PROJECT VALIDATION

A Guide to Improving Owner Value
and Team Performance

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Lean Construction Institute
Transforming the Built Environment

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About the Lean Construction Institute and Lean Project Management

Lean Construction Institute (LCI) is a non-profit organization founded in 1997. The Institute operates as a catalyst to transform the industry through Lean, using an operating system centered on a common language, fundamental principles and basic practices. The Lean operating system provides the foundation for a different, more collaborative and more effective form of project management. Use of Lean techniques produces a transformational way of designing and building capital facilities and generating major improvements in owner satisfaction while dramatically improving schedule and waste reduction, particularly on complex, uncertain and quick projects.

With over 200 corporate members, representing the owner, designer, general contractor and trade partner communities, LCI is a voice for industry as it relates to project work. LCI sponsors programs in education, networking and research to assist members on all stages of their Lean journey.

LCI Vision:

Transformational improvement in: the delivery of value to stakeholders, and the quality of the work environment for all participants, achieved by re-integrating a siloed industry through Lean.

Strategy:

LCI seeks to increase owner and construction supply chain satisfaction with design and construction delivery by creating demand for transformation in the owner community and developing the capacity in the supply chain necessary to meet this demand.

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EXECUTIVE SUMMARY

Project Validation aims at proving or disproving with limited or no design whether the project team can deliver a project that satisfies the owner's business case and scope within the owner's allowable constraints of cost and schedule and with an acceptable level of risk. It sets the commitment of the team towards achieving project goals and accepting the shared risks of failing to do so. Validation is not design: it aims at establishing the basis of design and conceptual estimate. Validation is the time to stay fluid and open, collaborate and innovate, identify opportunities, add value, and build certainty. Validation enables the team to explore trade-offs between project goals/expectations and owner priorities, first merely seeking to know if there is sufficient design space to satisfy all objectives/expectations, and if not, identifying where trade-offs must be made. During validation, the team explores and reflects with a multidisciplinary lens on different concepts and options for major project items and chooses an option to build the conceptual estimate without committing to the design of such an option. Allowing the coexistence of multiple sets of options without necessarily settling on one enables the team, later on during design when additional information becomes available, to make design decisions that ensure the cumulative impact of such decisions and thus add further value. If at all advanced, schematic design is limited to provide the required certainty. Validation culminates in an informed decision by the owner on whether to authorize (go) or not (no-go) the project and thus ahead of the final resolution to fund and build the project. Validation is executed within a short duration and limited budget. Owners seek the minimum resource investment that results in the certainty needed for an informed decision. Validation offers owners what likely is the "biggest bang for the buck" in today's capital delivery landscape.

Subject matter experts express that, when properly implemented, validation sets the project team towards the generation of value and innovation and the improvement of team performance. Validation requires the team to develop the basis of design that meets the scope of the built product, which, at the same time, enables the programs/operations anticipated by the owner. The team's multidisciplinary focus and informed decision-making lead to improved and innovative solutions that add project value and enable the elimination of waste during the project delivery process. Additionally, validation improves the team's reliability to deliver the project within the anticipated cost and schedule. In other words, it enhances predictability, i.e. the team's ability to anticipate project outcomes early (as opposed to late) in the delivery process. Such ability to anticipate cost and schedule outcomes should be regarded as a breakthrough in the construction industry, which, since early in the 20th century, has been characterized by endemic cost and schedule overruns accompanied by disclosures of actual performance late in the delivery process. Such late disclosures make corrective actions expensive, inefficient, or simply unfeasible.

Validation results in a win-win situation for both the owner and the team whether the project is authorized or not. When authorized, the owner and the team contractually agree to the project based on the shared commitment that the success criterion can be met. When not authorized, validation enables the owner's informed decision about the project. The owner can extend validation in order to increase certainty further, increase the allowable budget, modify the business case, change the scope, or terminate the project and thus allocate the funds into alternative investments that can meet the owner's objectives. The value of validation rests in establishing certainty and enabling an informed decision, whatever the decision is, on behalf of the owner and the team at a fraction of the expenditure than traditional design and estimating approaches require. Organizations with validation expertise regard it as a competitive advantage.

PREFACE (how to use this Guide?)

What is the Purpose of this Guide?

Project validation is rarely leveraged, and when it is, teams differ on what validation entails. As a result of its novelty, validation is not described by the literature. This Guide is the result of a primary research effort by the Lean Construction Institute (LCI) to document validation and provide guidance to practitioners.

During the preparation of this Guide, the authors have observed confusion among construction practitioners as to what validation is and how it should be executed. Thus, this Guide aims at providing direction, education, and resources that can assist practitioners through the multiple decisions that they will have to make when considering, planning, and implementing validation. This Guide is written with the intention to provide an unambiguous validation framework while still leaving room for variation during its planning and implementation.

How is it Organized?

This Guide is organized in four different chapters and two appendices. The chapters cover fundamentals of validation; the owner; validation process; and approval solicitation. The first two chapters discuss fundamental concepts and the owner's role, while the latter chapters detail the validation process and outcomes. The appendices include the summary of validation tools in this Guide and materials collected from effective validation efforts. Most readers will benefit from reading the Guide from beginning to end. Others may need specific information or may choose to review certain chapters or their sections.

How was it Produced?

Data were collected through open-ended phone interviews with eight subject matter experts. Experts averaged 19 years of design and construction experience and 10.5 years of lean construction experience. During the interviews, each expert was requested to select one remarkable project validation effort as a result, for example, of scale, cost, schedule, complexity, or success. Within the context of such project, each expert shared validation aspects such as information inputs and outputs, team and culture, validation steps, or approval solicitation. Table 1 illustrates the descriptive statistics of the sample of projects. In addition, experts were also requested to shared lessons learned gained through their cumulative validation experience. After each interview, additional questions were communicated and responded via email. Interview transcripts and the additional information were analyzed and results produced. While the scope of this Guide is inclusive of performance criteria related to program/operations, quality, schedule, and costs, it reflects a prevalent focus on cost as expressed by subject matter experts. Results from the interviews were complemented with the authors' observations at validation sessions.

How to Print this Guide?

This Guide was digitally produced. For best results, print in 17in x 11in paper format.

What are the Quotes?

Quotes aim at enlightening and educating the reader through the thoughts, experiences, and recommendations from subject matter experts. Quotes were extracted directly from the interviews and in this text appear delimited between quotation marks.

Table 1. Project Sample

Descriptive Statistics	
Investment Source	Private = 8 Public = None
Project Sector	Healthcare = 6 Manufacturing = 1 Biotechnology = 1
Expert Affiliation	Owner = 5 Design and Construction = 3
Total Installed Costs (TIC)	Maximum = $309 million Minimum = $60 million Average = $183.8 million
Project Completion Time	Maximum = 60 months Minimum = 14 months Average = 36.3 months
Validation Costs (% of TIC)	Maximum = 1.67% Minimum = 0.19% Average = 0.54%
Validation Schedule	Maximum = 27 weeks Minimum = 9 weeks Average = 16.9 weeks

WHAT IS VALIDATION?

Validation

Project validation aims at proving or disproving with limited or no design whether the project team can deliver a project that satisfies the owner's business case and scope within the owner's allowable constraints of cost and schedule and with an acceptable level of risk. It sets the commitment of the team towards achieving project goals and accepting the shared risks of failing to do so. Validation is ideally executed within a short duration, limited budget, and no design. Validation culminates in an informed decision by the owner on whether to authorize (go) or not (no-go) the project and thus ahead of the eventual resolution to fund and build the project. The value of validation rests in establishing certainty and enabling an informed decision, whatever the decision is, on behalf of the owner and the team.

"In validation, if you don't spend enough time upfront figuring out how do you want to work together and what is it you really want to achieve, you will simply do what you've always done and call it something different"

"I mean, certainty. So that's, I think, the key power in doing validation. It's not just knowing. It's knowing whether the project is going to happen"

What is Validation and What it is Not?

We have observed confusion among practitioners as to what validation is and what it is not. At the time of this publication, project validation is rarely leveraged, and when it is, teams often differ on what validation should entail. Indeed, some teams supposedly engage in project validation while in reality they "simply do what they have always done and call it something different [validation]." Thus, in order to facilitate a response to the above question, Table 2 illustrates the characteristics inherent to validation. Not meeting the characteristics in Table 2 is an indication that the so-called "validation" is likely being short-circuited in one way or another. For example, the lack of an effective go or no-go decision negates the possibility of the project being stopped and denies the essence of validation. Also, evidence shows that failing to allocate cost and schedule resources in support of validation forces teams to elude validation and engage in traditional design and estimating.

Table 2. Identification of Validation

Validation Characteristics	Yes	No
Follows the Business Case	❑	❑
Culminates in a Decision on Whether or Not to Authorize the Project	❑	❑
Has a dedicated Budget & Schedule	❑	❑
Has a dedicated Team of Experts	❑	❑
Design is Omitted or, at most, Limited	❑	❑

Validation and Integrated Project Delivery

Integrated Project Delivery (IPD) is a team-driven delivery approach that aims at enhancing performance, innovation, and value. IPD is characterized by the early involvement of team members, shared risks and rewards based on performance, joint project management, liability reduction, and joint development of Conditions of Satisfaction (CoS). IPD demands a relational contracting approach that aligns project goals with the team-driven delivery approach. During design and construction, the team operationalizes the delivery through lean processes and techniques such as Value Stream Mapping, Last Planner™ System, Target Value Delivery, or production monitoring and controls.

What are Conditions of Satisfaction?

CoS are an explicit description by the owner and team stating all primary requirements that must be satisfied to deem the project outcomes as successful. CoS include owner priorities (e.g. scope, budget, schedule) and often include additional conditions by the team.

"CoS were essentially what mattered to the owner combined with what mattered to the team"

What is the Integrated Form of Agreement?

The Integrated Form of Agreement (IFOA) is a poly-party or relational agreement that includes, at a minimum, the owner, design professional(s), and contractor(s) as signatories to the same construction contract. Selected CoS are incorporated into the poly-party agreement as measures of project success and are often rolled into the incentive compensation program. Such compensation program determines the portion of the incentive pool that is shared by each team partner organization either as a loss (risk) or profit (reward).

How does Validation support IPD?

Its focus and team approach make validation the natural predecessor of IPD. Validation and IPD share their team-driven, collaborative, and risk-sharing characteristics. Validation results in the shared commitment that the project success criterion can be met, and anticipates and nurtures the team knowledge, behaviors, and skills characteristic of IPD. Also, while validation aims at proving or disproving whether the project team should deliver the project, IPD aims at delivering the project. Validation is ideally executed as the basis for the commercial terms of the IFOA contract. Validation informs the poly-party agreement of shared risks and rewards. Once validation is over the validation team transitions at the core of the IPD team.

Does this Guide focus on the Validation of IPD Projects?

During the preparation of this Guide, we documented a prevalent combination of validation and IPD. Indeed, IPD was characteristic of all sampled projects but one, which was delivered with an "IPD-like" approach. Thus, this text provides guidance for the validation of IPD projects.

Can I Validate non-IPD Projects?

We have found anecdotal evidence that validation can be eventually used in non-IPD projects. For example, validation can be

used as stand-alone consultation or in combination with other delivery methods, e.g. design-build. Also, a public agency may perform validation prior to the solicitation of design services. Other implementation approaches are likely to exist.

For more information about IPD, see:

R. Cheng, M. Allison, H. Ashcraft, S. Klawans, and J. Pease (2018). *Integrated Project Delivery – An Action Guide for Leaders.* University of Washington, Seattle, WA, USA. Available: <*http://cm.be.uw.edu/wp-content/uploads/sites/29/2018/06/Pankow_IPD Guide.pdf*>

R. Cheng, and A. Johnson (2016). *Motivation and Means: How and Why IPD and Lean Lead to Success*. Lean Construction Institute and Integrated Project Delivery Alliance, Arlington, VA, USA. Available: <*https://www.leanconstruction.org/wp-content/uploads/2016/02/MotivationMeans_IPDA_LCI_Report.pdf*>

For more information about how to define CoS, see:

M. Fischer, H. Ashcraft, D. Read, and A. Khanzode (2017). "Managing with Metrics" (chapter 11) and "Collaborating in an Integrated Project" (chapter 13, particularly section 13.4) in *Integrating Project Delivery* (Hoboken, NJ: Wiley, 2017).

When is Validation Performed?

Validation follows the development of the owner's business case and precedes the contractual agreement to design and build the project. The business case justifies why the owner wants to build a building/facility. It establishes the owner priorities such as scope and programmatic/operational functions that the project is to enable and the allowable cost and schedule. In doing so, the business case informs validation. Complementarily, validation precedes and informs the resolution by the owner on whether or not to authorize and fund the project. Validation engages the project team in the analysis of the gap between project objectives/expectations and owner priorities. When authorized, validation informs the contractual agreement, design, and construction. The Validation Study or similar deliverable from validation becomes a touchstone for the duration of the project.

In its leanest approach, validation sets the basis of design and conceptual estimate —i.e. without traditional design, which only starts once validation has been completed and the project authorized. See Figure 1. In an alternative approach, though, the owner can require the team to advance schematic design during validation. See Figure 2. Commonly, such approach aims at either reducing project completion time when an expectation exists that the project will be authorized or aims at further increasing certainty. In such case, schematic design is limited to attain the required level of certainty. However, the reader wants to notice that there is nothing new in reducing uncertainty and increasing project performance predictability through design.

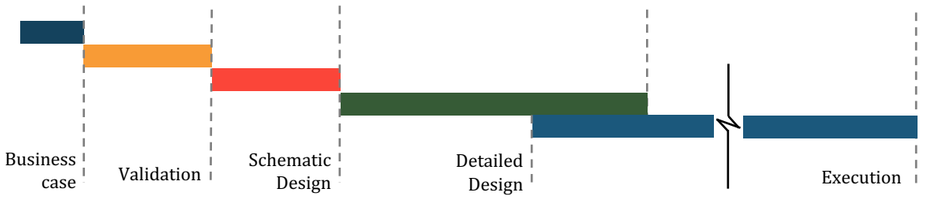


Figure 1. Validation in the Delivery Process

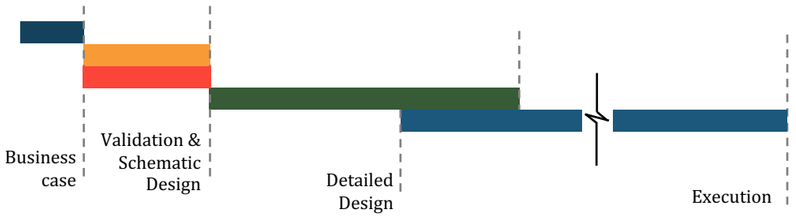


Figure 2. Concurrent Validation and Schematic Design

Basis of Design vs. Schematic Design

Subject matter experts agree that setting the basis of design is sufficient for the generation of estimates during validation; thus, traditional schematic design is not necessary. However, as detailed in the previous section, we have found evidence of teams advancing schematic design during validation. In order to reduce uncertainty and/or the gap between expected cost and owner's allowable cost, a recommendation can be made to proceed with design and extend validation. Also, we found evidence of owner organizations with a mature validation process that routinely advance schematic design in order to reduce project completion time.

"Because validation is spitting out as much information as you know relative to the scope and conditions of satisfaction. And putting together a level quality, and time, and cost to that. There isn't really a point in which you're designing or detailing anything"

"There were sketches of plans, layouts, what it could look like. There was sketches of what the exterior could look like, what an interior lobby might look like. Some examples of systems that we might use: structural, plumbing, specifications of any of the systems to informal level quality. And that would be our basis of design, plus cost information"

Whatever the approach, traditional design is not an aim of validation. It can unnecessarily extend the validation timeline and force design decisions that limit the ability of the team to, later on when additional information becomes available, enhance value. Table 3 illustrates key differences between the development of the basis of design and the development of schematic design during validation. *The reader wants to notice that a conceptual estimating competency, i.e. the ability to accurately estimate costs with minimal or no design information, among team members is necessary in either of the two design approaches.*

"So, the team discussed three different structural systems that were possibilities. And they ended up in the validation and one of them in the validation estimate. I don't know necessarily that is what ended up in the project, but that's what was in validation"

Table 3. Basis of Design vs. Schematic Design

Validation Factor	Basis of Design	Schematic Design
Project Authorization Expectation	High or Low	High
Uncertainty	High or Low	High
Ability to Explore, Innovate, and Add Value	Higher	Lower
Costs (as % of Total Installed Costs) (*)	≳0.2 & ≲1.75%	≳2% & ≲4%
Time to Authorization Decision (*)	by 1/2 or 1/3	by 2 or 3
Conceptual Estimating Competency	Required	Required

(*) Values based on sampled projects

For more information about Conceptual Estimating, see:

G. Ballard and A. Pennanen (2013). *Conceptual Estimating and Target Costing.* In:, Formoso, C.T. & Tzortzopoulos, P., 21th Annual Conference of the International Group for Lean Construction. Fortaleza, Brazil, 31-2 Aug 2013. pp 217-226 Available: <http://iglc.net/Papers/Details/872 >

Benefits

Why should I Validate?

Validation results in a win-win situation whether the project is authorized or not for both the owner and the team, and eventually for all other stakeholders who touch or are touched by the life of the project or its products, such as users, regulatory and permitting agencies, or neighbors. Specific benefits are discussed in this section.

Continuous Learning and Alignment. Validation sets the soft skills and dynamics within the team. In addition to the generation of project knowledge, it offers multiple benefits to the team such as alignment, cohesive behaviors, clear communication and information, establishing onboarding protocols, or establishing a lean culture of continuous learning. In doing so, validation anticipates and nurtures the knowledge and culture that will eventually support the team during design and construction.

Business Case Evidence. Validation confirms, modifies, or denies the owner's business case. Validation informs the business case and can result in its iteration and improvement. Thus, the owner may decide to revise the business case and/or scope in order to reduce project costs below the allowable budget. Also, validation can uncover opportunities. The owner can increase the project scope for a marginal cost or eliminate an aspect/component that adds an unreasonable cost or complexity. When validation exposes that owner priorities cannot be met (no-go), it avoids the owner and team to invest in a project that would likely result in a loss and could damage the reputation of the partner organizations in the team.

"We [designers] do not need to guess since the basis of design becomes very clear"

Scope Definition. The validation team develops the basis of design that meets the scope of the built product (building/facility), which, at the same time, enables the program/operations anticipated by the owner. Thus, the validation team analyzes the consistency between built product and programs/operations so that it can identify and resolve discrepancies or issues. By focusing on clarity, validated projects often avoid scope changes during design and construction, and, when these occur, they are typically driven by the owner's decision to revise the business case.

"Through validation we have shown some real movement on getting waste out of what's inherent currently in the traditional approach to construction"

Enhanced Value and Innovation. Validation enables the generation of value to the owner and team and the reduction of waste during the project delivery process. The multidisciplinary and collaborative work during the development of the basis of design enables the team to explore and reflect on design and construction options, risks, and opportunities. Validation often results in better or more innovative components or solutions. Validation teams reflect not only on what item is needed but also on why such an item is required. For the team and its partner organizations, when a project is authorized the combination of validation and IPD offers many benefits, such as improved resource management, reduced cost of pursuit, rework reduction, and better margins.

Cost and Schedule Predictability. Validation enhances the ability to anticipate team performance and project outcomes. Subject matter experts express that the combination of validation and IPD virtually eliminates cost and schedule overruns. Conceptual estimating is a necessary competency among team members in order to realize accurate project outcome predictions with limited or no design.

"Can the owner afford it? Does the owner need to make big adjustments? But it's also the team understanding where everybody is and what their interpretation of the scope is. Normally in a project, you don't figure that out until later on"

Streamlined Design. By setting the basis of design, validation reduces information loops during design. Designers express that they do not need to make assumptions during the design process since the team evaluates multiple options for each major project item. This comparative information sets the basis of design. Even when alternatives are left for analysis during design, designers state that they can obtain rapid feedback from team members since team alignment, dynamics, and communication have been already established during validation.

"So during validation the task was to answer the question, can we build this program for this much money and get it opened on this date? Can we do that? And that was what the validation process was all about. And the team knew that if the project got approved that they would be collectively at risk for achieving it. They were aligned because they knew what the business deal would be if the project got approved"

THE OWNER

Owner's Role

The owner should carefully analyze whether it should engage in validation. In the same manner that IPD may not be appropriate for every project or owner since its team-driven and risk-sharing characteristics inherently require greater leadership and effort, validation may not always be appropriate.

During validation, the owner must actively set a role model. It should set goals and priorities, provide leadership, and model transparency and collaboration to the rest of members and partner organizations in the team. Although these attributes apply to the entire team, they are especially important in the owner representatives and its leader(s) within the team. Also, validation requires the support from owner's upper management. Without such support, validation is likely to fail, for example due to lack of resources.

Why should I Manage Politics?

When political aspects (e.g. permitting, entitlements, public funds) exist, the owner should actively manage them. Not doing so can easily jeopardize the team's assessment of certainty and risks. Thus, the owner must proactively address politics and keep the team updated on progress and expected outcomes so that the team can incorporate such information into validation.

What Projects should I Validate?

The larger the uncertainty and risk, the more the need for validation. Validation requires a dedicated team and the corresponding budget to support it. The investment in those resources demands justification and often results in the owner setting basic rules to determine whether or not validation needs to be performed. Not all projects justify validation.

Thus, we documented owner organizations that require the validation of a project only when its expected costs exceed a minimum dollar value. Owners observe both exceeding such cost value as an indication of increased uncertainty and risks and project validation as the mechanism to provide clarity. Sources of uncertainty vary widely among projects, owners, and industry sectors. For example, in the residential sector, the market behavior becomes a critical contributor to uncertainty. Similarly, in downstream oil and gas capital investment costs can be accurately predicted, while global market fluctuations set whether or not there is a business case for the investment. Projects with foreseeable costs do not require validation.

When is a “Lean Coach” needed?

The owner must have representation in the team that is competent in the design, planning, and execution aspects of the project. Ideally, the owner representatives are also experienced in validation, IPD, and lean. However, owner organizations novel to validation can engage a “lean coach” or similar expert to help establish a foundation of knowledge within the team and operationalize lean thinking into action, for instance setting the big room environment and activities. The coach should not be a leader, but a facilitator. Care should be exercised to select a coach with a true lean mindset as opposed to old-fashion coaches who, for example, may tend to “defend” the owner. Such non-collaborative behavior would send the wrong message to team members who, for example, could needlessly increase pricing to offset perceived risks. Also, a coach intervention should be carefully planned and measured. We have observed that not every coach produces a meaningful impact.

“We had a lean coach that helped us establish a big room environment, and helped with behaviors using many of our current lean tools to help improve collaboration and communication”

As an alternative, the owner can bring the required expertise through experienced team members, for instance in the role of team co-leaders. When appointed, co-leaders represent one or more core partners in the team, such as the architect, general contractor, or trade contractors.

Can those novel to Validation succeed?

We have documented instances of successful validation for complex projects by teams without prior validation experience. However, we have also observed that those novel to validation often feel compelled to engage in traditional design in order to generate information that increases certainty. The more the design is developed, the greater the knowledge about the project and thus the higher the certainty are. However, there is nothing new in reducing uncertainty and increasing predictability through design. With proper guidance —i.e. coach or team partner, project validation with minimal or no design is possible by those novel to validation.

In any case, when the owner lacks experience or access to experienced partners, it should consider testing validation in low-risk projects. A controlled and experimental environment will facilitate the learning and cultural shift that the development of validation expertise requires. IPD-experienced owners may only need the development of validation-specific skills since its team-driven and risk-sharing characteristics are those of IPD.

Process Re-engineering vs. Project Validation

Process re-engineering is an owner-driven effort aiming at the improvement of the functions, programs, or operations that the built product is to enable. It aims at improving performance measures such as cost, quality, service, or time. It breaks down processes into tasks, which are streamlined based on the analysis of their requirements, such as people, information, technologies, materials, tools and equipment, or space. Process re-engineering, which is sometimes referred to as functional design or process change management, is not within the scope of validation. Validation centers the focus of the team on the built product, e.g. building or facility.

However, evidence indicates that a concurrent owner’s focus on process re-engineering results in a synergistic interaction and exchange of information with the validation team that further enhances validation, adds value, and drives innovation. For example, workflow analysis requires the consideration of both process constraints and the building/facility requirements and layout that enable such process. Thus, process re-engineering results in valuable information that the validation team can incorporate into the basis of design, and vice-versa.

Such type of dialogue often results in notable improvements in facility/building design, workflows, services, speed, or costs. In order to enlighten the reader, two examples follow. A combination of validation and process re-engineering efforts for a new healthcare facility resulted in the reduction of square footage while maintaining the programmatic functions and quality of services to patients. The dialogue between process re-engineering and validation teams sparked the negotiation of daily replenishment of inventories with suppliers and thus led to a substantial reduction of inventory space. In another healthcare project, a decision was made to change the location of a water fixture in the patient rooms despite the increase in construction costs. Thus, the dialogue between the two teams led to an informed decision to prioritize long-term operation workflows and costs despite increased upfront costs.

“Large projects typically always have some political dimension to them, and to validate a large project without a clear plan of how to manage the political sphere is not smart”

For more information about Process Re-engineering and full-scale mock-ups, see:

U. Nanda, Z. Rybkowski, S. Pati, and & A. Nejati, A. (2017). *A Value Analysis of Lean Processes in Target Value Design and Integrated Project Delivery: Stakeholder Perception*. HERD: Health Environments Research & Design Journal, 10(3), 99–115.

Business Case

The business case justifies the project investment by meeting owner's needs related to market, finances, or regulatory and compliance requirements. We have documented large differences in the level of business case detail ranging from highly structured and documented to very succinct yet informative.

"You have the business case. Once that's done, then we set the goals for the cost, timing, and scope for the project team"

How does the Business Case inform Validation?

The owner's business case is often translated into a memorandum or similar document that describes the owner's priorities inclusive of scope, and allowable budget and schedule. The business case justifies the project so that the team can focus not only on the product "What do we want to build?" but also on the owner's motivation "Why do we want to build it?". The allowable cost is the owner's maximum investment and sets the maximum cost that the project team should commit to if the project is to be authorized. During kickoff, owner upper managers communicate priorities to the validation team. If the owner decides to revise the business case, then the parameters informing validation must be updated and communicated.

"It's everything that you would normally want to find out which is, you want soils reports, you want to know that you've got room to turn a fire truck around, you want to know that you understand how you're going to anchor the foundation. You know what kind of structural system you're going to use. You've got to know where all your heavy items are in the building"

Additional information sources

Validation requires the collection of data and information from multiple sources in order to produce the conceptual estimate and basis of design. Information sources vary depending on the project, and can include soil reports, site conditions (e.g. utilities), data from similar projects/items, labor market (e.g. labor shortage), regulatory and compliance requirements, entitlements, logistics (e.g. traffic, signals, roads, parking, storage), program/operations data, or project constraints.

In addition, teams often leverage Gemba Walks to gather factual information when a similar building/facility exists —or the same building/facility in renovation or expansion projects. The team visits the existing facility and documents information related to operations, flows, layout, equipment, and workers' & users' opinions and feedback. The real-world context and information from Gemba Walks increase the team's confidence in the validation outcomes.

"We would strip the project back to the absolute essentials in order to meet the business case and then add everything else in a wishlist, so that the team understood to the extent that head room was created within the budget, those elements could be added back"

Validation Resources

Validation must have a dedicated budget, schedule, and team of experts with full-time dedication. The budget covers the fee of each expert plus additional expenses, such as travel. The owner anticipates the duration of validation, the profiles of team members, and allocates the budget.

Validation is executed within a short duration and limited budget. Always seek the minimum resource investment that results in the certainty needed for an informed decision.

What does the Budget look like?

It varies with team size and duration. We have documented succinct validation efforts extending from 6 to 10 weeks with budgets in the low hundred thousand dollars for projects worth between $100 million and $200 million. See Table 1. The development of schematic design during validation is likely to increase the budget above 2% of total installed costs.

What does the Schedule look like?

Subject matter experts advocate for an intense validation effort that reduces its time to completion. We have documented successful validation efforts extending from 6 weeks up to 4 months, and eventually more. See Table 1. The greater the complexity, size, and uncertainty of the project are, the longer the validation effort will be. Subject matter experts within owner organizations with a history of validation efforts report notable reductions (about 50%) in the time necessary to validate a project when compared to the time invested in the first validation efforts of similar projects.

"I actually asked for funding twice during validation. At the end of validation, we felt we were within striking distance, but the team wanted to do some deeper studies in order to gain further confidence and so I requested additional funding."

Validation Team

How do I select Team Partners?

We have observed a variety of owner approaches to select team partners. Some owners have an ongoing set of partner organizations (e.g. architects, designers, contractors, trade contractors) and select the team partners from such pool. Another common approach involves pre-qualification and solicitation of proposals. We also documented instances in which the owner requires two or more proposers to enter a joint venture, for example when the owner considers that the aggregation of ideas, skills, or resources is necessary to meet its objectives. During the selection process, owner visits at the facilities of potential partners are common.

"Define CoS, design business parameters, spend the time to get the common language, and get the right people in the room"

What Team Member Profiles do I need?

Do I have the right people in the room?

Disciplines expected to provide information continuously must be represented in the team. At a minimum, the validation team is represented by experts from owner, architect,

"Some companies get paralyzed at the ability to show a range of costs with little or no information. They cannot do it"

"Validation requires the right team of experts that continuously learn, innovate, drive down capital costs, shorten the duration of construction, and provide value back to the owner"

contractor, and key trade contractors such as mechanical, civil, or electrical. Each partner must allocate one or more experts that secure the estimating and design expertise and volume of work that validation requires. For example, we documented a team in which a leader and an estimating expert represented the owner; a designer/estimator represented the architect; an estimator, planning/construction expert, and superintendent(s) represented the contractor; and, one or more experts with design and estimating competencies represented the electrical/mechanical/civil contractors.

Why do I need Conceptual Estimating skills?

Conceptual estimating responds to the ability to estimate costs with limited or no design and is a required competency among team members. Conceptual estimators must have the experience and skills to continuously collaborate, propose design concepts and options, and estimate an accurate range of costs in a short time. A combination of design (at a minimum basic design) and in-depth estimating skills is necessary. Besides, previous experience with similar projects is highly

desired. Table 4 can be used as a resource tool to assess team candidate competencies. Within those, core competencies (which team members should always have) are indicated with (*).

What is first, Team Partner or Team Member selection?

There is not a single answer to this question. Some owners select what they consider the right partners and within each partner the best candidate(s) for the team. Other owners identify, among proposer organizations, the best candidate(s); that is, they prioritize the preferred candidate(s) over the proposals. In any case, team leaders should interview candidates, so that selected team members have the desired experience, behaviors, and skills. Owners with a set of ongoing partners are prone to roll over teams from previous projects.

"By identifying someone that knows how to do conceptual estimating. Someone that knows how to have frequent conversations about cost and don't just look at risk; look for opportunities and value generation"

Team Leaders

The owner's leader within the team (alternatively with the support of co-leader[s] from architect, contractor, or trade contractor(s)) is accountable for the success of validation. Team leaders must have experience with similar projects and should be able to coach and facilitate in addition to managing cost and schedule estimates. Experience in lean construction and validation can be very valuable but is not indispensable.

"We develop a list of the deliverables and part of what we're asking the teams to identify is, "In order to produce a conceptual estimate, what do you need in order to have sufficient certainty about what you would build, for how much and how long?""

When do I need Supports?

When information from a discipline is only required at specific times, experts in such discipline should only be invited with the role of supports, i.e. when their input is required. Typical examples of support disciplines are roofing, cladding, or interior partitioning.

Table 4. Expert Competencies

	High	Low
Technical Skills		
Conceptual Estimating (*)	❑	❑
Basic Design (*)	❑	❑
Detailed Design	❑	❑
Experience		
Similar Projects (*)	❑	❑
IPD	❑	❑
Lean Construction	❑	❑
Behavior		
Team Building (*)	❑	❑
Commitment (*)	❑	❑
Problem Solving (*)	❑	❑
Time Management (*)	❑	❑
Accountability (*)	❑	❑
Leadership	❑	❑

(*) Core competency

For more information about Conceptual Estimating, see:

G. Ballard and A. Pennanen (2013). *Conceptual Estimating and Target Costing.* In:, Formoso, C.T. & Tzortzopoulos, P., 21th Annual Conference of the International Group for Lean Construction. Fortaleza, Brazil, 31-2 Aug 2013. pp 217-226 Available: <*http://iglc.net/Papers/Details/872* >

VALIDATING THE PROJECT

Team Kickoff

What is a Big Room Session?

A big room session is a co-located and structured workshop that optimizes team alignment and collaboration, strengthens team relations, and promotes decision-making and sharing of information. The room setting facilitates such team dynamics, for example with a common table; a large screen/monitor (or set of monitors) through which team members can share information (e.g. from their computers); or, plenty of vertical write-on space (e.g. whiteboards, write-on painted walls, flipcharts).

Why is it important?

The sheer magnitude of communications and information analysis and handoffs coupled with the pace at which information is shared and decisions made during validation require a work setting that enables continuous interaction and creativity. Co-located sessions reduce latency in asking and answering questions; support collaborative work and innovation; eliminate misunderstandings, rework, or gaps in expectations; expedite decision-making; and, ultimately, build alignment and trust. Such alignment and trust built among the disciplines in the team coupled with the collaborative and multidisciplinary exploration of design concepts and options result in a productive and energizing work environment that stimulates team's talents and creativity.

What happens during Kickoff?

The kickoff is a multiple-day big room session that builds alignment around culture, project expectations, behaviors, and delivery techniques. The kickoff session informs the team, provides training, and sets behavior expectations so that the team can immediately start performing at a high level during validation. Subject matter experts emphasize that gaining such early alignment and immediately setting the team in the right direction are crucial for success.

There is not a set of contents applicable to every kickoff. It varies based on project, site conditions, team experience, team members acquaintance, and regulatory and permitting requirements, among others. Nonetheless,

"We had everybody in the in-person kickoff, which included team-building, leadership and capacity development, IFOA training, behavioral contracting, creating conditions of satisfaction, or rules of engagement. Really high-level stuff so that we were on the same page"

Table 5 groups common kickoff contents under the categories of information, team advancement or training, and team activities. Core content, which should always be considered, is indicated with (*). The rest of this section details the information input and team activities.

Table 5. Kickoff Content

	Yes	No
Information Input		
Owner's Culture and Project Significance (*)	❑	❑
Owner's Priorities (*)	❑	❑
Behaviors of Excellence (*)	❑	❑
Project Approval Process (*)	❑	❑
Others (write down)	❑	❑
Team Advancement		
Relational Contracting (IFOA)	❑	❑
IPD	❑	❑
Last Planner™ System	❑	❑
Target Value Delivery	❑	❑
Others (write down)	❑	❑
Team Activities		
Identification of Validation Deliverables (*)	❑	❑
Pull Planning Validation (*)	❑	❑
Determining Rules of Engagement & Communication (*)	❑	❑
Determining Conditions of Satisfaction (*)	❑	❑
Others (write down)	❑	❑

Information Input

Owner's Culture and Project Significance. Informs the broader vision and goals of the owner (history, service, community, or market), how the project relates to them, and what the project aims to accomplish. Team members, and team leaders especially, must get acquainted with the overarching project goals, not solely focused on scope, cost, or schedule. Owner upper managers present such information to the team.

"We had two high-level managers from the owner come and tell the room why we were all there, why the project mattered, and what the business case was"

"I mean, apart from just like blocking and mapping and pricing your project, you should know your pathway through approvals"

Owner's Priorities. The owner's business case is translated into a memorandum or similar document with the priorities. Owner upper managers present them to the team.

Behaviors of Excellence. Expectations of team members' behaviors, inclusive but not limited to accountability, timing, respect and equality, diligence, and communication rules and tools.

"You just need to be very clear on the deliverables that you need to create during validation, and why each one is needed"

Project Approval Process. Informs on what distinct owner stakeholders (e.g. board of directors, business development, real estate, facilities, planning, operations) must approve what elements in the project, and what needs to happen during the approval solicitation for the project to be authorized. It informs about contents, required information, level of detail, or format of the validation deliverables. This is an often overlooked but crucial information so that the team can immediately work in the right direction and with the end goal in mind.

"We use behaviors of excellence as a starting point, and the behaviors of excellence would include: be responsible, be respectful, be professional, be accountable, and be collaborative. Really collaborative. And with that will come innovation"

Team Activities

Identify Deliverables. Based on the validation budget, schedule, and project scope, the team identifies the specific deliverable(s) of validation (e.g. Validation Study) and corresponding content.

Pull Plan Validation. Pulling from deliverables, the team determines the intermediate milestones. During validation, the team monitors progress against the plan.

"We started building how we were going to do last planner, and how we were going to be accountable, and how we were going to do target value. A lot of the structure was built during validation, but implemented after validation"

Determine Rules of Engagement and Communication. In consideration of behaviors of excellence or similar information that has been presented to the team, the team generates a set of rules of engagement and communication protocols that promote and facilitate alignment, information sharing, collaboration, and innovation. Rules of engagement also set the frequency and logistics for big room sessions and remote meetings, and the file-sharing or similar storage and communication tool(s).

The importance of such tool should not be overlooked. Its selection will impact the team's ability to efficiently produce work during the tight validation schedule. We documented instances of validation teams that had adopted a tool available through a team partner without assessment, and that, later on, reported that work efficiency and team member satisfaction had been compromised. At a minimum, the tool(s) should: be user-friendly, customizable, secure, and technology compatible; provide effective data storage and data sharing; promote efficient collaboration and communication inside the big room and during remote work; and, eventually satisfy all team members.

"We spent a lot of time during validation creating our construction schedule and pull plan. Superintendent-level folks were able to walk out of validation with an additional project schedule that, later on, they then took to the construction site, put all the stickies on the wall, and that became the milestone pull plan"

"Spend enough time upfront defining your project's conditions of satisfaction for validation and investing in developing the people and process to support achieving those objectives"

Determine CoS. CoS include owner priorities and additional conditions based on the drivers within the team. Table 6 lists examples of CoS. Some teams choose to match CoS to owner priorities.

"Well, we didn't know exactly what it would be, but we generally knew what it would be, because it had to be, in order to meet the conditions of satisfaction"

Table 6. Examples of Conditions of Satisfaction

Conditions of Satisfaction	Yes	No
Team		
Maintain behaviors of excellence	❑	❑
Enhance team efficiency	❑	❑
Cause an IPD-novel owner to engage in future IPD projects	❑	❑
Motivate the owner to roll the team over a future project	❑	❑
Others (write down)	❑	❑
Project Delivery		
Meet scope	❑	❑
Meet or improve target cost value	❑	❑
Meet or improve target schedule	❑	❑
Meet or improve safety goals	❑	❑
Engage local labor	❑	❑
Meet or improve the acceptable level of risk	❑	❑
Obtain green building certification	❑	❑
Enhance aesthetics/branding (e.g. seek for design award)	❑	❑
Engage service/operation providers (e.g. physicians, operators)	❑	❑
Minimize the impact on ongoing operations	❑	❑
Engage community (e.g. during design)	❑	❑
Minimize the impact on the local community (e.g. during construction)	❑	❑
Others (write down)	❑	❑
Operations & Maintenance		
Advance operations start date	❑	❑
Improve flows	❑	❑
Reduce energy costs	❑	❑
Reduce operation costs	❑	❑
Others (write down)	❑	❑

For more information about Lean Methods, see:

Messner, J., Leicht, R., and Bhawani, S. (2018). *Lean Deployment Planning Guide - Version 1.0*. Computer Integrated Construction Research Program, The Pennsylvania State University, University Park, PA, USA. Available: <http://cic.psu.edu/lean>

For more information about Last Planner™, see:

Ballard, G. and Tommelein, I.T. (2016). *Current Process Benchmark for the Last Planner System.* Project Production Systems, University of California, Berkeley. Available: <p2sl.berkeley.edu>

Team Culture

Subject matter experts unanimously agree that building and maintaining the right team culture from kickoff is of paramount importance. Setting the team culture will not only benefit validation but also, when the project is authorized, design and construction.

Besides the technical skills of each team member, we have observed two core components within teams: lean experience and behaviors -often referred to by subject matter experts as “behaviors of excellence." See Table 4. Of those, behaviors are necessary for the success of the team, while lean experience and skills are desired but often optional, and can be trained. On the one hand, soft behaviors and skills are paramount to validation. CoS relative to how the team should behave and work together are common. Often, team behavioral performance is monitored through short surveys (e.g. “pulse surveys”). Whenever the team deviates from the desired behaviors, these are reinforced.

“Validation is like a first date. You're just getting to know someone. But the relationship doesn't really get built until design and construction. It sets the first conversations of really getting to know the people on the team and then that gets built from there”

“"So, how do you build the ability to communicate among team members effectively?"

"Leadership... change management... brute force... perseverance"”

On the other hand, we have found that lean knowledge and skills are desired but not essential. Some team members may be experienced with IPD and lean construction, while some others may not be and thus require training and support. Nonetheless, early exposure to lean concepts and techniques, even when those will only be needed after validation, comes with benefits. Such early exposure helps to establish a lean culture during validation, and eventually improve the team proficiency when, later on, lean concepts and skills need to be implemented.

Team Building

It is said that "those that play together work together." Initially, team members often lack acquaintance with their new teammates. Team building activities get members to know each other and set the foundation for strong team dynamics. Bonding the team together will result in improved networking, collaboration, motivation, innovation, and team performance. Team building activities

“CoS relative to how the team would work as a team were monitored during the project with surveys”

greatly vary from team to team, but often include informal lunches and dinners; attending recreational events; playing together (e.g. minigolfer); or solving problems.

Problem-solving exercises can be designed not only to bond the team but also to settle its culture. For example, we documented problem-solving activities that forced members to go through, as a team, the nuances of the integrated teamwork, innovation, or conceptual estimating. In doing so, these exercises force teams to grasp fundamental concepts and require each team member to reach out to her/his peers.

"Team building activities started immediately and continued all the way through the job, just getting people to get a level of comfort with each other"

Is Onboarding necessary?

Most validation efforts do not offer the opportunity for incorporating members due to their limited time to completion. The entire team starts from kickoff. However, there are exceptions such as complex or large projects that

"Some of those were as simple as tossing a tennis ball around, and how could you innovate on and expedite, and how many turns you could do with the tennis ball with all team members hitting it"

"Simple things, that actually get people to think about, as a team, how can you improve some of these sorts of fundamental things. Which gets them into the mindset of, you know I have to rely on these guys at some point during this project, and so I need to be able to reach out to them, and feel comfortable with it"

can require longer validation schedules and larger teams. In such cases, it is fundamental to integrate new members with the team's knowledge, progress, and culture.

A proper onboarding or similar protocol aligns new members with the necessary knowledge, skills, and behaviors so that they become active collaborators immediately. The content of onboarding is very similar to that of the kickoff (see Table 5) and should also include a review of the team's progress to date. Some teams decide to onboard new members through synchronous (in person) orientation while other teams use asynchronous communications (e.g. audiovisual recordings) or a combination of both.

"We did many informal beer nights or sporting activities and other kinds of team building activities throughout the entire program"

For more information about how to successfully Build and Manage a Team, see:

R. Cheng, M. Allison, H. Ashcraft, S. Klawans, and J. Pease (2018). Pages 41-48 in *Integrated Project Delivery – An Action Guide for Leaders*. University of Washington, Seattle, WA, USA. Available: <http://cm.be.uw.edu/wp-content/uploads/sites/29/2018/06/Pankow_IPDGuide.pdf>

Validating the Project

At the core of validation lies the iteration between big room sessions and remote work by interdisciplinary cluster groups that rapidly builds knowledge and certainty. See Figure 3. Cluster groups are sometimes referred to as "innovation teams". We have found that, in most validation efforts, remote cluster work extends for about a week in-between big room sessions. For example, we observed that geographically-dispersed teams usually hold a big room session every other week. Each session lasts multiple days. When working remotely, these teams hold several calls a week to monitor progress and identify and mitigate issues that could impact work. In a different arrangement that resulted in the same latency of cluster work, a team with partners from the same vicinity decided to hold a single-day big room session every week. In another example, a geographically-dispersed team worked together during the kickoff but remotely for the remaining six weeks. Subject matter experts recommend that co-located meetings and periods of remote cluster work intertwine. In doing so, cluster work supports the collaborative team insights and decisions during big room sessions, while co-located sessions maintain alignment, provide an opportunity for reinforcing training and behaviors, and contribute to keeping the momentum in the team.

"Don't settle on one solution yet. It's too early. If you can just put in your best solution, but don't say that whatever is in validation is the end product. There's still an opportunity to make adjustments as the project goes on"

Keep your ideas open

Validation is not design yet. It is the time to stay fluid and open, collaborate, innovate, add value, and build certainty. Validation enables the team to explore trade-offs between project goals/expectations and owner priorities, first merely seeking to know if there is sufficient design space to satisfy all expectations, and if not, identifying where trade-offs must be made. During validation, the team explores and reflects with a multidisciplinary lens on different concepts and options for major project items and chooses an option to build the conceptual estimate without committing to the design of such an option.

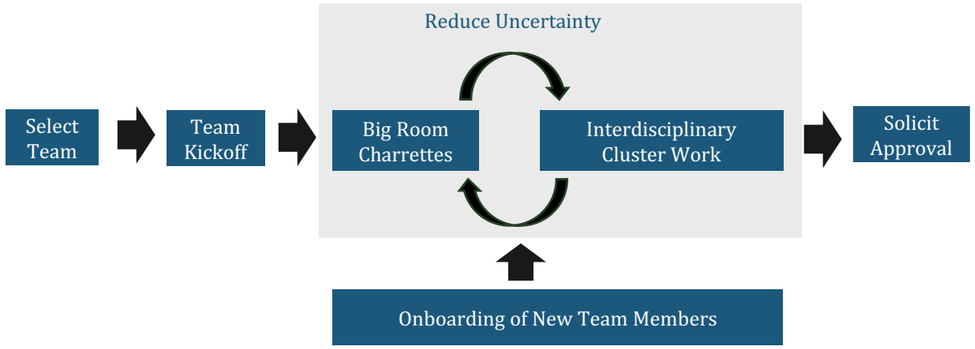


Figure 3. Validation Process

Allowing the coexistence of multiple sets of options without necessarily settling on one enables the team, later on when design information is available, to make design decisions that ensure the cumulative impact of such decisions and thus add further value.

Go slow to go fast

Maintaining alignment is a cornerstone of validation and requires the full understanding by each team member of the issues under discussion. The team and its leader(s) in particular must make sure that validation is designed and executed to promote full sharing and access to information so that every team member keeps aligned at all times.

"Design is really just a series of decisions and the artifacts of those decisions are the plans. We can make the necessary decisions when they need to be made in order to support something else and just hold that design decision in reserve and not begin producing the deliverable until we actually need it. That way we can assure that the cumulative impact of the decisions make sense"

Subject matter experts express that contrasting and maintaining such alignment is critical. The novelty of validation often results in team members believing they understand while, in reality, they do not. For example, conceptual estimates and value-generation are concepts difficult to grasp by those with less experience.

"You gotta sit in the big room and ask the architect, "Do you understand the estimate? Can you read it? Can you show me? If you do not understand the estimate, you're not participating actively enough." Just keep that kind of pressure on and get the proper alignment"

Experts also express that, in order to uncover gaps, the leader(s) must inquire and eventually challenge team members. When such a gap in understanding is identified, the leader nurtures and guides the team member back to alignment with the support of the team. The expert quotes in this section should help the reader appreciate the importance of keeping alignment at all times.

"One of the things we spent a lot of time doing in validation is making sure we understand customer value, even if we've been handed a set of guiding principles and conditions of satisfaction. Just because they think they've been clear in expressing that, doesn't mean that we're confident that we can understand it the way that they intend"

What do Big Room Sessions look like?

The team collaborates, shares information, makes decisions, and continuously learns. Table 7 groups common agenda items in four categories: team development and culture; estimating; innovation; and planning and control. In terms of estimating, each multidisciplinary cluster within the team shares the generated information and requires feedback, input, or information from the rest of the team. The team considers the different options and costs for major project items, and eventually chooses an option to build the validation estimate without necessarily committing to the design of such an option. A3 reports are commonly used to document analysis and decision making. For example, an A3 can compare one baseline and two additional options for the same project item, list their differences and similarities in a very succinct manner that is easy to read and provide an estimate for each option. In doing so, the team not only documents the option in the validation estimate but also the basis for such decision so that, later on, the information needed to make design decisions is accessible.

In addition to the core work around the estimate, the team leverages big room sessions to reinforce training, plan and control, or manage risk and opportunities. First, teams train and reinforce their cultural aspects such as lean principles and techniques, behaviors, project, or approval process.

"Spend the time developing that communication before you spend too much time designing things that people don't understand"

"I would go through in-person or explain the different sections, have them do a report instead of just putting it in a book. Because then it's up to the interpretation of whoever reads it, you put a level of quality in and a different level of quality gets priced. It needs to be a direct conversation. It really needs to be shared and explained no matter what it is"

Second, the team monitors progress based on the pull plan that was generated during kickoff and plans for the immediate work items and deliverables to be accomplished in the lapse of time between big room sessions. Finally, the team advances and updates the innovation log, which captures risks and opportunities. The team should immediately start building the log from kickoff and continuously update it after that. Based on the risk log, the team also builds and monitors the risk register (e.g. risk items with corresponding costs and their probability of occurrence). Both the innovation log and risk register will be incorporated in the Validation Study (or similar report) and evaluated during approval solicitation. If the project is approved, the team continues to update the innovation log, which is leveraged during design and execution. Thus, opportunities result in the generation of value during planning and design.

"If team members have any questions, it's better you just sit down and talk about it"

What does Cluster Work look like?

Cluster work is at the core of validation. It offers the opportunity for innovation and value generation during the development of the basis of design. With a multidisciplinary approach, cluster work breaks down discipline silos and offers the opportunity to explore, compare, and propose innovative design ideas collaboratively. Its multidisciplinary and collaborative focus enables the generation of creative, well-documented, and realistic

Table 7. Big Room Agenda Items

Big Room Agenda Items	Yes	No
Development and Culture		
Owner's Culture	❑	❑
Behaviors of Excellence	❑	❑
Owner's Project Approval Process	❑	❑
Relational Contracting (IFOA)	❑	❑
IPD	❑	❑
Last Planner™ System	❑	❑
Target Value Delivery	❑	❑
Others (write down)	❑	❑
Estimating		
Refreshment (e.g. owner goals, project, CoS)	❑	❑
Presentation of work by cluster groups	❑	❑
Requests for information	❑	❑
A3 analysis and decision making	❑	❑
Others (write down)	❑	❑
Innovation		
Identification of risks and opportunities	❑	❑
Assessment of risks and opportunities	❑	❑
Mitigation of risks	❑	❑
Update of the risk register	❑	❑
Others (write down)	❑	❑
Planning and Control		
Monitor validation progress against plan	❑	❑
Define the next validation goals and tasks	❑	❑
Revise/detail upcoming meeting logistics & agendas	❑	❑
Others (write down)	❑	❑

design options. A3 reports are often leveraged to document and compare design options. During big room sessions, the entire team reviews the outcomes of cluster work and eventually recommends a design option to build the validation estimate. Experts observe that this combination of cluster and teamwork results in an agreed upon basis of design that, later in design, minimizes information loops and design changes. Cluster work often becomes concise and specific as validation advances and project knowledge is built. The agenda of cluster work is set during big room sessions.

What Project Items should I focus on?

The team must set rules to identify what project items will be analyzed during validation. Commonly, a minimum dollar value is set. Such minimum dollar value enables the team to focus on those items that can potentially have an impact on the cost and/or schedule of the project. We have observed that for projects worth between $100 million and $200 million such minimum dollar value can range between $200K and $400K.

"Focus on the items that move the needle"

What does "Done" look like?

We have documented two main reasons for a "done" decision. Either the team will solicit the owner's approval or the team decides to terminate validation since evidence indicates that the project cannot be delivered within the

"Avoid falling into rabbit trails"

owner constraints. On the one hand, the project is to be solicited for approval when all team members are willing to commit to the delivery of the project under specific conditions of success (inclusive of target cost and schedule) and the team can justify that such commitment should get the approval from the owner.

"It was a combination of team effort and individual effort. We would go through the different scopes of work, and divide it, and have sub-meetings, and then bring the information back"

On the other hand, subject matter experts share that a project likely to result in a no-go decision does not necessarily make it to approval solicitation. Often, the owner leads within the team will decide to cancel validation once evidence exists that the project cannot meet the owner constraints. In doing so, validation costs are reduced and team members can move to other endeavors. However, the same experts express that an ability to anticipate a no-go requires a combination of validation experience and knowledge about the decision-making process within the owner.

"We broke the budget between clusters and they worked on their own pricing, and then we would come together [in the Big Room] and figure it out"

For more information about Lean Methods, see:

Messner, J., Leicht, R., and Bhawani, S. (2018). *Lean Deployment Planning Guide - Version 1.0*. Computer Integrated Construction Research Program, The Pennsylvania State University, University Park, PA, USA. Available: <http://cic.psu.edu/lean>

For more information about Last Planner™, see:

Ballard, G. and Tommelein, I.T. (2016). *Current Process Benchmark for the Last Planner System.* Project Production Systems, University of California, Berkeley. Available: <p2sl.berkeley.edu>

APPROVAL SOLICITATION

Validation Study

The Validation Study is the deliverable of validation and is presented to the owner stakeholders during approval solicitation. It unequivocally determines the team commitment towards scope, schedule, and budget and provides information (e.g. estimates, sketches, renderings, flowcharts, narratives) that support such commitment. The Validation Study should be thorough but informative so that a reader not familiar with the project could arrive at a similar degree of certainty about the outcomes proposed by the team. Among others, the Validation Study contains information about: team members and affiliation; scope; permitting; program functions/operations; planning; basis of design (or schematic design); building systems; budget; schedule; and, risk register and opportunities. If the project is authorized, the Validation Study sets the basis of design and execution and thus becomes a touchstone for the duration of the project.

What is the Project Charter?

The Validation Study often contains hundreds of pages of information. Thus, the Project Charter or similar document in the Validation Study summarizes the team's commitment and seeks to gain the owner stakeholders' internal approval and alignment. Among others, the Charter aims at: a) summarizing the project description and objectives; b) providing visibility, alignment and formalizing the approval of the intent of the project within the owner organization; c) defining what project success looks like for the owner, and what

""How did the validation study inform the design and project delivery process?"

"Massively. It was really the reference point for the rest of the project""

project success looks like for the team; d) identify the distinct owner stakeholders / sponsors; or, e) identify owner team member resources assigned to the project if this is authorized. In a few pages, the Charter summarizes and details critical information such as: what is and what is not included in the scope; how driver decisions will be made between scope, schedule, and cost; project constraints; budget and schedule; owner's vision, goals, and measures of success; CoS and project success metrics; owner personnel; or, project team personnel.

Who owns the Budget?

The budget reflects the cost of the project to the owner. The budget is divided into cost categories or chapters such as permitting, design, construction, equipment, information and communication technologies, professional services, or operational expenses. For instance, the moving of ongoing

operations during the renovation of an existing facility will be captured in the operational expense or similar category.

The budget also sets the exposure of the team. The amount of profit/loss exposure shared by the team is often computed based on the team's responsibility in each budget category. Thus, when an owner provides for permitting, equipment, or operations, their costs are not included in the team's profit/loss exposure since the team is not responsible for them.

Approval Solicitation & Decision

At approval solicitation, the Project Charter and the supporting information in the Validation Study are discussed and presented to owner stakeholders with the objective to obtain the authorization for the project and corresponding release of funds. Stakeholders evaluate the team commitment and the certainty that the team can meet such a commitment. Validation culminates in an informed decision by the owner on whether to authorize (go) or not (no-go) the project. See Figure 4. The ultimate value rests in establishing certainty and enabling an informed decision, whatever the decision is, on behalf of the owner and the team at a fraction of the expenditure than traditional design and estimating approaches require.

"That's how we knew we were done, the owner said, "If you're prepared to commit to that, we're prepared to move forward""

What does a Go decision imply?

Validation is over. The owner is satisfied with the team's commitment to execute an agreed-upon scope within a target cost and completion time. The owner authorizes the project and funds are released. The owner and the team contractually agree to the project based on the shared commitment that the success criterion can be met. The IFOA captures each stakeholder's share of profit/loss, which has been negotiated at the end of validation. The project is designed, built, commissioned and started. At completion, losses or profits are shared among team partners.

"The final go, no-go, is based on the team's capabilities of ensuring that we can get the project at the scope that we were approved by the board, at the budget, or below"

What is next for the Team?

The validation team transitions at the core of the project team that delivers the project. Such transition aims at anchoring alignment, dynamics, commitment, and project knowledge. We have documented owners

"Validation was also understanding all of the key trade partners that were going to be a part of the project work authorization, and what their percentage of contribution was to the project work authorization itself. Because that defined what their portion of reward would be on getting below the target value of the project, and it would become a risk if they didn't hit the target value"

that bind the participation of team members through liquidated damages or similar contractual compensation mechanisms. The aim is not the realization of liquidated damages, but securing team expertise throughout the project duration.

What is the value of a No-Go?

In the process of validation, it may become apparent that owner priorities cannot be met. This is valuable information to convey to the owner and team. Whenever a project is terminated, validation accomplishes the objective to avoid a capital expenditure towards an effort that cannot meet priorities or that is too risky. Thus, the owner can allocate the project funds to other investments that can meet business objectives. For the team, it avoids the commitment of significant time and resources towards an effort that would likely result in a loss and could damage the reputation of the partner organizations.

Is the Project terminated?

Validation enables the owner's informed decision about the project when this is not authorized. A no-go decision does not necessarily imply that the project is forgotten, being this one option. That the schedule proposed by the team does not meet time-to-market constraints often leads to the shelving of the project.

"A no-go decision is just as good as a go decision, because the worst thing you could do is sign up for a project that has an outcome that's completely unrealistic"

Alternatively, a no-go can result in the revision or iteration of the owner's business case and/or change in scope with the objective to reduce project costs. It can also result in the temporary freeze of the project with the expectation that, in the future, the owner will be able to increase the allowable budget. Finally, owner stakeholders can require the extension of validation in order to increase certainty before the project is presented for approval once more.

the owner and the team contractually agree to the project based on the shared commitment that the success criterion can be met. When not authorized, validation enables the owner's informed decision about the project. The owner can extend validation in order to increase certainty further, increase the allowable budget, modify the business case, change the scope, or terminate the project and thus allocate the funds into alternative investments that can meet the owner's objectives. The value of validation rests in establishing certainty and enabling an informed decision, whatever the decision is, on behalf of the owner and the team at a fraction of the expenditure than traditional design and estimating approaches require. Organizations with validation expertise regard it as a competitive advantage.

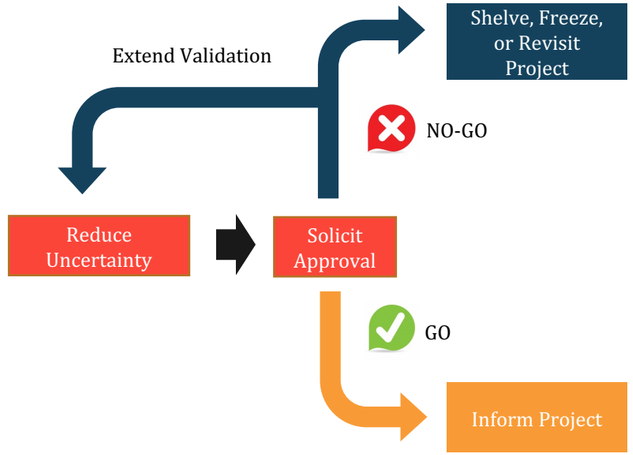


Figure 4. Go/No-Go decision

APPENDIX I – VALIDATION TOOLS

The tools contained in this Guide are summarized in this Appendix and presented with a format that intends to facilitate their use. Practitioners are encouraged to adapt and modify these tools according to the specific characteristics of their organizations, projects, teams, and validation processes.

In order to facilitate use, each tool is presented in a separate sheet. For best results, print in a 17in x 11in paper format.

Validation Characteristics

Validation Characteristics	Yes	No
Follows the Business Case	❑	❑
Culminates in a Decision on Whether or Not to Authorize the Project	❑	❑
Has a dedicated Budget & Schedule	❑	❑
Has a dedicated Team of Experts	❑	❑
Design is Omitted or, at most, Limited	❑	❑

Team Member Competencies

Competency	High	Low
Technical Skills		
Conceptual Estimating (*)	❑	❑
Basic Design (*)	❑	❑
Detailed Design	❑	❑
Experience		
Similar Projects (*)	❑	❑
IPD	❑	❑
Lean Construction	❑	❑
Behavior		
Team Building (*)	❑	❑
Commitment (*)	❑	❑
Problem Solving (*)	❑	❑
Time Management (*)	❑	❑
Accountability (*)	❑	❑
Leadership	❑	❑

(*) Core competency

Kickoff Content

Content	Yes	No
Information Input		
Owner's Culture and Project Significance (*)	❑	❑
Owner's Priorities (*)	❑	❑
Behaviors of Excellence (*)	❑	❑
Project Approval Process (*)	❑	❑
Others (write down)	❑	❑
Team Advancement		
Relational Contracting (IFOA)	❑	❑
IPD	❑	❑
Last Planner™ System	❑	❑
Target Value Delivery	❑	❑
Others (write down)	❑	❑
Team Activities		
Identification of Validation Deliverables (*)	❑	❑
Pull Planning Validation (*)	❑	❑
Determining Rules of Engagement & Communication (*)	❑	❑
Determining Conditions of Satisfaction (*)	❑	❑
Others (write down)	❑	❑

(*) Core content

Big Room Agenda Items

Agenda Items	Yes	No
Development and Culture		
Owner's Culture	❑	❑
Behaviors of Excellence	❑	❑
Owner's Project Approval Process	❑	❑
Relational Contracting (IFOA)	❑	❑
IPD	❑	❑
Last Planner™ System	❑	❑
Target Value Delivery	❑	❑
Others (write down)	❑	❑
Estimating		
Refreshment (e.g. owner goals, project, CoS)	❑	❑
Presentation of work by cluster groups	❑	❑
Requests for information	❑	❑
A3 analysis and decision making	❑	❑
Others (write down)	❑	❑
Innovation		
Identification of risks and opportunities	❑	❑
Assessment of risks and opportunities	❑	❑
Mitigation of risks	❑	❑
Update of the risk register	❑	❑
Others (write down)	❑	❑
Planning and Control		
Monitor validation progress against plan	❑	❑
Define the next validation goals and tasks	❑	❑
Revise/detail upcoming meeting logistics & agendas	❑	❑
Others (write down)	❑	❑

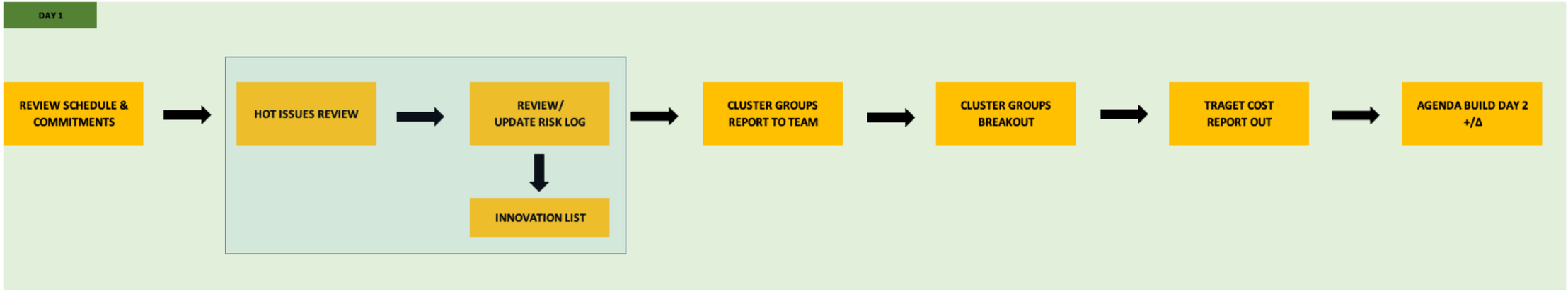
APPENDIX II – MATERIAL SAMPLES

The materials in this Appendix represent a small sample of the multiple possible manners to validate a project. Materials were chosen because they are representative of common content and format found in validation documents and Validation Study reports specifically.

Materials intend to provide guidance and inspire thought and creativity in the process of validating a project. Such materials provide a sense of the scope, support documents, and methods that have proved useful in the validation of projects by expert teams.

Materials were adapted or combined from original validation documents. Original data were sanitized so that information cannot be traced back to organizations, individuals, or projects.

Sample of Big Room Session Agenda



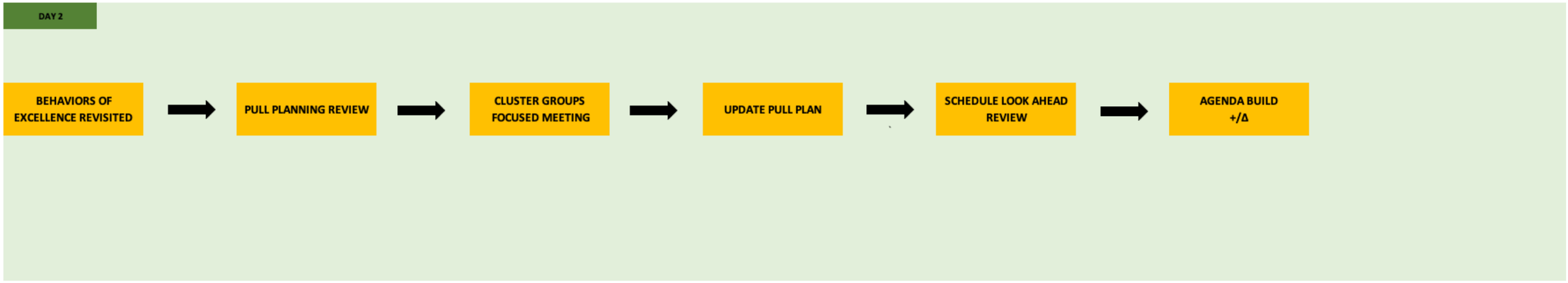


Table of Contents – Validation Study

Project Scope Definition Sample

The scope includes:

- Building expansion of 102,450 square feet
- Renovation of approximately 22,350 square feet in existing facility/building
- Expansion shell of approximately 8,322 square feet for future tenant improvement
- 24 new emergency care rooms
- 37 new intensive care beds (25 operational; 12 built out but not equipped or furnished)
- Shell space for future 12 intensive care bays
- Building systems (mechanical, electrical, plumbing, telecom) to support expansion and renovation above
- Additional emergency power circuitry to support intensive care
- New dedicated set of three elevators in expansion facility
- Relocated drop off/entry/expanded waiting area
- Stucco exterior skin
- Moment frame structural system
- 40% maximum exterior glazing and exterior accent finishes
- Drought tolerant planting

The scope does not include:

- Expansions built in more than one phase
- Excessive phasing, imposed schedule delays or out-of-sequence construction
- Renovation of existing spaces not impacted by expansion
- Extensive renovation of existing square footage other than flooring and paint / cosmetic upgrades
- More than 24 new emergency rooms
- More than 25 licensed and operational intensive care beds
- Expansion of parking space / capacity
- Washer and dryer services
- Highly decorative elements
- Extensive window or exterior glazing
- High performing structural system design
- LEED or similar certification

Mission and Vision

Project Mission: Provide a facility that increases access to services for the community and allows for necessary provider growth to maintain current market share.

Owner's Mission: We improve the well-being of the communities we serve through our continuous commitment to excellence in quality, services, and access.

Project Vision: A healthcare facility designed with and for patients that supports the highest quality care and with the highest value in building systems and design components.

Owner's Vision: We lead the transformation of the communities we serve and the achievement of the people's health and well-being through excellence in quality, access, and affordability.

Conditions of Satisfaction

Sample of Team's Prioritized Conditions of Satisfaction

1. Reduce total project costs below $2,800,000

2. Do not impact/disrupt ongoing operations during renovation

3. Reduce owner's operation start date – the sooner, the better

4. Consensus driven

5. Achieve energy efficiency and reliable building systems with lower operational costs

6. Considers operational changes to address capacity demands

7. Considers alternative facilities to address capacity demands

8. Engage the community through design (e.g. exterior, access)

9. Increase owner's expected market share

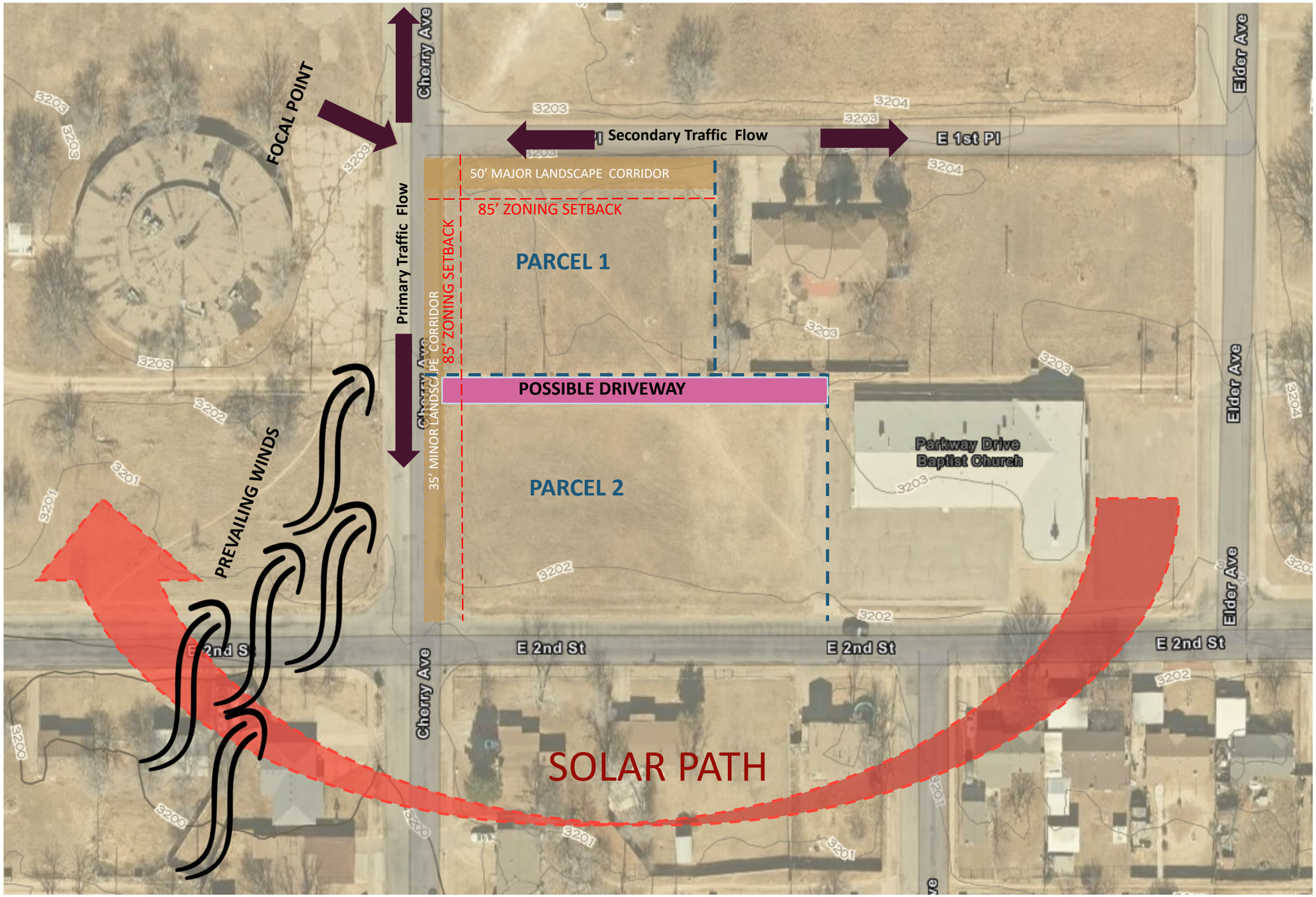
10. Capture the modesty of the owner organization

Prioritization of Drivers

(*Priority 1 being the most important; rank accordingly*)

Scope	Schedule	Budget
2	3	1

Site Plan – Basis of Design



A3 Analysis and Documentation

Structural Systems

A3 Sheet

A3 Title	Champion	Collaborators	Date
Structural Systems			

Section 1 -Background	Section 2- Problem Statement/Current state	Section 3 - Future State
This A3 informs the decision of the structral system to be used for the project.	"L" shaped building, 5 story, above grade. Evaluation of super-structure above the foundation. Exterior skin assume to be 2" for exterior finish, 6" for stud, and 5/8" for interior gypsum board for all structural systems as a common denominator.	Structural system that has: efficient/lean building footprint size; ease of future renovations; ease of expansion; and flexibility in exterior skin options/features.

Section 4 - Analysis

	Option 1 - Tilt-Up		Option 2 - Conventional Moment Frame @Exterior Wall		Option 3- Braced Frame		Option 4 - ConXTech w/Interior Moment Columns	
Building Footprint size and thickness of exterior wall assembly, less is better	11"	1	9"	4	9"	4	9"	4
TI flexibility within building footprint and interior openness, more is better	May require interior bracing or shear walls	2	Maximum flexibility	4	May require interior bracing and may be exposed at exterior walls.	1	Maximum flexibility with exception of plumbing at column lines requires more space for interior chases	2
Time Schedule of Construction, less Is better	Superstructure & skin erection=10 weeks (shortest overall Schedule)	4	Superstructure erection - 6 weeks	2	Superstructure erection - 6 weeks	2	Superstructure erection - 3 weeks	3
Increased exterior skin options / architectural features, more is better	Least opportunity for architectural articulation. Lose cost advantage with adding features	1	No limitations	4	No limitations, however, bracing may be expressed at exterior and interior elevations	2	No limitations	4
Ability to upgrade to higher performance builiding for a seismic activity , more is better	Not possible	1	Can be upgarded, colud be cost neutral	3	Can be upgraded, with nominal cost increase	2	Can be upgraded, could be cost neutral	3
Confilct with under ground utilities, less is better	Exterior grade beams, but less confilct	4	Exterior grade beams, but less conflict	4	may require interior grade beams, some confict	2	All interior grade beams, conflict	1
Initial cost of Superstructure , less is better	$20/sf		$25/sf		$20/sf		$24/sf	
TOTAL SCORE - Points, more is better		13		21		13		17
COST/SF	20	$	25	$	20	$	24	$
VALUE - Cost per SF per point total	**1.54**		**1.19**		**1.54**		**1.41**	

Section 5 - Proposal

Based on value, the project team will design either conventional moment frame, OPTION 2. (no change to recommendations after updates to pricing & building scope)

Section 6 - Follow Up

Risk Identification and Assessment

#	Risk Items	Status	Priority (A=High)	Potential Cost (High $)	Likelihood (%)	Projected Risk	Comments - Resolution	Impact (Y/N)				Responsible Party / Individual
								Contingency	Schedule	Scope	Other	
1	Potential need for booster pump based on the water pressure. Assume duplex booster pump with hot box located on the exterior of building to the east.	Active		$72,000	80%	$57,600	Alternatively could provide local booster pump within the building where needed	N	Y	Y	N	
2	Sitework unknown, assumptions made based on limited information on hand.	Active		$100,000	10%	$10,000	Meeting with city muncipalty required	N	N	Y	N	
3	IT closet on each floor to meet 400ft maximum distance (assumes $225kper room)	Active		$675,000	75%	$506,250	Review in more detail. New Information Systems standard is implemented with this	Y	Y	Y	N	
4	Electronic Security of the Second Floor	Mitigated		$25,000	0%	$0	Eliminate or Redesign					
5	Redesign of mechanical / electrical due to unavailable information on mechanical and electrical services in existing facility	Active		$55,000	50%	$27,500	None	Y	Y	N	N	
6	Contractor parking not available on site	Active		$500,000	80%	$400,000	Need 3rd party review, following the building being built.	Y	N	N	N	
7	Temporary relocation of organic lab unit during construction	Active		$150,000	50%	$75,000	Need to revise schedule / sequence of construction with facilities departments	N	Y	Y	N	
8	Above ceiling corrections being required in the existing facility when adding new utility runs for the expansion project	Active		$100,000	50%	$50,000	Cost assumes infrastructure is implemented	N	N	Y	N	
9	Lack of project labor aggreement required for the project	Active		$850,000	100%	$850,000	There are currently no plans to sign Labor Agreement	Y	N	N	N	
10	Mold remediation if encountered in renovation project	Active		$100,000	100%	$100,000	High risk in wet areas	N	Y	Y	N	
11	Facilities - Preventative Maintenance - Heat Exchanger Replacement	Active		$250,000	90%	$225,000	Potential repair/correction	N	Y	Y	N	
12	Fire Sprinklers - Upright Heads above Ceiling	Active		$350,000	100%	$350,000	Requires acceptance letter from Fire Marshall	N	N	Y	Y	
13	Co-location of design (on-stie design)	Active		$150,000	60%	$90,000	Co-location in lease space adjacent to office (Lease Option)	N	N	N	Y	

Total Project Risk	**$2,741,350**	
Contingency	**$1,850,000**	
Difference	**($891,350)**	***Risks beyond available contingency***

About the Authors

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David Grau is an internationally renowned researcher with a focus on streamlining design and construction. With an Industrial Engineering background, his work has investigated the project delivery process from a production systems perspective. His work at the intersection of innovative project and production controls aims at proactively supporting with accurate and timely information the decisions on behalf of the project, portfolio of projects, and stakeholder organizations. David is also well-known for the design of an automated materials tracking approach that has been leveraged in support of construction projects around the world.

Previous to his academic career, he has practiced in the private industry for more than ten years in positions such as construction program manager for industrial projects and director of a large engineering department. He has led large interdisciplinary and multicultural teams to deliver capital projects in South America, Africa, and Europe.

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Fernanda Cruz-Rios is passionate about sustainability, innovation, and interdisciplinary collaboration to achieve common goals. Her research is focused on sustainable construction, specifically zero waste and circular economy in the built environment, and how it can be fostered by the collaboration among design and construction stakeholders. Fernanda has a Ph.D. in Civil, Environmental, and Sustainable Engineering and a B.S. in Architecture and Urban Planning.

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Rachael Sherman is a student researcher at Arizona State University passionate about improving industrial project performance through planning and collaboration. Her research is primarily focused on assessing large-scale construction projects. Rachael is interested in exploring the root causes of poor project performance that can support improved planning and in turn lead to more predictable projects in terms of cost and schedule performances.

Version 1.0