Figure 9B.1).

Communities of practice have been around for a long time. They have been called guilds, but we might refer to them as domains of expertise – in healthcare, Lean, building information modeling (BIM), where people get together to share ideas, build standards and expertise, and grow in knowledge. Firms are already doing this – we are just putting a name on it. A question to ask is how can we do this better and faster? A good quote for how knowledge management can help firms is, "Learning faster than one project at a time."

Lessons Learned: as firms grow in knowledge they are able to share information and learn more quickly and in an aggregate fashion and to more than one person or team at a time.

What Types of Information (or Knowledge) Do AE Firms Capture and Share?

Examples include: lessons learned, technology procedures, firm processes, and standards; customer relationship management (CRM); image and employee databases; intranets; the capability to find anything easily; human resources materials and policies; and marketing – all the core information needed for people to do their jobs.

Firms get to be a certain size, perhaps 25–30 people, and you reach an inflection point where you start to hear, *I'm answering the same question every day,* or *Our stuff is stored in 20 different areas*. There is a need to bring it all together where people can find it asynchronously, on their own without hunting down a specific person. Make information available (Figure 9B.2).

Around 2009, I became aware of firms like Gensler, Kieran Timberlake, Arup, and others who engaged in research and development. Market sector research, post-occupancy evaluations, all looking for ways to gain competitive advantage and further their businesses.

Many firms have corporate universities, mentorship programs, process improvement – we're looking for where the knowledge lives now and how we get access to and share it.

Knowledge management is intimidating when you discover that you are surrounded by knowledge; you did not realize it much as a fish swimming in water does not know it is surrounded by water. It becomes daunting to even think of managing it, but that is the task. They key to getting started is the realization that you can't manage of your firm's knowledge. You have to figure out what knowledge is most critical to capture and share within your organization and start the process of intentionally stewarding it.

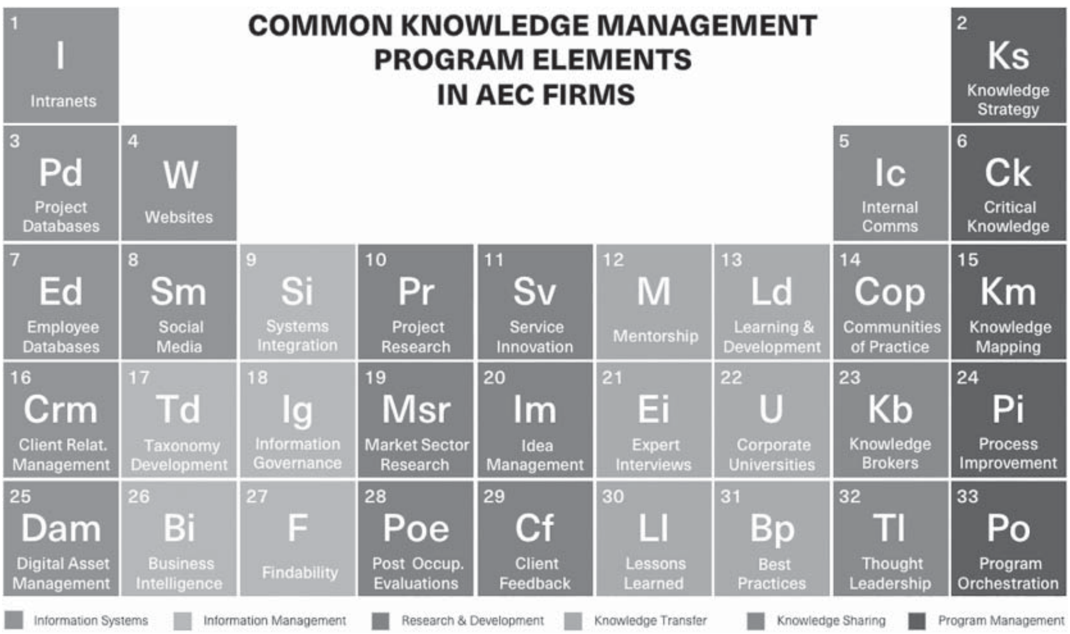

FIGURE 9B.2 Periodic table of knowledge. *Source:* © Knowledge Architecture.

Our approach at Knowledge Architecture is for all of what I have just listed to integrate back into the firm's business strategy and overarching priorities. That might be growth of the firm, profitability, or design excellence. We seek to understand the priorities of the organization and to focus on the knowledge that will empower those priorities. Connecting knowledge management with what you are trying to achieve as an organization: this is number one.

What Are Typical Problems Faced by AE Firms That Knowledge Management Can Address?

Every architecture, engineering, and construction (AEC) knowledge management program is different due to differing priorities, cultures, and firm expertise. As discussed already, the firm's business strategy drives the problems to be resolved through the use and implementation of knowledge management. As a company, Knowledge Architecture works to find out the firm's priorities using tools and techniques can be applied to figure out where to put your knowledge management energy. Dr. Carla O'Dell, chair with APQC, a go-to resource for large global organizations put it well, saying something along these lines: *Find a problem that you can solve and resolve it, and you'll have all the credentials you need to do more knowledge management*. This is the key again: to align the knowledge management program with solving business problems related to the firm's long-term strategies.

It is important not to be seduced by the technologies themselves and what we can do, allowing that to distract us from this prime objective. We always want to remember that we are all about creating value within the organization through knowledge management.

The best knowledge managers within firms have Lean principles at heart because they do not work on problems that do not matter. Our observation also is that a lot of the people championing knowledge management within the firm is from the middle out.

Knowledge management implementation involves governance, process, people, and technology. Some see knowledge management as a technology issue primarily; we try to make sure that senior leadership is at the table all through the implementation process, and that they understand what is required from the start. We want the stakeholders who will take ownership within their firms for areas.

What Does an Effective Knowledge Management Platform Let Firms Do That They Could Not Otherwise?

Intranet platforms are essentially internal websites that connect offices across geography. It functions as a portal or digital home, expanding the ecosystem of firm platforms and resources. It becomes the source of truth, so to speak, in one place.

In addition to what is mentioned already, they can gain the benefits of artificial intelligence with analytics and search engine optimization. This lets you can see what people are looking for and what are they not finding; the questions being asked and if they are being answered. You can also see through metrics what areas or features are being used or not.

Software platforms like Microsoft Teams or Slack can be seen as an inner loop allowing rapid collaboration among focused teams. Good knowledge management intranet platforms are an outer loop letting different teams, disciplines, and interest groups within a firm to connect and share as well as to know what is going on today at the firm.

How Do the Social Aspects Factor of a Knowledge Management Platform Factor In?

There are three areas: acting as a company Facebook, facilitating corporate communications, and corporate learning.

There can be some concern initially about the social aspects and how it will be used in the firm. What we have seen that it becomes transformative by helping foster connections, it is a platform letting people get to know each other and building trust between people who do not know each other and may work apart geographically. You get used to interacting digitally with people you do not know. This in turn leads to a dynamic of natural sharing and interaction. It also serves to reinforce and amplify corporate culture and firm DNA as well as the company's pulse. People know what is happening, what projects are being pursued and won, and who joined the company. It also enables what we call *learning out loud* through the sharing of information.

What Is Required for Firms to Effectively Set Up and Implement Knowledge Management?

It's important first to discover the top three to five priorities in the business and then to find stakeholders who will own and do the work. It is also important to establish success metrics or SMART (Specific, Measurable, Attainable, Realistic, and Timely) goals (Figure 9B.3). Vague goals are bad. Also, set short time horizons for implementation and ongoing development and check in often quarterly. This is a strategy to stay close to the heartbeat of the business.

How Is Technology Facilitating the Development and Deployment of Knowledge Management?

Technology provides ease of use. The user's experience can be enhanced by layouts that are intuitive. Features like native video can be built in; this is a powerful tool when one can see body language and nuances.

It also lets us create two degrees of separation – in other words, the ability to find people with knowledge and answers in just a couple of mouse clicks. It also provides a digital space within which to think about and give a better response versus the immediacy of a face-to-face conversation or telephone call.

Technology also allows for diversification, deepening the pool of people that can contribute.

FIGURE 9B.3 Client success factors. *Source:* © Knowledge Architecture.

What Problems Do You See Resolved Better by Purchasing a Platform Like Knowledge Architecture's Synthesis as Opposed to Home-Grown Solutions Developed by Firms Themselves?

We refer to platforms like Synthesis as a prefabricated intranet: they are fast to launch (only 4–6 months), require no internal development, and architects and engineers are not designing software. There is a quicker time to value using built-in features. They also incorporate the learning and feedback of many prior firms' usage over time and a shared pool of investment in addition to the underlying technology.

The code of prefabricated intranets do not have to be maintained over time by the firm itself. Everyone knows technology is evolving and will continue to. Knowledge Architecture's Synthesis is a core platform that can also be extended by embedding or linking firm specific applications. For example, Microsoft Forms and Google Forms are complex workflows for onboarding and similar business processes that are then embedded into the intranet.

How Does a Firm Get Started?

Key elements to a successful program are understanding why you want to build a knowledge management platform now. Everyone is busy, and it is important to know why you would invest 4–6 months in knowledge management versus something else. What are the problems you want to resolve? Do you have the commitment and internal momentum to follow the project through?

END OF BACKGROUNDER

Knowledge Management

Barry Isaakson, AIA, of Architectronica made the observation in the 1990s that while firms were interested in developing standards for employees using CAD, those in leadership did not consider the value of their own time. He questioned why it should be acceptable for an executive to spend effort hunting for contact information or project data. Would it not be a worthwhile investment to be able to get information about your projects, firm, or people within three or four mouse clicks? He may have been the first architect to recognize the potential and to develop technology-driven solutions for the design profession for what is called knowledge management.

Knowledge

Knowledge is but one legacy of a design firm, and it is constantly being invented, redeveloped, and applied. Without the ability to capture and apply knowledge well, can firms succeed in the long-term? Perhaps, but only by living with a significant constraint. Possessing knowledge is not enough, though; we must have the ability to share it with the entire firm. Unfortunately, many design professionals tend to silo expertise and information. Ask yourself these questions: (1) Is the firm actively seeking to identify new knowledge that is being developed and identifying what should become best practices? (2) Does your firm's culture encourage the sharing of ideas? (3) Are staff emboldened to test new approaches and ways of working without being maligned for doing something that was not approved by their superiors?

Chief Knowledge Officer

It is in our interest to find and propagate good ideas, wherever they exist. The best ones may be out in the firm but known only by an isolated project team. What if someone in the firm was responsible for finding and sharing them? Most are familiar with the traditional roles of CEO and chief information officer (CIO). Few firms, if any, have someone in the role of a chief knowledge officer (CKO), who find and champion good ideas, processes, and tools. This involves learning from the organization itself, helping foster innovation, and working to implement new ideas across the firm. We are not suggesting increasing overhead costs with a formal, nonbillable position, but we do believe it is necessary to have a designated person or group of individuals who pay attention to how the firm works and who manage the intellectual capital.

> **The best ideas tend to be developed by a relative few and to remain isolated within individual project teams.**

The CKO's mission is to uncover and spur innovation at the project delivery level. Their job description would read like this:

- Ensure that technology and project practices work together.
- Interact at all levels of the firm and with all disciplines.

- Systematically look for patterns of project delivery failure to identify the issues and put in place solutions.
- Look out for what hinders teams from doing good work as firm policies, practices, people, and deficiencies of expertise or equipment create obstructions.

The possibilities for this type of role will vary from firm to firm, but the importance of carrying the torch of cultivating and managing the firm's knowledge is invaluable.

Handle with Care

Knowledge should earn its way into your firm's day-to-day practice, and some discipline is needed to parse ideas and recommendations. Remember, the goal is not quantity but quality. Not every idea will prove worthy and effort must be made to (a) identify and capture relevant information, research, new ideas and processes; (b) assess for accuracy and applicability; (c) package the content to be useable and easily understood; (d) seamlessly distribute via an intranet or through BIM and document templates; (e) revisit content periodically to ensure it remains up to date.

Developing best practices for detailing low-slope modified bitumen roofs will require reviewing details and coordinating with your specifications master; however, making improvements to the specifications editing process itself may be quickly ascertained and implemented. Both are aspects of knowledge management but can be handled in different ways.

Data are aggregated into information, distilled into knowledge, and applied using wisdom.

DEVELOPING TOOLS

Theories are fine and words can inspire, but eventually we must get to work and develop new processes and workflows. Tools, as discussed in this book, are the instruments used to implement processes. Think of them as the architect's means and methods. They combine firm knowledge and research into a package that is meant to be used repeatedly. They generally take form as templates for BIM and CAD or word processing and spreadsheets. Consideration should be given to making the templates themselves easy to find, understand, and use. Prepackaged, Web-based programs are increasingly used for project-based team organization, visual scheduling, and task management.

Purposeful tool development is a major part of what separates humans from animals. Several nonhuman primates use implements, but the human species evolved with the ability to fashion ever more useful ones. An analogy can be made to the design profession, where there are those who use tools today not much differently than the profession did 100 years ago and others who create or adapt them to increase productivity by leveraging knowledge and technology. The best developments are generally based around an improved process and are the means to implement it.

DESIGNED FOR USE BY HUMANS

"There are two primary functions of a good human interface design; make the product easy to learn, and make it easy to use" (Tognazzini 1982, p. 9).

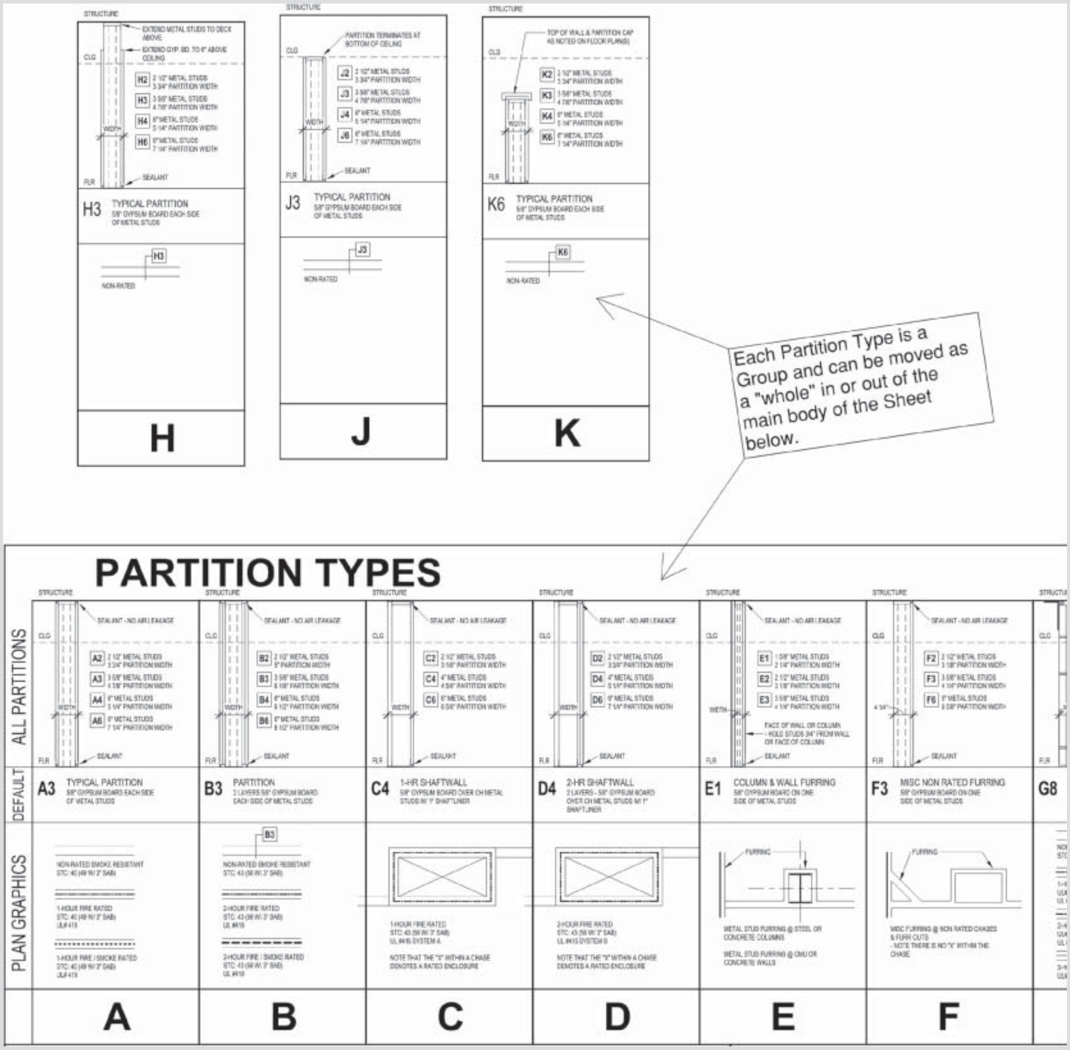

FIGURE 9.6 Grouped elements.

This quote is from the 1982 Apple IIe Design Guidelines, which was published about 2 years before the Apple Macintosh computer debuted and outlines their understanding then of the importance of developing products for people. They termed it *human interface design*. Not only should software perform a function, like crunching numbers or editing text, but it should also be designed so that anyone using it picks up on visual clues and hints on how to do things – and it should be beautiful. They laid out the following goals: simplicity, consistency, efficiency, self-teaching, speediness, minimum strain on the user's memory and honesty. They also included two principles: *Keep it simple* and *Make it familiar and intuitive*. Today we refer to these qualitative aspects as being user-friendly.

Should the same not be true for the workflows and processes we develop at our firms? What about the deliverables we produce during design and the construction documents later? These are the tools used by clients, contractors, and code officials to carry out their work.

BIM or CAD standards, including the way the program's interface is adjusted for the firm's own template, should be such so that all users – especially younger, inexperienced staff and new employees – can intuitively begin to understand the conventions used and become productive quickly. This requires thinking about how they use the program and to anticipate the questions we need to answer.

A primary goal in creating documenting system tools, such as those covered in Chapter 8, was for them to be relatively simple to understand and implement and to be easily edited within the BIM template itself. In the case of building system sheets used in Autodesk's Revit software, this entailed using menu descriptions for partition family members that were uncomplicated and not an alphabet soup of characters: "M8 – 7 5/8" CMU to Deck" and "E2 – Mtl Std Furr -2 1/2" GB to Deck"

Model components for partition type or exterior wall type assemblies consist of grouped elements that are easy to grab as a whole and move about or delete as the sheet is edited (Figure 9.6): they are more difficult to accidently delete text or drawn elements; minimal to no editing is required; and it is quick work to recompose the sheet.

The companion systems packet is a succinct document where all system components are explained, and there is a workflow with do's and don'ts and plenty of graphical examples including vignette drawings with cartoonish notes that advise the architect modeler or contractor on how the system is used throughout the set.

Bugs

If the best ideas tend to arise out of necessity, then a great place to begin exploring is to think about tasks and processes that bug or bother you. These can be little things like cumbersome processes, too many meetings, or larger, more structural issues that face your firm such as developing a training curriculum. To get some inspiration, watch Lean champion Paul Akers's excellent TEDx Talk "What Bugs You?" (Akers 2013). In it he provides a great introduction to start exploring ideas and can help you begin to identify the things that need improvement in your daily practice or across the firm.

One example of fixing something that bothers you may be as simple as placing an often-used BIM component into your template to eliminate the need to search it out to copy from a previous project. Moving the component into the template saves time and creates consistency across projects. Something small like this illustrates that Lean thinking is just that – a way of thinking that, among other things, begins to influence how you organize your workplace. In isolation, it may not seem impactful to a practice, but many little things ultimately add up together with a cumulative effect.

A more involved case is streamlining project delivery processes across a firm with multiple offices. This might require developing simple documentation systems like those discussed in earlier chapters.

> **Make a list of the trivial things that bug you, and begin there before addressing the larger issues.**

Identify a Problem and Make a New Process

Oftentimes there is a larger problem that bugs you and requires a more systematic approach to get to a solution. How do you go about this? One way is by implementing a process management technique identified in Chapter 2 – Six Sigma can be effective in design firm problem-solving or process creation. We have found that employing the define, measure, analyze, improve, and control (DMAIC) approach to a process provides an easy-to-follow recipe for making improvement. Its application to design differs somewhat from the original use in manufacturing and business processes, yet the overall concepts are the same.

The following example illustrates how the Six Sigma approach has been used by a firm to examine how they were documenting project code compliance across different offices and the process to improve the workflow. Remember that Six Sigma is about reducing variation in the ways we work.

Define a Process

The inception for developing a new process started simply enough with wanting to improve how life safety was researched and documented. Over the course of performing routine quality reviews, there was a realization that teams were following different processes on their projects, and the resulting documentation was inconsistent across the office and firm. This caused additional work by reviewers to decipher the differing approaches used. Given that there was no consistent approach or template with archetypal documentation standards in the BIM software, teams were left to adapting processes previously used in CAD. These did not take advantage of BIM software capabilities, employing it only as a drafting tool. This problem was universal across the firm and one that could be solved by the creation of BIM tools that can use the information inherent in the model to create consistent code and life safety documentation.

Goals for improvement:

- Reduce the variety of ways teams prepared life safety plans
- Leverage BIM capabilities to reduce time spent re-researching basic code conventions
- Embed a better system within the firm's BIM template
- Pull the information in the BIM model to assist with documentation

Measure

In business, measurement can be easy to define. For example, the amount of profit is a tangible piece of information that is tracked often, and a reduction or increase in profit is easy to see on a monthly, quarterly, or annual basis. But how does one measure the success of the new process compared with the prior inconsistent processes? To measure the value of creating consistent code compliance tools, there must be a value proposition; otherwise, the time spent doing so is not worth the effort.

Measures considered prior to the process of improvement:

- Find a lack of consistent process or documentation standards across the firm
- Discover lack of leveraging firmwide experts in building code knowledge
- Analyze information and outcomes resulting from plan review comments
- Understand the time requirements to document code compliance

These measurements were selected to show that if a common method and set of tools were developed, then the amount of inconsistencies and potential mistakes could be eliminated, resulting in the reduction in the number of plan review comments and the amount of time saved in research and the effort of documentation. It was clear by experience and logic that the effort would result in improvement, but in this scenario substantiation of the measures would not occur until the system had been in place and several projects had gone through plan review.

Analyze

Examining how we are currently working can be time-consuming and is necessary to finding the solution to a problem. In a multioffice firm, evaluating best practices can involve collecting examples through e-mail requests or by random investigation. Getting replies is a mission in itself, because architects and design teams can often be protective of their methods. The effort to collect examples of code compliance drawings from the different offices and across the different practice areas was the first step in the investigation. Understanding the type of information relevant to each practice area was important to create a holistic set of tools that could adapt to any project type regardless of location.

Analyzation methods:

- Gather internal examples and compare similarities and differences
- Research examples from others through internet searches of best practices
- Exploit the internal code experts and BIM experts

The analysis involved hours of reading, interpreting, and weeding out the good from the bad. The Internet searches did discover thought leaders in the industry facing similar problems. It was by chance that attendance at a national conference included a presentation by some individuals who were developing a similar set of tools. Listening to their seminar and seeing examples of the work they presented led to different methods of approaching the solution. The task of analyzing the information after gathering the examples included studying the most relevant samples and starting to experiment in the BIM software to prove out the methodology. Leaning upon internal experts focused the efforts to eliminate rabbit holes of distraction. Some information proved to be misleading, while others rose to the top and became a great starting point to build a BIM approach around.

Improve

Achieving improvement of documentation methods does not seem that far out of reach unless you consider having to convince others to join the quest. This is not an altogether negative view, but looking across the firm to build interest may be met with skepticism. Finding like-minded, enthusiastic individuals who share the goals of improving work processes and who are willing to take part is imperative to creating tools that staff will want to use. The undertaking of process improvement also takes a marketing effort and sales pitch to persuade leadership that it is necessary to involve others – communications must be crafted and phone calls made to explain the reasons why the task at hand is important and beneficial to the firm.

The most difficult challenge was to ask for resources to conduct a 2-day workshop with the volunteers from across the firm. Asking for funding represented a substantial investment in people and time. Options to meet over video conferencing were considered to reduce costs, but in the end a face-to-face gathering was deemed the most effective type of meeting to have meaningful and lasting impact. A centrally located office was selected for the location that resulted in minimized travel time by participants. As a multidiscipline firm, both architects and engineers were included to build consensus. The proposed workshop became branded as the Life Safety Summit.

The summit was a working session where ideas were presented, discussed, and shared. It was sprinkled with presentations, debates, brainstorming sessions, real-time BIM content development, food, and fun. Having the meeting in person served to build trust, especially across the aisle between the architects and engineers. Fortunately, by the end, everyone – even the skeptics – agreed that the time spent was worthy of the effort. A chance meeting with the CEO during the final day allowed for a quick exchange of the success story with a request to send a follow-up communication of the outcome. About a week later, the following e-mail was sent (edited for content):

> *Nine people came together in the cold of winter… Six of these people travelled from across the country with one purpose in mind - to come to a consensus of how to graphically prepare code compliance drawings within the BIM platform and share best practices amongst the multiple office locations… This "Life Safety Summit" became a pursuit after realizing the lack of consistency across the firm on how these drawings were being executed within the different offices. Over the years, many different methods to document code compliance within our BIM platform were created, however no one method was widely adopted. Attempts to leverage the BIM information to help calculate occupant loads, tag rooms, and graphically illustrate fire and life safety concepts were successful in parts, but not as a whole. The group of professionals assembled for the Summit were recruited as experts in their respective areas of practice to help resolve these dissimilarities. Many subjects were discussed, and demonstrations presented as the group worked hard to recognize differences in philosophy of documentation and preconceived ideas… The meeting purpose was clear, and everyone worked collaboratively to come to a mutually agreed upon conclusion across disciplines… There is still work to be done to finalize all the content, and implement this firm wide, yet we all returned to back to our offices with a feeling of accomplishment and belief that our mission to collaborate was a success!*

While the summit to work out the framework of the new method was an accomplishment, the effort was not over; it was just beginning of the implementation. Improving the documentation system involved creating and vetting the content to be used and agreeing to the final graphics and layout of the prototypical sheets. This effort was helped by utilizing the new content on an actual project in production to test the workflow and adjust or create any collateral material which may not have been thought through at the time of initial development. This beta test also allowed for challenges to be dealt with in an isolated instance in lieu of a large deployment. Following the productive collaboration among the architects, engineers, and BIM experts on the project, it was time to move on into incorporating the content into the firm-wide BIM template. Working closely with the BIM implementation staff, consistent naming conventions for symbols, parameters, and families were developed and deployed. A handful of additional projects were completed prior to full implementation to staff and broader use throughout the firm. The expanded testing uncovered several unknown variables that did require a quick response and rapid redeployment back into the firm-wide BIM template.

Improvements to documentation workflow:

- Development of consistent graphic symbols and BIM families
- Incorporation of highest value code references pertinent to code officials
- Leveraging the BIM properties to address occupant loads with more precision
- Reduction in time to document code compliance by using prototypical layouts
- Creation of modular documentation components for analytical information (Figure 9.7)

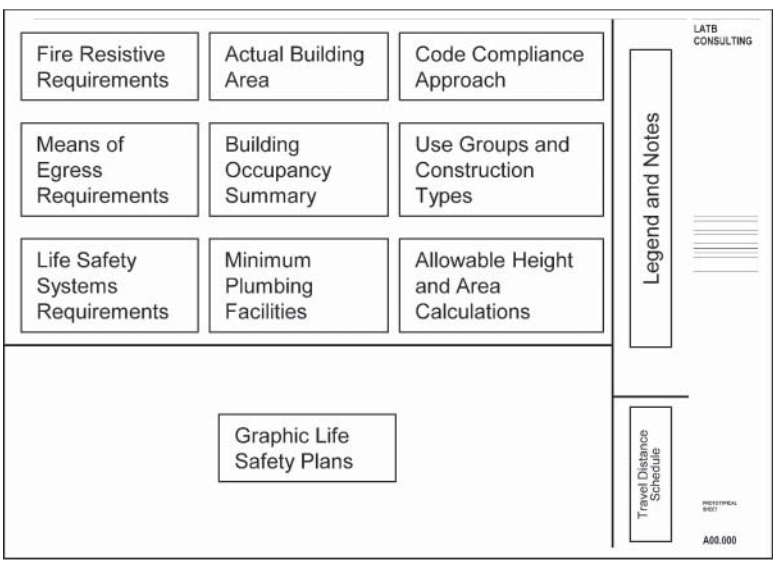

FIGURE 9.7 Mockup of life safety sheet.

This was not a quick effort; the initial ideas began nearly 2 years prior to the summit and full implementation into the firm-wide template was approximately a year in the making. The outcome was a set of comprehensive code compliance and life safety tools incorporated into the BIM platform that were easy to use. The final developed tool set incorporated the analytical aspects of code compliance documentation and paired them with the graphical documentation. All occupant load, building area, and categorization information is controlled by a single master schedule. This schedule allows for the area properties to be sorted and filtered such that information can be displayed as necessary to convey different aspects of compliance. By doing this, the BIM user is provided tools to do their job easier with less chance of errors.

Two observations can be gleaned here. First, by creating a system there is less chance that important information is left out since the process of following it acts like a checklist. Second, we should attempt to streamline processes and all work from the same set of tools that are tailored to the specific project and region as required.

Control

It was important to make the overall BIM template impact minimal within the firm. The method was developed to be as flexible as possible and universally available, with the goal of ensuring that the content was nearly undetectable in the template, but still there if needed.

In some respects, controlling an outcome is more difficult than improving a workflow. Without control, the system developed can be misused and misunderstood. With that in mind, development of a step-by-step documentation manual along with the creation of a comprehensive video training session was initiated to help staff realize the potential benefits of the new life safety tools. Simply put, if it had been developed and then placed in the template, all under the radar, little traction would have been gained.

As the new system began to be adopted more widely, staff began to ask questions of how to adapt the tools to different situations and how to modify the universal information to their specific project requirements. After several months of these questions, an FAQ document was created and shared on the firm-wide intranet. Thus began the final part of control: the continuous improvement and maintenance. Very few methods can be created without some sort of upkeep to keep the content relevant, and this must be factored into any decision when creating tools for deployment.

Stepping back to the to the main value proposition of developing a system in the measure section, the outcome was effective. It turned out that plan review comments were reduced due to the information being consistent throughout the code compliance documentation. Further, there were positive comments received from the Authorities Having Jurisdiction (AHJs) who offered positive feedback and appreciated the clear concise approach to the documentation.

Outcome:

- All offices adopted all or parts of the method
- Variation was reduced or eliminated with a consistent graphic identity
- Code officials were receptive and provided positive feedback
- Review of projects using the system was easier, resulting in time saved
- Mistakes were reduced, information was more accurate
- The learning curve to document was reduced after the initial use, and time was saved going forward

Reinvention

If we think of tools as things that make it easy to do your job and good work, how often should we reinvent the tools we create? This is a complicated question; the answer is that it depends. There are factors outside of our control such as the frequency that the software we use is improved and updated, how often the codes and standards change, and when your firm wants to change course.

Experimentation can allow for new ideas, so experiment with small processes. In terms of BIM, it helps to have an expert on staff to assist. Perhaps you want to create a toolbar with shortcuts to your favorite commands, an architect or designer may not have the skill to code this, but a BIM expert can help in this endeavor.

In terms of tools outside of BIM, there are many other platforms and processes to consider, whether for reinvention or new uses. We suggest you look at all aspects of your practice as part of a Lean implementation in your offices along with the technical aspects of your office.

There are several considerations here. First, when were your firm's standard word processing or spreadsheet forms last updated? Second, experiment with planning strategies such as the scrum and agile process, Kanban, and pull planning. Third, leverage your neophyte staff to help teach new technology (software) to seasoned staff. And last, explore digital platforms for knowledge, e-mail and document management, and construction administration management.

IMPORTANCE OF TRAINING

What is the first thing new employees do upon joining a firm? They meet with the human resources department to fill out paperwork and receive instruction on firm processes and systems. The kinds of things a new hire is usually exposed to on their first day include standard paperwork including benefits selection and enrollments, computer systems, timesheets, expense reports, and introductions.

We recognize there is a benefit to onboarding them this way, to get them into the accounting and payroll systems, to make it possible to fill out a timesheet. While each of these areas is important, they do not address where the firm's risk lies or how we serve clients and make money. What about the teaching of office project delivery processes, documentation standards, and how the firm works? Seldom does this happen at larger firms.

There is pressure to get new employees billable and become productive immediately, and overhead time is typically kept to a minimum. Technical and management onboarding should not be overlooked. New employees who become familiar with the goals, methodologies, and resources of the firm are in a better position to contribute value to projects, and onboarding in this respect can have a return on investment.

How do you get started? Many large firms have a talent coordinator on staff who oversees the training programs of the organization. These professionals have extensive knowledge of how to implement a firm-wide training culture. The value proposition is that the overhead cost is offset by the productivity gains of the staff. If a full-time position is not feasible, consider a part-time coordinator with additional responsibilities. If a neither is possible, consider self-creating and managing your own training programs to meet this need.

Every size of firm can benefit from internal training series such as lunch and learns, after-hours discussions, or a 30-minute stand-up session in the conference room. So-called stand-up sessions can even have catchy titles and vary in how they are delivered. These short, informal gatherings are often more impactful than an hour-long lunch and learn.

SUMMARY

Rethinking your firm may seem a stretch but is a noble goal to strive for in order to achieve excellence in project delivery. Little improvements matter just as much as the big ones, and it is up to you to find the right balance.

3 Goals:
Structure work to flow
Reduce variation
Eliminate or mitigate obstacles to progressing the work (constraints)

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RESOURCE MATERIAL

Figures 9.8 – 9.10: Lean Design Kickoff
Figure 9.11: Lean Project Review Agenda

LEAN DESIGN KICKOFF
Define / Design / Deliver

GOALS OF LEAN

Define the project, Solve the Puzzle (i.e., **Design**) and **Document** the Solution

- Identify project challenges early
- Identify the Lean "opportunities"
- Planning for productive design meetings
    - Meeting reports (as simple as an email w/ marked PDFs)
    - Use of 3D BIM model during meetings
- Accelerate design decisions
    - Reference the Define, Design, Deliver and Phase checklists guides
- Plan design deliverables by phase
    - Examples of Lean SD and DD deliverables – understand what is different and why

DATE:

Validate the Milestone schedule

Are the dates valid and realistic?

DATE:

Pull Plan for Schematic Design Issue

Goal:	Identify and choreograph the information flow for all AE disciplines.
Method:	Team meeting w/ each discipline represented
Notes:	Requires understanding the interdependencies between A / E tasks to support this document issue.

DATE:

Building Systems Review (the 1st value engineering effort)

- Review and define all building systems w/ client, AE team and contractor
- Find and identify "the money"
- Define project assumptions and unknowns
- Identify potential problems (to prevent or mitigate them)

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FIGURE 9.8 Lean Design Kickoff.

DATE:

Streamline Final Construction Documents / Issue for Construction Deliverables

Goal:	Final coordination of documents.
Method:	Face-to-face meeting w/ each discipline
Notes:	What is required to adequately convey scope and intent for the client and contractor?

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FIGURE 9.9 Lean Design Kickoff.

DATE:

Streamline Schematic Design Set Deliverables

Goal: Identify all building systems and document the project scope.
Method: Face-to-face meeting w/ each discipline
Notes: What is required to adequately convey scope and intent for the client and contractor?

DATE:

Optimize Cartoon Set after Schematic Design Issue

- What is required to adequately convey scope and intent for the client and contractor?
- Drawings "earn" their way onto CDs
- Identify critical intersections
- Reduce redundancy in drawings
- Use of Default Scheduling Systems

DATE:

Pull Plan for Design Development Issue

See description above for Pull Plan

DATE:

Streamline Design Development Set Deliverables

Goal: Finalized design of all building systems and life safety strategy; horizontal and vertical dimensional control.
Method: Face-to-face meeting w/ each discipline
Notes: What is required to adequately convey scope and intent for the client and contractor?

DATE:

Pull Plan for Issue for Final Construction Documents / Issue for Construction

See description above for Pull Plan

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FIGURE 9.10 Lean Design Kickoff.

LEAN PROJECT REVIEW AGENDA

DATE:

BRING THE FOLLOWING

☐ Drawings – view PDFs on screen – or bring a half-size set of current drawings
☐ Copy of milestone schedule for reference

PROJECT OVERVIEW

☐ Scope of Work – Provide overview of the project
☐ Construction Budget
- Anticipated Construction Cost
- Current estimate status

☐ Milestone Schedule
- Current status
- What is left to complete?
- Deadlines

☐ A/E team makeup
- Consultants
- Internal Team

☐ Type of Delivery
- Design, Bid, Build / CM at Risk / Design-Build / Fast Track

☐ QA / QC plan and current status

DISCUSSION

☐ What challenges do we anticipate?
- Finances
- Staffing
- Risk Management
- Risk Recovery

☐ What type of software(s) are you using and when (Sketchup, Rhino, Revit, etc.)
☐ How are design meetings w/ client conducted?
- How do we share info w/ client, contractor & A/E team?
- Current status of client relationship

☐ Design deliverables x phase
☐ Opportunities to accelerate design decisions.
- Define, Design, Deliver and Phase checklists
- Building Systems Review
- Pull Schedule

☐ Pull Schedule review
☐ Cartoon Set / Sheet setup review
☐ Life Safety Review

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FIGURE 9.11 Lean Project Review Agenda.

CHAPTER 10

Role of Technology

SHIFTING PARADIGMS

"The times they are a-changin'" – so said Bob Dylan over 50 years ago. He was a keen observer of the times, who chronicled and gave voice for many on the turmoil and influences affecting the United States during the 1960s. The times have been a-changin' for architectural and engineering professionals since the early 1980s, and technology continues to impact the tools in use today that bear no resemblance to those of a generation ago. Technology has enabled near instantaneous communication from almost anywhere and the ability to easily visualize design in more than three dimensions. Buildings and their sites can be rapidly modeled using data-rich components, with the inherent capability for better coordination of the components and disciplines. Computing power continues to increase allowing for the automation of more and more design tasks, and coupled with worldwide interconnectedness, we can work from anywhere and at any time.

Until recently, construction drawings and specifications remained essentially the same as we simply automated old processes. The use of new technologies has now begun to alter the design process itself along with the deliverables, and we can visualize and document ideas that were once thought impossible. Much effort is being invested to devise ways to leverage the building information modeling (BIM) model for downstream uses by all project stakeholders from the design team to contractors, fabricators, installers, and the client. At this time contractual, industry, and traditional practice barriers are being worked through but still stand in the way of broad-based fundamental change.

NEW ROLES

Computer-aided design (CAD) and BIM have spawned an entirely new type of role within the profession where the focus is on managing the complexities of software. The titles of CAD manager, BIM implementer, or digital design leader have become commonplace. Expertise in software is sometimes confused knowledge of codes or building systems and their proper integration.

We are still amid ongoing generational change where the tools of practice have shifted significantly and those with knowledge and experience are disconnected with the means of design and delivery. In the United States the profession is at another crossroads, where Baby Boomers are still practicing but with Gen Xers leading many firms. Millennials are moving into leadership roles, and Gen Zers are entering the workforce. Gen Xers were in the middle of the hand drawing, CAD, and BIM transitions. A few can still draw by hand, but soon after entering the workforce CAD became the standard, followed about 20 years later by BIM. Millennials entered a primarily BIM profession, with Gen Zers joining a BIM and mobile digital products workplace.

Digital tools can be wielded in many ways – some more useful than others – but if we are not careful, they can become a hindrance. BIM is only a means to an end, and the objective remains to facilitate a built structure for humans to use and occupy. Working out the design and producing coordinated documents should not take a back seat to the desire to model endlessly and with perfection.

The importance of conveying information remains paramount, regardless of the medium. While the art and physical nature of hand drawing is largely forgotten, a hand-drawn line on paper represents essentially the same information in CAD or BIM, the exception of course being that BIM enables the embedding of information and geometric relationships. The knowledge required to draw the line using a computer is multifaceted, but there still is a value to knowing what each line means as it is placed.

TECHNOLOGY

Opportunities abound to improve almost every aspect of architectural and engineering practice using technology. While design practices and tools may change, the underlying principles and objectives do not, and Lean thinking would suggest that technology has value only by enabling better work with reduced effort. Buildings must still meet codes, and the roof and exterior skin should not leak. Architects and engineers must think through and resolve the issues of a project, understanding that the time required to do that is not necessarily reduced.

Think slowly, and model or draw quickly.

Information has become cheap due to the ease with which one can digitally create, assemble, slice, dice, and reuse data. We must exercise with care all the power that comes with these processes. One observation we can make is that data and digital elements are easily manipulated, without needing to understand the purpose, context, or interrelationships between them. Second, models and drawings can have the appearance of completion but contain errors or be uncoordinated – and this is often due to the inclusion of unedited placeholder drawings. Third, BIM allows us to include attributes that are invisible; that is, there is hidden data embedded within BIM elements that often goes without review, whereas linework and components that are readily visible can be verified simply by being seen in context with other components. If we are not careful, technology can also lead to the development of unnecessarily complicated workflows and processes. Technology should be managed and made to work for the designer's best use, not only speeding work up but also increasing the usefulness of our services and products.

Essential Goals

- Facilitating understanding is critical. Deliverables should be easily understood by clients, regulatory officials, and contractors by taking advantage of 3D visualization and intuitive organization. This requires an understanding of their level of technical comprehension and the fundamentals of good communication using graphics. For example, contemporary printing and display technologies allow for documents with increased clarity and the use of color with 3D imagery. And BIM tools allow for concurrent estimating. The need remains for conceptual estimating that can see around corners, so to speak, and make appraisals of constructability and other nonquantifiable aspects.
- It's also important to simplify the implementation of technology. Design project workflows for new hires and inexperienced people, not the technical gurus in the firm.
- Prioritize the reliability of networks, equipment, and software availability as time spent resolving recurring problems or hunting for a software license contributes no value to the work. Firm resources and standards also should be readily accessible to everyone.
- Streamline document management to reduce the time spent looking for files. Inexpensive storage has allowed for the proliferation of project files, and it is common to scatter related information over a multitude of folders. For example, limit the number of project folders. Multiple nested folders create places to "hide" information that can be difficult to locate. Organize files contextually by topic or issue instead of by the file type or extension (e.g., images, JPG, PDF, DWG), locating differing file types together in the same folder or related subfolders that are part of a document issuance, such as Schematic Design or for Design Development Meeting No. Two. This saves time when trying to locate content compared with looking in multiple locations to find and piece together the various files. A request for information (RFI) response may entail correspondence with multiple parties, some materials research along with images and PDFs – all of which contribute to making the final response. Placing these within the same folder provides context simply by locating them together. Name files to allow understanding of the document's subject matter just by looking at the filename itself and eliminating the need to open and scan the contents. The examples below organize files chronologically using the format: yyyy-mm-dd XYZ (a three- or four-letter project identifier) – and a description (e.g., 2019-1118 ABCD – Updated Project Budget.pdf or 2020-0603 MOB – SD1 Mtg Report.docx). Minimize or eliminate multiple copies and versions of the same file.
- It will also help to devise simple methods to record client comments, preferences, and project decisions with a goal of handling data as few times as possible before it takes final form in your documents. Each time we transcribe information, there is an increased likelihood that errors will be introduced.

EFFECTIVE USE OF TECHNOLOGY

Using any tool or implement effectively requires knowledge of the tool itself and how it is used, some experience with it, and an understanding of what is to be accomplished. The goal of using any tool is to provide an advantage, to make us more productive. It also requires practice. In sports, teams do not just go out and play a game without preparation; they repeat plays over and over. The same holds true with design professionals: technology changes; you have to have your hand in it, or you will lose your touch.

You have to have your hand in it, or you will lose your touch.

Just as a microphone and speaker together amplify the sound of a voice, what is being said is of primary importance. Likewise, the use of technology within the design profession must help us to better express ideas and convey information. Attending a conference in the mid-2000s, one session inquired if attendees would soon be requiring the use of BIM on projects. Of the 90 or so owner representatives in attendance, almost everyone indicated their campus or organization would. The next question asked them to share specifically what they wanted to achieve or the benefits they expected to receive. Not a single person responded. This demonstrates a classic human characteristic where new is presumed to be better apart from consideration of the actual value it brings or the cost. There must be a return that justifies investment, and the design professionals' implementation of new technology should include an expectation of what is to be accomplished or improved.

BIM WITHOUT THE ROSE-COLORED GLASSES

The BIM platform is the main tool architects and engineers use today. There are still holdouts who use traditional drafting or computer-aided design (CAD) software, but the majority have transitioned to the new platform since the mid- to late 2000s. BIM by far has the greatest impact to the majority of our professional service fees. There are different flavors in the industry, but the premise is the same: elements contain information, and the model is a database of the information with each element having a unique identifier. How to use the information is unique among firms and even within firms themselves. Effective use of BIM is as individual as each person. If that is true, then why did the transition occur? Well, good question, and one that will not be debated in this book. Ultimately, if you treat BIM software as more than a drafting tool, then there can be an improvement in your return on investment.

The number of hours to draw has been reduced due to advancements in drafting techniques such as BIM, but the benefits do not eliminate the effort required to maintain details, plans, and sheets. In fact, one can argue that there is increased – or at least the same – effort required. We no longer are checking reference numbers in callouts, but we now must check for extraneous model elements which magically appear at the wrong time. Take for example a linked model from a structural consultant that gets updated weekly in the architectural model. As the project progresses, more detail is provided for miscellaneous steel angles and cladding supports. Now imagine you go to print the set, and suddenly you notice floating beams or otherwise extra pieces that were not there when you finished your wall section. Now you must go back and hide elements and double check visibilities. Was any time saved? This repeats at each model exchange.

As the example shows, BIM is not the be-all and end-all. The fine art of hand drafting has mostly disappeared in the professional office, but there are benefits to the amazing technology we use today. We can now find in minutes what would have taken hours in previous generations by overlaying 3D models and using clash detection. The usefulness of spinning a model around and detecting clashes can benefit the entire job. It may be one of the most useful tasks to do on a project. To be able to avoid potential conflicts now versus during the course of construction is invaluable, saving the client unforeseen costs and hassles later when tempers flare at the job site. Of course, it does not resolve all conflicts; that will never go away because the BIM model is not perfect. And the rigor to perform these clashes is not without an investment in time.

Is there a benefit to a clash-free design model? Part of the design process is the need to create clashes. Some of the best design solutions come from unexpected clashes. The goal should not be to be clash free in every aspect, although it has been observed that some on the construction side expect such an outcome.

Yes, it is not all rosy, but let us not forget the olden days when hours spent laboring over door schedules and finish schedules were a way of life! We are better off; however, the output is only as good as the information input and how it is used.

Technology Serves Process

To get the most from our technology investments, link the use of software with well-thought-out workflows and procedures. This prevents wasteful embellishment where additional software features are employed for their own sake, adding precision or detail that provide no real benefit just because we can. Creating constraints in how software is used in a production environment can lead to productivity increases by reigning in the variation between users, especially those with a tendency to pursue unnecessary complexity. Some staff are looking to solve problems we do not have and, in the process, create new ones. There are others who believe that every problem can be resolved using technology, regardless of the time involved or cost. Most problems can be resolved by improving our work processes and technology may be part of the solution.

Process Serves Clients

The means and methods used by architects and engineers must bend and adapt to differing client requirements and project types. Technology can aid in this by enabling us to easily locate and switch between different templates and forms.

Technology Facilitates New Processes

New technologies may enable processes and practices not thought of before or bring improvement to existing ones. This is a worthy pursuit and often occurs by experimenting on projects and breaking the rules, so to speak. Clients will continue to challenge us when we least expect it – often by asking

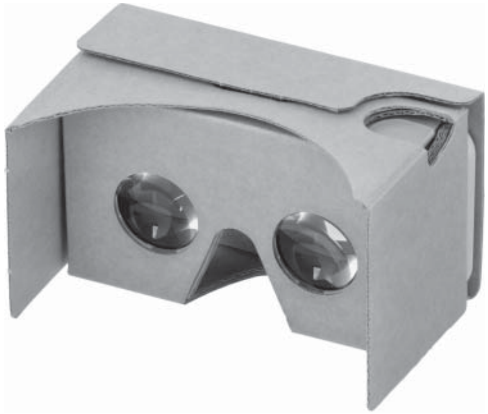

FIGURE 10.1 Google Cardboard. *Source:* Wikipedia.

for more work product for lower fees and projects delivered in less time. We will know if we are succeeding when:

- Tasks become easier to perform
- The time and effort required to perform work lessens
- The quality of information and deliverables increases

Technology has evolved in recent years to include virtual reality (VR) and augmented reality (AR), and some firms are using these technologies to assist in the design process. Smartphones with VR goggles (Figure 10.1) are a relatively inexpensive way to allow clients to experience spatial relationships and the overall look and feel of a space. These options make it easier to understand our design ideas and help in the decision-making process. VR allows architects and designers to showcase design solutions in real time, even making changes on the fly during a client presentation. This technology can reduce the back and forth of presentation, review, and response feedback loops that may take weeks in a standard design process. The reduction in conceptual and schematic design effort allows for two outcomes: (1) the ability to decrease time and fee spent in the early phases of a project; and (2) the potential to flow more work through your firm, increasing the number of projects your firm can produce and resulting in increased revenue potential.

There will never be a one-size-fits-all approach to the application of technology – either in design or documentation or with BIM as a deliverable. Projects of all types and sizes as well as differing delivery methods for construction delivery will remain with a variety of design firms doing the work. Cost will always remain the prime consideration, so it is wise to retain the ability to work in a less costly manner and provide the level of service commensurate with the client and project. The complexity of the project should be the challenge, not the difficulty of employing technology.

PART IV

Final Words and Advice

CHAPTER 11

More Than an Initiative

Changing a firm is a significant endeavor and one not easily accomplished. There is often an expectation for big ideas and noteworthy programs, when what may be needed is quiet persistence and unrelenting effort. We have experienced the ever-changing initiatives in firms we have worked with, and one thing they have in common is the desire to make an immediate impact. Most work well as short-term endeavors to solve immediate problems, but Lean is not an initiative. To be effective, it must become part of a long-term view and an underlying proposition within your company. It must be instilled within our DNA to continually look for ways to simplify how we work and to become better at designing and delivering projects by always looking to improve processes and leverage technology. Yes, there will be initiatives that arise out of Lean adoption; however, these are generally part of a broader strategy rather than a reaction. We see some key essentials here.

First, place emphasis on firm processes and how you work ahead of profitability. By acknowledging the practicalities of running a business, many firms have nonetheless lost sight of the simplicity of providing good service with excellence. Plus, developing methodologies that allow us to work smarter will incur an investment, but one that should pay practical and financial dividends down the road.

Second, institute new methods of evaluation that more accurately reflect and drive a productive effort with an emphasis on creating value. The numerical assessment of singular projects and individual performance lacks context and can provide only a general indication of real effectiveness; too often, it results in humorous behaviors due to the pursuit of looking good within the firm.

Third, emphasize the effective use of technology for design and production. The key word here is *effective*, which connotes what is useful, helpful, valuable, and efficient. Too often, technology is employed for its own sake or to automate inefficient processes that serve to more easily replicate bad practices. Automate the processes that do not require much thinking as much as possible.

> **In preparing for battle I have always found that plans are useless, but planning is indispensable.**
>
> —Dwight D. Eisenhower

We have not offered a plan but rather a way of looking at what you do along with a set of ideas and values that underlie a Lean approach to working. What you call it is less important than doing it, and if our goal is to get better at what we do and become best-in-class, that is a journey worthy of a lifetime's effort. We have provided many examples and shared tools and resources. Your job is to now draw from these and develop a plan that works for your firm at this time; one that starts everyone on the road to working together in the pursuit of excellence in project delivery.

No Elixir

In our search to become better deliverers of projects, we have observed there are no magic potions. Trial and error are necessary ingredients, and the pursuit of big and little ideas is part of the journey.

Eating Elephants

There is a saying that goes something like this: when trying to eat an elephant, the best way is one bite at a time. Small and incremental efforts over time can accomplish something originally thought impossible. Many seemingly inconsequential improvements add up to bring a benefit, and patience is a tool used to accomplish great things.

No Fear

Toes will be stepped on, and it may be difficult to avoid resistance. Our encouragement is to be fearless and embrace the difficulty, to step up and become agents of change. If needed, begin alone by thinking and working work differently. Results and good practices tend to speak for themselves.

Failure Is an Option

The company SpaceX indicated they would embrace failure as a means to more quickly iterate design and engineering. They would do this in a way that did not cause anyone harm but in fact would result in a lesser likelihood of someone being hurt. Likewise, design firms can embrace failure in noncritical ways to test ideas and find improvement more quickly.

No Monuments (Only Iconoclasts Need Apply)

While there must be standards, templates, and a consistent approach to work, it is important not to forever memorialize a way of working. Technology will continue to change along with client and industry expectations, and periodically we must tear down or shred how we work by asking if there is not a better way. This arises from an underlying understanding and commitment to becoming better practitioners with ongoing development and evolution of work processes.

NONNEGOTIABLES

Awards are bestowed by peers for great design, but few if any are given for excellence in project management, creative documentation, or technical merit. Nonetheless, doing good work is not negotiable.

Architectural practice is a blending of the largely subjective tasks of planning and design with the more objective areas of constructability, technical implementation, and documentation. It is advantageous for firms to excel in each of these. It is tempting to settle for a three-dimensional focus on the aesthetics of a built structure and to think that it is only about design or profit. Architects, however, must endeavor to master the fourth dimension: the complete project delivery continuum, which includes providing value with excellence in service to our clients – all of them.

PERMISSION TO THINK LEAN AND DO THE STUFF

Congratulations! You have made it to the end of this book, and we hereby grant you permission to think and work Lean, to challenge the status quo, and to explore new ideas – finding better ways of delivering work that makes for an enhanced client experience and one that improves your firm's bottom line (Figure 11.1). Now go out and do great things!

FIGURE 11.1 Certificate to think and work Lean.

Appendix

RECOMMENDED READING

- *The Goal* by Dr. Eliyahu M. Goldratt
- *Critical Chain* by Dr. Eliyahu M. Goldratt
- *Made in America, Regaining the Productive Edge* by MIT Commission on Industrial Productivity
- *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* by James P. Womack and Daniel T. Jones
- *Lean Solutions* by James P. Womack and Daniel T. Jones
- *The Death and Life of Great American Cities* by Jane Jacobs
- *PMBOK Guide* by Project Management Institute
- *The Architect's Handbook of Professional Practice,* 15th ed., Chapter 10.6 by Grant A. Simpson and Michael F. Czap

ONLINE RESOURCES

- www.leanarchitecture.com
- https://www.knowledge-architecture.com

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Note: Page numbers in *italics* refer to figures.