Integrated Project Delivery: Different Outcomes, Different Rules

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The contexts of project delivery are perhaps best illustrated by current initiatives to implement its newest incarnation. The approach on a project for Sutter Health, undertaken by Ghafari Associates and McDonough Holland & Allen, is outlined and discussed.

At the outset, it is important to put project delivery and design and construction contracting in its proper context. Over the past one hundred years, the design and construction industry has become increasingly fragmented. Each specialized participant tends to work in an isolated silo, with no real integration of the participants' collective wisdom. As construction practitioners, we are familiar with the most common industry responses to issues which arise from this fragmentation. In the past 30 years, post-design constructability reviews and value engineering exercises, together with "partnering" and contractual efforts to shift risk, have been the most prevalent. However, these "solutions" do not attack the problem at its root cause; rather than working to *avoid the problems* and provide higher value with less waste, these attempts merely try to *mitigate the negative impact* of the problems. With due respect, they are well-intended band-aids.[1]

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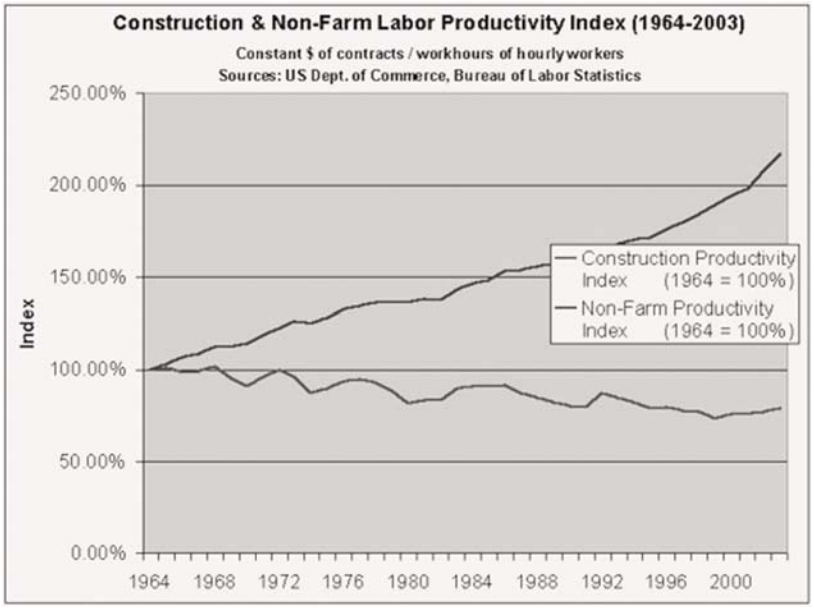
With these "solutions" in place, over the course of the last 40 years construction productivity has fallen, while non-farm productivity has more than doubled.[2] One study of the Construction Industry Institute (CII), a national research organization funded by major owners, designers, and constructors, found that up to 75% of construction activities are typically non-value added,[3] and that the cost of quality deviations reach as high as 12% of total project costs.[4] Moreover, when it comes to claims against design professionals, according to Schinnerer's 2006 study *From Risk to Profit: Benchmarking and Claims Studies*, nearly 70% of all claims arise either prior to or within a year after substantial completion, and are often "related to delays or additional costs . . . ."[5]



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Jim Carroll, a longtime contractor, offered the valuable insight that at the outset of a project, the owner needs to decide what it is buying—a product, or the services of a team to help solve a problem that no one really understands and that keeps changing.[6] At about the same time, Victor Sanvido, then a professor at Penn State University, undertook a comprehensive CII-sponsored study of project delivery methods. Among his other conclusions, Professor Sanvido concluded:

> Projects are built by people. Research into successful projects has shown that there are several critical keys to success:
>
> 1. A knowledgeable, trustworthy, and decisive facility owner/developer;
> 2. A team with relevant experience and chemistry assembled as early as possible, but certainly before 25% of the project design is complete; and
> 3. A contract that encourages and rewards organizations for behaving as a team.[7]

In an effort to better address the challenges and past failings of the design and construction industry, several international efforts are now underway to approach design and construction contracting with a "relational contracting" model.[8] The most prominent of these efforts to date in the United States is the "Integrated Agreement for Lean Project Delivery" (IFOA). A variation on this agreement has since become part of the standard forms of agreement produced by ConsensusDocs, a national consortium of organizations representing owners, designers, contractors, subcontractors, insurers, and sureties. The AIA's

C195, calling for the formation of a single purpose entity to deliver the project, also exhibits relational roots.

Within a basic contracting structure that facilitates the lean operating system, the IFOA focuses on developing and sustaining the relationships needed to cope with the reality that the future will unfold in ways that cannot be predicted and will constantly be changing. While project teams forecast and plan for what might happen, on sophisticated construction projects it is universally true that the plan at the outset is usually out-of-date by the time the ink is dry. The collaborative problem-solving skills of the project leadership team—the owner, contractors, and designers—is the key to delivering these projects successfully. The goal is a project delivery structure that best encourages the participants to function as a nimble, high-performing team and causes individuals to take responsibility for the success of the project as a whole, rather than just a small slice.

Both Ghafari and MHA are working with a Sutter Health[9] project design/construction team to utilize the IFOA, lean project delivery, and BIM best practices not only for current project improvements but also to refine Sutter Health's design and delivery template for future gains. The following discussion provides background on the evolution of Sutter Health's lean project delivery/IFOA journey.

Before BIM And IPD—What Does "Lean" Mean?

Manufacturing has been working to adopt lean practices for decades, perhaps best exemplified by 1990's *The Machine That Changed the World, The Story of Lean Production.*[14] Its account of Toyota's Lean Advantage was highly indicative of things to come and tellingly included chapters on "Coordinating the Supply Chain" and "Managing the Lean Enterprise," concepts that still haunt the building industry's fractured value stream.[15]

Machine was rife with lean nuggets, but it also offered some intimidating glimpses of the challenges of creating flow across an existing supply chain:

- "pushing the traditional (mass-supply) system to its limits under pressure rather than fundamentally changing the way the system works."[12]
- "Instead operate in a completely different framework that channels the efforts of parties toward mutually beneficial ends with a minimum of wasted effort."[13]
- "By abandoning power based bargaining and substituting an agreed-upon rational structure for jointly analyzing costs, determining prices, and sharing profits adversarial relationships give way to cooperative ones."[14]

This aptly defined why industries are now adopting approaches such as integrated project delivery (IPD) in an effort to transform supply chain wastes into value stream efficiencies. While *Machine* focused on vehicle production, its lessons are equally applicable to capital projects.

So what was it that Toyota did so differently, and how can that understanding be applied to projects? The terms "Lean Production" and "Lean Manufacturing" largely derive from the Toyota Production System (TPS). At Toyota, TPS represents only part of a broader business philosophy, known as the "Toyota Way." Although a number of TPS "tools" have been developed, the underlying philosophy of Lean Production and its context are important in this discussion of the IFOA.

Stated simply, the goal and philosophy of TPS is to produce value, as defined by the customer, without producing waste. To understand TPS, one first must understand its underlying principles and the context in which it developed. Toyota's industrial roots were as a loom manufacturer. Its initial innovation was to power its looms with a steam engine. Powered looms presented a new dilemma—the loom would continue to run even if the thread broke, producing defective fabric. Toyota devised a system that would automatically shut down the loom when thread broke—when a "defect" appeared. This eliminated the waste of producing defective fabric. This principle of "autonomation" or self-regulation (shutting down production in the face of a defect) was carried forward into TPS as one of what are often referred to as the two "pillars" of TPS.

Toyota Motor Company was formed in the late 1920s and was only marginally successful. After a visit to the United States, Toyota's chairman challenged the chief engineer, Taiichi Ohno, to meet U.S. productivity levels (a ten-fold improvement) within three years. Toyota did not have the capital, supply chain, or infrastructure to support a level of productivity comparable to Ford and GM. Demand for cars in Japan was not constant and consumer demand was more varied. As a result of these limitations, the second pillar of TPS developed: Just-in-Time Delivery. Using "Just-in-Time Delivery," Toyota *only produces items when there is an order*, minimizing inventories of finished goods. Large stores of raw materials or work-in-process are avoided by having those goods "pulled" to the plant when an order is received. Toyota's ultimate goal was and is to produce a car to the requirements of a specific customer, deliver it instantly, and maintain no inventories or immediate stores.

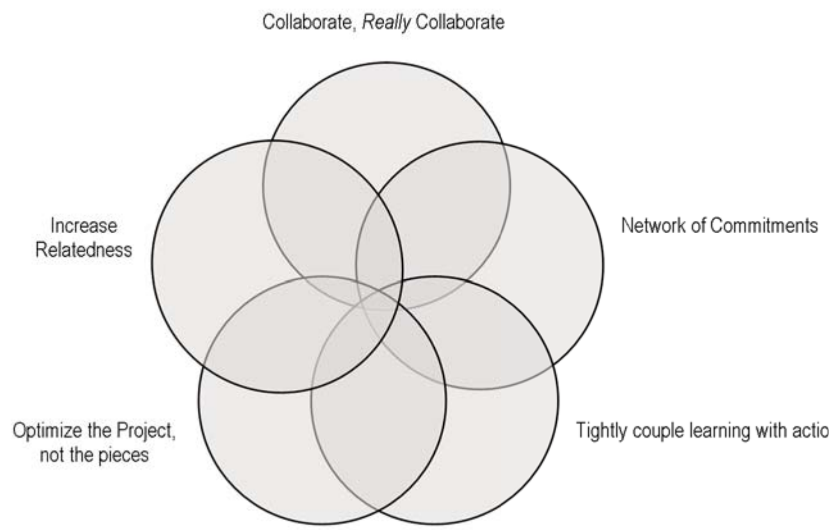
In order to sustain a system with no inventory or work-in-process, Toyota needed to produce items without defects because a defect would require stopping the production line. This would require tight coordination between all sections of the factory, using clear language and systematically requesting parts and materials at the proper time. To assure that defective parts were not forced further into production, Toyota workers were expected to act as the autonomic loom had: *stopping production if they find a defect.* This system decentralizes authority and empowers factory workers in ways that were previously unprecedented in the West (or in Japan, for that matter).

Finally, the implementation of Just-in-Time Delivery shifted the focus from the productivity of each unit in the factory to the overall productivity of the system. Since no unit could individually produce parts or perform a function to create inventory, *units were only as productive as the overall system.* This had the profound benefit of keeping the entire factory focused on "through-put," the output of the entire plant.

Sutter Health's Approach

In 2004, faced with a multi-billion dollar building program, Sutter Health embarked on its pursuit of a different project delivery method—one that sought to address the root causes that limited the effectiveness of other models. Sutter Health's delivery model combined lean project delivery and a new contractual model that sought to align the commercial interests of the major project participants and govern the delivery process as a collective enterprise. The IFOA offered improved project performance both from the owner's perspective (reduced cost and time, improved quality and safety) and from the viewpoint of the designers and contractors (increased profit and profit velocity, improved safety and employee satisfaction, decreased risk).

Sutter Health's approach to lean project delivery seeks to adapt what has been learned in manufacturing to the project environment. It strives to address the root causes of project delivery's failures and coherently address each level of the project delivery system—the physics of work, organizational structure, and commercial relationships. This approach has become known in the lean project delivery community as the Five Big Ideas [left].



The Five Big Ideas

The Five Big Ideas form the framework for approaching all aspects of Sutter Health's lean project delivery. The description that follows is taken from the manifesto that was signed by members of its Facility, Planning & Development Department (FPD) and its design and construction vendors at the outset of Sutter Health's lean initiative:[15]

> *1. Collaborate; really collaborate, throughout design, planning, and execution.*
>
> Constructable, maintainable, and affordable design requires the participation of the range of project performers and constituencies. Since abandoning the master-builder concept and separating design from construction, we have been patching a poorly conceived design practice. Value engineering, design assist, and constructability reviews mask an underlying assumption—that design can be successful when separated from engineering and construction. Design is an iterative conversation; the choice of ends affects means, and available means affects ends. Collaborative design and planning maximizes positive iterations and reduces negative iterations.
>
> *2. Increase relatedness among all project participants.*
>
> People come together on architect/engineer/contractor projects as strangers. They too often leave as enemies. Healthcare facilities projects are complex and long-lived, requiring ongoing learning, innovation, and collaboration to be successful. The chief impediment to transforming the design and delivery of capital projects is an insufficient relatedness of project participants. Participants need to develop relationships founded

on trust if they are to share their mistakes as learning opportunities for their project and all the other projects. This will not just happen. However, we are learning that relationships can be developed intentionally.

3. *Projects are networks of commitments.*

Projects are not processes. They are not value streams. The work of management in project environments is the ongoing articulation and activation of unique networks of commitment. The work of leaders is bringing coherence to the network of commitments in the face of the uncertain future and co-creating the future with project participants. This contrasts with the common sense understanding that limits planning as predicting, managing as controlling, and leadership as setting direction.

4. *Optimize the project not the pieces.*

Project work is messy. Projects get messier and spin out of control when contracts and project practices push every activity manager to press for speed and lowest cost. Pushing for high productivity at the task level may maximize local performance but it reduces the predictable release of work downstream, increases project durations, complicates coordination, and reduces trust. In design, we incur rework and delays. In the field, this means greater danger. We have a significant opportunity and responsibility to reduce workers' exposure to hazards on construction projects. Doing so can bring about greater than 50% improvements in the safety on the work site. As the leading community-based healthcare system in northern California, we are committed to do all that is possible so that the people who build these projects are able to go home each night the way they came to work. The way we understand work and manage planning can increase that messiness or reduce it.

5. *Tightly couple action with learning.*

Continuous improvement of costs, schedule, and overall project value is possible when project performers learn in action. Work can be performed in a way that the performer gets immediate feedback on how well it matched the intended conditions of satisfaction. Doing work as single-piece flow avoids producing batches that in some way don't meet customer expectations. The current separation of planning, execution, and control contributes to poor project performance and to declining expectations of what is possible.

The Lean Construction Institute has identified "Three Linked Opportunities" made available through the acceptance and application of the Five Big Ideas by project teams: "Impeccable Coordination," "Projects as Production Systems," and "Projects as Collective Enterprise."[16] Like the interlocking rings of chain mail, each of these opportunities contributes to optimizing the project as a whole rather than optimizing its individual parts. To the extent it realizes these opportunities, lean project delivery makes available levels of performance that are not possible under more conventional practice.

"Impeccable Coordination" represents an opportunity to create predictable workflow within and across trades and disciplines and to improve quality through optimized handoff of work. Currently, projects demonstrate nearly chaotic workflow, with an average of only 55% of work promised in a week actually being completed as promised. This state of workflow is comparable to driving at rush hour behind a car that is constantly

jamming on the gas and slamming on the brakes.

Taking action to create predictable workflow effectively stabilizes the project environment and reduces both time and cost, while coordinating handoffs to agreed upon 'conditions of satisfaction' improves quality. Improved workflow also frees up human capacity to focus on innovation and continuous improvement, further adding value to the project.

"*Projects as Production Systems*" opens the possibility of changing the structure of work in both design and construction, and includes elevating cost and other owner values to explicit design criteria. Including the general contractor and major specialty contractors in the design phase improves the design at all levels, and also serves to greatly increase the understanding of the builders at an earlier stage, thus improving construction quality and reducing the need for requests for information and other submittals during construction. In construction, production system design coupled with impeccable coordination enable modularization, off-site fabrication and multi-trade composition of work, with the ultimate goal of improving system-wide performance.

"*Projects as Collective Enterprise*" is an opportunity to align the project participants' commercial incentives and provide the team with a greater ability to move money across traditional commercial boundaries with the goal of project-wide optimization rather than a trade-level or silo focus. Realigning project players into a more entrepreneurial approach allows for an improved ability and willingness to invest "here and now" for returns "there and then," regardless of which trade partner performs that piece of the project. The goal is to create an "all for one, one for all" mentality. Contract structure plays a critical role in realizing this opportunity.

Sutter and MHA recognized that pursuing the Five Big Ideas and exploiting the Three Opportunities required new methods of thinking, performing, and relating at every level of the organization and over the life of the project. They also realized that current contracts inhibited achieving those goals.

Ghafari's Digital Factory Experience

Since the 1990s, many of the global automotive manufacturers have pursued some form of "Digital Factory" aimed at bringing lean practices and 3D model based integration (used in their manufacturing processes) to their capital project work flows.

In the late 1990s, under mounting global pressures, General Motors (GM) Management challenged their World Wide Facilities Group (WFG) to improve key metrics for capital projects by 25% in schedule, cost, quality, and construction site safety.[17] WFG realized that such breakthrough results could not be achieved by tweaking existing processes, and their leadership team adopted three out-of-the-box approaches:

- Lean Practices borrowed from manufacturing colleagues.
- 3D Math Based Modeling and data exchange now branded as BIM in the building sector.
- Some form of collaborative design/construction process.

With these enhancements forming the foundation for a new method of project delivery, GM launched a series of smaller pilots to prove its potential. In 2004, the first in a series of several projects adopting what was then called "3D Enabled Lean" was launched to deliver safer, higher quality projects at reduced time and cost.[18]

Contractually, the projects were design/build (D/B) with a single contract between owner and the general contractor, and with subcontracts between the general contractor and the consultants. The D/B team was built around key principles including 3D-enabled lean, shared risk, and shared incentives. Performance metrics were mutually agreed upon for safety, schedule, operational continuity, cost control, quality, value engineering, and team building/community relations.[19]

The projects required co-location of Owner's staff, the general contractor, Ghafari (as architect/engineer), and key 3D-capable subcontractors and fabricators to encourage timely decision making and the transition from paper-based supply chain hand-offs to model-based flow. Weekly team oriented integration (Big Room) sessions were conducted for automated collision detection, as well as reviews of coordination, constructability and target costing. This collaborative, model-based approach, where model data transitioned from design intent to fabrication/installation level, allowed highly coordinated solutions to be delivered to the customer.

Highly coordinated solutions raised the opportunity to move beyond stick-built methodologies and mentalities and opened the door for a host of downstream efficiency gains including: off-site fabrication and, increasingly, Just-In-Time delivery and installation.[20] Highly coordinated solutions also supported a build-to-the-model mandate.[21] When compared to previous internal benchmarks, select projects were delivered to the customer faster (up to 26%) and at lower cost (up to 15%) through improved efficiency and enhanced value.[22]

Integrated Design/Delivery: Steel Shows The Way

While flow across the entire spectrum of building systems is the goal, Ghafari observed that 3D model data exchange between structural engineers and steel fabricators set the standard for flow induced efficiencies for the GM projects. Bi-directional direct-digital-exchange (DDE) between structural engineer and fabricator reduced steel mill orders from 10-12 weeks to as little as 10 days.

As structural steel model data flowed, by sequence, from the structural engineer to the steel fabricator and back, the composite models were systematically transitioned from design intent to fabrication level detail. Team-oriented weekly reviews brought high visibility to the integrated model. Many of the coordination, constructability, and costing issues that would formerly have been addressed downstream were solved through real-time Big Room reviews.

Structural steel detailing, in particular, allowed in-model reviews of shop drawing data with significantly faster, less adversarial turnaround times when compared to traditional paper-based exchanges. In-model reviews eliminated the generation and handling of what can typically be several thousand paper-based structural steel shop drawings.

The GM projects showed Ghafari that 3D model-based exchange enables a better flow and transparency of data between the design team members and their build-side partners, significantly reducing coordination problems.

Sutter Health's Development Of The Integrated Agreement For Lean Project Delivery

While Ghafari was making strides with General Motors on the 3D enabled lean delivery approach, Sutter Health was looking for a contractual vehicle to help it realize the Five Big Ideas and the Three Opportunities. Sutter determined that it should develop a relational contract, an agreement that would be signed by the architect, the construction manager/general contractor (CM/GC) and owner, and would describe how they were to relate throughout the life of the project. Further, the new relational agreement would also address the underlying principles of lean project delivery and IPD so that all members of the integrated project delivery team would have a clear understanding of how the project would be administered. The IFOA was the result.

The IFOA is a significant departure from other project delivery and contractual models. It was developed in an effort to support the values of lean project delivery that are exemplified in the Toyota Production System—the elimination of system-wide waste and the pursuit of value from the customer's perspective. It seeks to align the commercial relationships with the lean ideals and also recognizes the highly relational nature of the interactions of a construction project's design and construction participants, acknowledging the reality that they are assembled as an interdependent temporary production system. Rather than focusing on risk transfer, the IFOA seeks to establish systems and empower the IPD Team to reduce or eliminate risk by employing new approaches to project delivery. Early assessments of and experiences with lean project delivery support the conclusion that risks associated with time, cost, quality, and safety issues can be reduced by implementing lean thinking. The IFOA provides the contractual framework to support the IPD Team's efforts to implement lean project delivery.

Relationship of the Parties

The IFOA is a single contract signed by the owner, architect, and the CM/GC. It is not a design-build agreement, where one entity takes total responsibility for all aspects of project delivery. Instead, the IFOA describes the relationships that are established among the members of the integrated project delivery team, recognizing that different members, whether traditionally a consultant or a subcontractor, may have design responsibility. Often, the trade contractors and engineering consultants participate directly in negotiating the agreement's terms as it governs the relationships of all project participants.

From the outset, the IFOA seeks to create coherence between the interests of the project and the participants and to align the interests of the project performers. The IFOA calls for team members to be selected based upon responses to requests for proposal—it is a quality, value-based selection rather than based upon lowest price. Conceptually, the primary members of the team are selected at the outset of the project. Whether the architect or CM/GC is selected first, or whether a group comes forward as a self-assembled team depends largely on the preference of the owner. However, since historically the architect has been selected first, an interesting message of commitment to change can be signaled by selecting the CM/GC first.

Typically, the direct parties to the IFOA are the owner, the architect, and the CM/GC. Rather than being conceived as a "three legged stool," this primary relationship is depicted as three overlapping circles. The project representatives for each of these entities form the "Core Group." This group, which may also invite other members of the IPD team to join (or leave) the Core Group, has primary responsibility for the selection of the rest of the IPD team and for management and operation of the project. Most major project-related decisions are to be made by consensus of the Core Group. Only in the event of impasse does resolution of issues transfer to the owner. The Core Group, which is to meet regularly, is also responsible for developing and implementing various project plans that reflect the Core Group's strategy for communication, planning, quality, and other aspects of the project.

The Core Group also is responsible for joint selection of other members of the IPD Team. While the owner, CM/GC and architect each can recommend firms from whom proposals should be solicited, ultimately the list is developed and approved by the Core Group. Once additional IPD Team members are chosen, each is expected to sign a joining agreement, acknowledging that the firm is familiar with the terms of the IFOA and agrees to participate in the project based upon the described level of responsibility and collaboration. To facilitate integration into the team and the anticipated level of collaboration, the IFOA contemplates that the major consultants and trade contractors will be selected during the validation phase (see discussion below). By bringing the team together early, the agreement seeks to gain maximum participation and innovation when the team's efforts are likely to have the greatest financial impact.[23]

The IFOA also calls for executive oversight for the Core Group to foster learning and a collaborative environment. Senior executive representatives are expected to join the Core Group meetings on at least a quarterly basis. In addition, the senior executives are expected to participate in problem solving in the event the Core Group is unable to promptly resolve an issue. Beyond to the Core Group meetings, the Core Group is called upon to schedule regular IPD Team meetings to address project design and construction issues, to confirm that information is being shared across project teams, and to gain the benefit of having shared expertise to address pre-construction issues.[24] Finally, the IFOA expressly sets forth the goals of forming an IPD Team:

> By forming an Integrated Team, the parties intend to gain the benefit of an open and creative learning environment, where team members are encouraged to share ideas freely in an atmosphere of mutual respect and tolerance. Team Members shall work together and individually to achieve transparent and cooperative exchange of information in all matters relating to the Project, and to share ideas for improving Project Delivery as contemplated in the Project Evaluation Criteria. Team members shall actively promote harmony, collaboration and cooperation among all entities performing on the Project.

The parties recognize that each of their opportunities to succeed on the project is directly tied to the performance of other project participants. The parties shall therefore work together in the spirit of cooperation, collaboration, and mutual respect for the benefit of the project, and within the limits of their professional expertise and abilities. Throughout the project, the parties shall use their best efforts to perform the work in an expeditious and economical manner consistent with the interests of the project.

Creating a Collaborative Design and Construction Environment

Collaboration occurs best when the participants view themselves as equal in the process and when the initial collaboration centers on exploring and defining the problem, rather than commenting on another's proposed solution. The IFOA recognizes this need as follows:

> In order to achieve owner's basic value proposition, design of the Project must proceed with informed, accurate information concerning program, quality, cost and schedule. While each IPD Team Member will bring different expertise to each of these issues, all of these issues and the full weight of the entire teams' expertise will need to be integrated throughout the pre-construction process if the value proposition is to be attained. None of the parties can proceed in isolation from the others; there must be deep collaboration and continuous flow of information.

In support of the goal to make the owner's value proposition paramount, the IFOA calls for the Core Group to develop a target value design[25] plan and requires the IPD Team members to provide target value design support services throughout development of the design. Target value design is intended to make explicit that value, cost, schedule, and constructability (including work structuring) are basic components of the design criteria. It contemplates that the owner will have a series of value propositions (e.g., a desire that each worker have access to natural light), in addition to its purely programmatic needs, which may need to be ranked to achieve the basic business case. The Core Group's target value design plan is expected to address the formation and meeting schedule of cross-functional teams or clusters; meetings for the system or cluster leaders to share information about their system with those responsible for other systems; continuous cost model updating to assure that on-going design is not exceeding budget; and methods for evaluating target value design tradeoffs and opportunities (including function/cost trade-offs) to maintain total project target cost.

The goal of target value design is to enable the design to proceed informed, on a real-time basis, by the cost, quality, schedule, and constructability implications of proceeding with a design concept. Traditionally, the construction team participated, if at all, only after designs had been committed to paper and thrown over the wall—performing "un-constructability analysis" and "de-value engineering." At best, this resulted in negative iteration and waste when designs had to be changed when they proved to be over budget or not constructible. Instead, the IFOA seeks to create the equivalent of "paired programming," where individuals with different backgrounds and expertise simultaneously, side-by-side, attack the same problem, allowing each to benefit from the expertise of the other. The team is expected to engage in design reviews with an eye toward value—constantly exploring whether other construction options will better serve the owner's value proposition.

The IFOA permits the Core Group to identify which firm will have design responsibility for a given scope. It expects that major portions of the project will garner the participation of design-collaboration or design-build trade contractors (e.g., mechanical, electrical, plumbing, fire, curtain wall, skin). Again, the design process is structured to encourage the sharing of intermediate design documents, rather than just handing off large batches of drawings at extended intervals.

The IFOA also expects that the Core Group will collaboratively develop a joint site/existing condition investigation plan, proposing the level of investigation that the team recommends as prudent. In addition, the Core Group jointly develops the scope for third-party consultants and collectively assesses the resulting work product to evaluate it for completeness and sufficiency to inform design and construction.

Collaboration does not end when the contract documents are approved for construction. The IFOA calls for the Core Group to develop a built-in quality plan. The goal of the built-in quality plan is to cause the IPD Team to openly develop ways to ensure that the expectations of the firms and individuals who will be responsible for accepting the work are communicated to the workers who will be executing the work. In addition, the plan should empower workers to "stop the production line" if they determine that work is being passed along that does not meet the agreed-upon hand-off criteria. Again, the overall goal is for all project participants to collaborate in advance about what is required and put systems in place to "mistake-proof" the process and minimize the amount of re-work.

Another example of focused collaboration is in the realm of problem solving and dispute resolution. Initially, problem solving is facilitated by the Core Group. Rather than making the architect the arbiter of project disagreements, the IFOA calls upon the Core Group to conciliate and resolve these issues. If they are unable to do so, then the senior management representatives are expected to join the Core Group in a meeting to resolve the issue. If the issue is still not resolved, the Core Group may elect to retain an independent expert to review the issue and provide an unbiased assessment to the Core Group. Each of these levels is an effort to allow the team the opportunity to resolve any issues without creating direct adversity where one among a group of equals is empowered to make a "decision."

Articulating and Activating the Network of Commitments

The IFOA acknowledges that the ability to establish reliable work-flow is dependent on the making and securing of reliable promises. Fundamental to the success of lean project delivery is the willingness and ability of all IPD team members to make and secure reliable promises as the basis for planning and executing the project. In order for a promise to be reliable, the following elements must be present:

- ❖ The conditions of satisfaction are clear to both parties—the performer and the customer;

- The performer/promisor is competent to perform the task or has access to the competence and the wherewithal (materials, tools, equipment, instructions) to perform the task;
- The performer/promisor has accurately estimated the time to perform the task and has internally allocated adequate resources and has blocked the time on its internal schedule;
- The performer/promisor is sincere in the moment that the promise is made—only making the promise if there is no current basis for believing that the promise cannot or will not be fulfilled; and
- The performer/promisor is prepared to accept the consequences that may ensue if the promise cannot be performed as promised and will promptly advise the IPD team if confidence is lost that the task can be performed as promised.

One area where the IFOA seeks to expressly implement commitment-based management, focusing on requests and promises, is concerning Requests for Information (RFIs). Under the traditional model, an RFI is often submitted, logged, tracked, hot listed, and ultimately responded to without any direct conversation between the parties, without regard to the work activity affected by the RFI, and without any promise, reliable or otherwise, being made about when a response might be forthcoming. The IFOA boldly states a "zero RFI goal"; given the deep level of pre-construction collaboration why should construction–phase questions remain? In the event that clarification is needed, however, the agreement provides:

> To the extent that the need for clarification does arise, the party seeking clarification should first raise the issue either in a face-to-face conversation or via telephone in accordance with the Project Communication Protocols. The initial conversation shall describe the issue, identify the area affected, and request the clarification needed. If the parties to that conversation are able to resolve the issue in the course of that conversation, they shall also agree on how the clarification shall be documented and reported to the Core Group. If the parties to that conversation are not able to resolve the issue in the course of that conversation, they shall agree on how the issue will be resolved (who, will do what, by when) and shall agree which of them will notify the Core Group concerning the issue and how they plan to resolve it. It is the parties' goal that RFI's will only be issued to document solutions, rather than raise questions that have not previously been the subject of a conversation. To the extent that resolution of the issue may affect progress of the Work, the issue shall be included in the planning system.

The IFOA also calls for the project planning system to be based on collaborative, pull planning—using the last planner system or an equivalent. It identifies the fundamental characteristics that must be met:

> At a minimum the system must include a milestone schedule, collaboratively created phase schedules, "make-ready" look ahead plans, weekly work plans, and a method for measuring, recording, and improving planning reliability.

The IFOA goes on to describe each of these elements in further detail and what is required at each level of the planning system. It also describes the elements of the planning system that need to be addressed at the "Weekly Look Ahead Planning Meeting" (identification and promises for removal of constraints—e.g., RFI responses which must precede identified work) and the "Weekly Work Planning Meeting" (reliable promises from "last planners" of what work identified in the Look Ahead Process as constraint-free, will be completed to agreed-upon, hand-off criteria each day and by week's end). Finally, the system must capture and calculate planning reliability and root causes for variance so that the IPD team can develop a plan to improve reliability.

Optimizing the Project, not the Pieces

The IFOA seeks to create a system of shared risk, with the goal of reducing overall project risk, rather than just shifting it. In part, this goal is supported by investing significant efforts in up-front collaboration, with the owner funding early involvement of the project team in an effort to eliminate ambiguity in the documents and maximize the collective understanding of the project's conditions of satisfaction. The IFOA also strives to raise the quality of design by insisting that design fees be supported by a resource-loaded work plan. The CM/GC is compensated on a cost-plus fee basis with either a guaranteed maximum price (GMP) or an estimated maximum price (EMP). An EMP operates as a pain and gain sharing threshold, but limits the potential loses to the IPD team at their collective profit, keeping with the owner the risk of more significant cost overruns. Some trade contractors are also compensated on a cost-plus basis. GMP/EMP proposals usually are based on drawings submitted for permit, reducing the need for added contingency.

Historically, project owners have established separate contingency amounts for design issues and construction issues. The IFOA combines these contingencies into one IPD team contingency. The benefit of this shared contingency is that it focuses each team member not only on its own performance, but on the quality of other team member's performance as well. In this way, the success of every team member is directly tied to the performance of all members of the IPD team. Furthermore, access to contingencies is jointly managed throughout design and construction by the Core Group. The sharing of contingency begins to shape the sense of a collective enterprise.

In addition, as a result of their early involvement, the CM/GC and trade contractors agree to a limited basis for change orders—material scope changes, changed site conditions, or unforeseen regulatory or code interpretations. The traditional bases for many change orders—lack of document or discipline coordination—are eliminated as a result of the coordination efforts during the design phase. Despite its lean ideals, the IFOA does not contemplate perfection; the IPD team contingency is made available to address work that was inadvertently omitted from the GMP/EMP estimate or results from coordination mistakes.

The IFOA also supplements the traditional "negligence" standard as the exclusive measure of the designers' financial responsibility. Instead, the owner and the Core Group members agree that the IPD team contingency can be used to cover construction costs for "errors & omissions," even those resulting from negligence. While the designer would still have access to insurance for costs that resulted from work that fell below the standard of care, this would not be the exclusive recourse. This system allows the parties to establish an agreed level of quality and share the risk without being forced into an adversarial system that creates significant waste. With the level of quality established, the architect is able to prepare its resource loaded work plan accordingly.

In the past, some owners have used a "shared savings" mechanism with the CM/GC; however, this may cause optimizing the pieces and forecloses participation of the trade contractors who enabled the savings or design team members. The IFOA permits the Core Group to adopt an incentive sharing plan "to encourage superior performance" based upon the lean project delivery goals. The program must be fashioned to support the Five Big Ideas and balance between the different behaviors and results called for by those concepts. Any program is expected to consider performance in the following areas: cost, quality, safety, schedule, planning system reliability, and innovative design or construction processes. The program must provide a basis for establishing project expectations and benchmarks and continually monitoring and reviewing the project team's performance, providing the team with periodic performance information to allow corrections or modifications *during* project performance to improve the quality of the services provided. Also, the team must participate in the pool so that it supports the creation of one, unified team focused on overall project performance. Again, this enhances the sense of a collective enterprise.

The incentive program would be funded with project savings as evidenced by both contingency preservation and reduction in the project's costs of the work as compared to the amounts contained within the EMP/GMP. These savings would create the "incentive pool" which would then be paid based upon evaluation of performance against the other performance criteria. For example, the Core Group might establish performance goals in at least the following areas: quality, safety, planning system reliability, and innovative design or construction processes. The team's goals would be expressed as a range of outcomes from "business-as-usual," to "stretch goals," to "exceptional performance." Performance would be monitored and rated, with the overall portion of the incentive pool to be paid to the team based upon performance on the non-cost performance criteria.

Tightly Couple Learning With Action

Too often, projects are completed without capturing the learning; "lessons learned," if discussed at all, are usually assessed at project completion to be applied on the "next" project. One of the Five Big Ideas is to "Tightly couple learning with action." If periodic project reviews are not performed, then the opportunity for improvement over the life of a multi-year project is lost. Moreover, the existence of financial incentives provides added motivation for individuals and organizations to stretch beyond their current levels of performance or ways of doing business and may help overcome the inertia and resignation that often exists on projects.

The concepts of continuous improvement and learning from project performance are embedded in many of the IFOA's performance requirements. As previously stated, the planning system calls for weekly assessments of planning system reliability and reasons for variance, with the IPD team responsible for determining ways to reduce variability. Similarly, monthly assessments are to be made during construction of root causes of contingency utilization and change orders with the goal of minimizing future need. The Core Group is specifically charged with developing the project evaluation criteria (this may be done in conjunction with the incentive sharing plan), conducting periodic project assessments, and planning and implementing "programs to improve Project performance and performer satisfaction with the Project." Similarly, the built-in quality plan specifically must address how to assess performance, identify root causes and continuously improve performance.

The Challenge Of Integration: How Integrated Is Integrated?

Even prior experience with the design/build bundling of designer and constructor may not prepare partners for the transparency required of an IPD team. Designers and builders "know" what traditional design-bid-build and D/B deliverables might be ("I'll give you what I have always given you"), but this hides the waste that is built into our traditions. It's like Yogi Bera said, "if you always do what you've always done, you will always get what you've always got."

On another IPD project, the team was struggling with early deliverables for a foundation package to meet the project's pull schedule. The designer "knew" that (traditionally) it would take approximately 20 weeks to design and obtain approval for the facade which impacts the structural loading to the foundation. The structural engineer, however, was focused more on expediting the completion of the foundation package. Hours of sometimes passionate discussion left the team at a near impasse until the root-cause revelation that the structural engineer did not really need the finalized facade—only the approximate weight per foot (in other words whether it was curtain wall or pre-cast) to proceed with the design—information that the designer could reasonably provide. Again, the conversations exposed the hidden waste.

Imagine the dialogue between a discipline and their downstream trade partner discussing when the design might most effectively be handed-off to meet milestone dates. Traditionally, the design is well along before build-side input is invited. Not only is early build-side input encouraged—so is the discussion of how granularly design might flow to their trade counterparts. Increased flow sets the stage for production leveling for IPD members since work is performed in smaller batches and nearly just-in-time—avoiding the sometimes wild resource demands required to meet "eleventh hour" crunches. This affects resource planning of both partners and resource planning typically harbors buffers—especially if the discipline/trade team has not worked together previously. Not surprisingly embedded buffers or contingencies are not as obvious as might seem and what looked like good internal business practices can look suspiciously wasteful under the IPD lens.

For example, design-side partners typically budget a percentage of fee for construction administration follow-up, while build-side partners protect a percentage of their budget for post-documentation design-assist efforts to comment on constructability and costing. At the time when initial pricing and fees are estimated neither knows precisely when the hand-off will occur and both will, justifiably, add time and money to cover less than optimum hand-offs. Agreeing on the hand-off criteria, timing, and mechanics allows the team to explore the reasonableness of those initial buffers on both sides of the hand-off. This dynamic is repeated for each discipline/trade team, not once but possibly several times, until flow is synchronized and buffers minimized for the project good. Much like peeling the proverbial onion, as the team becomes more integrated, layers of waste are uncovered and opportunities for value revealed.

It is not hard to see that this type of constant scrutiny can be, at times, uncomfortable. An effective IPD team requires a high degree of trust and cooperation. But as noted in *Machine*, "[c]ooperation does not mean a cozy relaxed atmosphere . . . suppliers face constant pressure to improve their performance."[26] Identifying and minimizing siloed buffers requires confidence that such legacy practices will not be used negatively as team members adjust to integrated work flows.

Crossing Paths: Sutter Health And Ghafari—Sutter Medical Center, Castro Valley

In early 2007, large healthcare owners expressed interest in the integrated structural steel flows that Ghafari had developed for the GM projects. In the hope of moderating red-hot building materials cost and accelerating the painfully long lead times for steel, several general contractors convened a full day session of Northern California structural engineers and west coast fabricators to explore the large health care facility opportunity. Opening keynotes were given by Sutter Health and other healthcare providers. At this time, Sutter Health was underway with its capital delivery program. In October 2007, MHA and Ghafari were invited to join Sutter Health Executives and the project team for a workshop to discuss the opportunities for marrying up some of the manufacturing-derived 3D enabled lean processes with Sutter Health's IFOA approach.

One of the central learning points that Ghafari brought to Sutter Health was that unless you have aligned your supply chain you are never going to maximize the power of BIM. Because of the monumental complexity of health care design and the intricacies of the plan review and permitting process in California, this was no small challenge. As Ghafari had learned while improving structural steel work flow, a powerful way to get a team to realize how to best work together was to adapt a technique called "value stream mapping." This process brings the team together and puts team members in direct conversation with each other about what they give and get from each other. That information is then captured in real time, posted on the wall, and provides the team with a visual depiction of the flow of their work. It then allows the team to explore whether the process they have depicted actually makes sense and where there may be opportunities to improve on 'business as usual." A very simple concept, but one that has not until now been applied to the design of healthcare facilities.

The fundamental concept that MHA had brought to Sutter was the IFOA, which embodies the lean operating system and creates a collective enterprise focused on the owner's goals. That constancy of purpose allowed the planning sessions to always return to the same basic focal point—what actions are in the best interest of the project? The IFOA aligned the interests of the parties and the project both implicitly, through its lean operating system, and explicitly, through its contractual language requiring the assembled parties to work together as one.

Sutter Medical Center, Castro Valley is a hospital that will replace the existing Eden Medical Center. It is approximately 223,000 sq. ft. and contains 130 licensed beds. The initial focus of the design effort centered on answering the question "what is the purpose of this building?" The starting point of the effort was to design the hospital's operations—a best-practice layout for the flow of clinical care within the building.

The team's initial effort, was a series of workshops aimed at "designing the project delivery process," centered around Sutter Health's IFOA, lean principles, and how BIM might enable improved flow between project team members. As noted by Ghafari, in order to optimize BIM implementation, the team would need to create and align its information flows across the design and construction supply chain. At the Castro Valley project, then, the value stream mapping sessions offered the first test for the team to behave as a single entity. The primary outcome from those early sessions was the team's collective realization that design should not start until the clinical space program was complete. To do otherwise would risk vast amounts of design rework at the owner's expense. The collective mind of the architects and structural engineers "knew" from experience that 15 months was the expected time to produce a 100% construction document structural submittal to the state regulatory agency. Hence, in October 2007 there was already tension about the ability to meet the December 31, 2008 deadline.

By planning and re-planning the team exposed the fallacies and waste hidden in standard practice. The team realized that this work could actually be completed in eight months, and it was done in eight months. This allowed the owner, along with its clinical care experts, an additional six months to finalize the correct clinical program. In exchange, the team was able to demonstrate to the owner that once the date established for finalizing the clinical program expired, no further changes to the program would be permitted if the owner wanted to meet the deadline for structural submittal and keep the project on budget. During this six-month window, design was pursued solely by lead designers who primarily worked, almost literally, with pencils and paper, with the owners and clinical care experts. As a result of this planning, between October 2007 and April 2008 only $3 million of the $320 million project budget was spent.

In this context, one should not underestimate the cultural challenges in moving to this way of thinking and planning. Even though the team repeatedly demonstrated that it could design better and faster in this system, the lingering fear that they were running very late never really left the minds of many team members. They were taking a leap of faith, and it was a scary place to be. It was realized that design teams had been working in isolated disciplines for so long now that they have very little knowledge of what other disciplines actually do. Time and again team members would change the content, timing, and format of their deliverables upon finding out what it was the other discipline actually needed.

Ultimately, the team proved that its planning was correct and history was wrong—all the deliverables were submitted on December 21, 2008—not at 11:59 pm on December 31, but 10 days earlier, so that everyone on the team could enjoy the Christmas season with their families.

The team experienced similar revelations that exposed the hidden waste of common assumptions. In order to design the structure, architects often develop a skin design very early in the project. Why would an architect develop a full elevation of a building exterior (especially when it's so early that he's making educated guesses) when the structural engineer only needs a rough idea of the total weight of the skin? Perhaps because the architect does not really understand what the structural engineer needs. Instead of preparing a design for the skin, perhaps the architect and general contractor, after an hour-long breakout session, can report to the structural engineer roughly how much the exterior will weigh and importantly, if some limits on material can be agreed, can agree on a range of costs for such an exterior. Suddenly, what was proposed in the initial planning as a task taking several weeks has collapsed to one or two hours.

Repeated revelations such as these make it possible to compress a standard 15 month design duration down to eight months, with no reduction in quality. Indeed, the team believes that the quality of this structural package far exceeds "typical" quality as many of the factors that could create a late change in structural design have been resolved. Moreover, the team's decisions have been made with the knowledge that they cannot be changed without threatening schedule, budget, and the owner's credibility with the permitting agency.

Another significant process outcome has been a redefinition of collaboration where designers now work hand-in-hand with their trade partners. The mechanical designers have been working collaboratively day in day out with the mechanical installers, similarly for electrical. For disciplines where design is progressing absent an expert specialty trade partner, the team instinctively perceives this as a major risk and has caused the team to reach out and engage the relevant specialty contractor (e.g. stairs, elevators, roofs). Once a team grows accustomed to integrated design and trade collaboration, it is remarkable how quickly the team seeks to mitigate the risk by engaging the proper trade.

Typically, people posit that this type of collaboration must require a disproportionate investment in design. Despite all the planning, re-planning, strategizing, all the early engagement of trade contractors, the total burn rate of design hours plus design/assist hours is tracking at or below what was expected. This alone should indicate the tremendous amount of rework and related waste that exist today in traditional healthcare design. Moreover, the end point of the design on this project, the permit set of documents, will include fully coordinated (in 3D, all disciplines), fully constructible designs. Consequently, the project has a very serious stretch goal of zero RFI's and zero change orders.

Most importantly from a contractual point of view, all the above drives a tremendous amount of risk out of the project. The structure of the IFOA harnesses the elimination of risk to the benefit of all parties to that contract. On the Sutter Medical Center, Castro Valley project eleven parties will sign the IFOA creating a virtual temporary design and construction entity, all with a shared financial interest in the over arching goal—to deliver this facility on time, at or below budget, with the agreed clinical program, configured in a way to transform clinical care. The eleven parties collectively share in the benefits of exceeding this goal, and agree to share the pain of failing in that effort.

It is possible to create a positive collaborative work environment for the human beings present day-to-day on a project under any contract structure—as long as the project is going well. That was the promise of "partnering." However, if things start to go wrong or challenges start to mount, people used to revert to their contractual bunkers and prepare for the battle. Under the IFOA, there is nowhere to hide. The contract language and the commercial structure require that the team to stay united, collaborative and collectively focused on the owner's primary goals. Equally important, the IFOA requires the company executives, the leaders who set the priorities of the human beings at the table, to be aligned in the same manner. By doing this, the IFOA creates that broad and deep alignment.

The IFOA gives the owner the opportunity to create a work environment that is focused on getting the job done and nothing else, all the project's frustrations and stresses are good ones related simply to the ambitious nature of the project and not to traditional adversarial contract relationships that drive, necessarily, a silo mentality. As a result, it creates a vastly improved work environment.

In the SMCCV project, the participants have learned that the collective enterprise formed under the IFOA is able to identify for each participant nearly every thing that has ever gone wrong on a healthcare project before. The team then is capable of answering the question "What would you do, given the chance, to prevent that from happening on this project?" The answers show that an integrated team already knows how to mitigate or eliminate nearly every risk present in these complicated projects. Although the behavioral changes needed to perform under an IFOA are difficult, if lean project delivery is smartly implemented the IPD team can unleash its vast collective knowledge to create a lower risk environment in which people and companies can perform, at last, to their true potential for the benefit of themselves and those that fund the project.

Different Outcomes, Different Rules, Different Results

So is Integrated Project Delivery worth the journey? According to Toyota, "Suppliers who participate (in the Toyota Production System) enjoy the same benefits that Toyota does, like just-in-time management, leveled production, and continuous flow . . ."[27] These are some of the same objectives and benefits that Sutter expects their integrated teams to pursue by embracing the Five Big Ideas and the Three Linked Opportunities. According to Digby Christian:

> [b]ecause the team talks, reviews, re-plans on at least a bi-weekly cycle, they are in constant problem-solving mode, which can make you feel like burning more hours in design than normal. However, what is happening

is planning at its best—resolving right now, in design, all the conflicts that typically are deferred until very late in the design process or even the construction phase. Despite initial skepticism, what we have found is that the total time to design is at or below standard expectations.

Thus far, our assessments of, and experiences with, lean project delivery support the conclusion that risks associated with time, cost, quality, and safety issues can be reduced by implementing lean thinking, IPD, and BIM.

ENDNOTES

[1]After a heavy investment of time, money, and ego in a proposed design, the inertia against considering the full range of solutions that might be offered by deep value analysis or constructability reviews becomes quite strong. The second author was recently involved with a project where the mechanical contractor became involved during the Construction Document phase. The project had serious budget problems and the mechanical contractor identified a number of potential cost-saving items. Among those was an idea that would have required some architectural redesign of the penthouse but would save mechanical costs of nearly $800,000. While the entire team basically agreed that the idea was valid, because of the timing and the need for "redesign" the team seriously considered not pursuing this item. Had the idea been floated during Design, there is little doubt that the design would have been modified to achieve this savings without the cost of "redesign."

[2]Paul Teicholz, CIFE, Stanford University, based on U.S. Bureau of Labor Statistics and Department of Census data.

[3]James E. Diekmann, et al, *Application Of Lean Manufacturing Principles To Construction*, Construction Industry Institute, Pub. RR 191-11, 76 (2004) (report also finds on page 121 that, if indirect construction work is factored in, the rate probably would be closer to 90%).

[4]*Id.* at 1.

[5]Victor O. Schinnerer & Company, Inc., *From Risk To Profit: Benchmarking and Claims Studies* (2006).

[6]Interview with Gregory A. Howell, P.E., Managing Director, Lean Construction Institute, in Sacramento, Cal. (November 11, 2008) (Howell heard this insight from Jim Carroll).

[7]Victor E. Sanvido And Mark D. Konchar, *Selecting Project Delivery Systems: Comparing Design-Build, Design-Bid-Build And Construction Management At Risk*, 3 (1999).

[8]The concept of relational contracts (as opposed to transactional contracts) was developed by Ian Macneil. For a historical retrospective of Macneil's theory of relational contracts, see David Campbell, *Ian Macneil and The Relational Theory Of Contract* (2004).

[9]Sutter Health is a not-for-profit, community-based health care and hospital system headquartered in Sacramento, California, with facilities throughout Northern California. It is in the midst of a multi-billion dollar building program to upgrade services to its communities and to meet state-mandated seismic requirements.

[10]James P. Womack et al., *The Machine That Changed The World: The Story of Lean Production,* 167-168 (1991).

[11]Chuck Eastman et al., *Bim Handbook: A Guide to Building Information Modeling 2* (2008) (2008) (see generally, all of chapter 1).

[12]*Womack*, *supra* note 10, at 167.

[13]*Id.*

[14]*Id.* at 167-168.

[15]"The Five Big Ideas" and the resulting manifesto were developed by Lean Project Consulting, Inc.

[16]Gregory Howell & Will Lichtig, *Three Linked Opportunities* 1 (2009), **www.leanconstruction.org**.

[17]"General Motors' 3D Enabled Lean Approach: A Revolution in Manufacturing Plant Construction," Presentation at the CoreNet Global Summit, *Sustainability Beyond Green Buildings*, Denver, May 2007.

[18]For a case study review of one of the GM projects, see Chapter 9 of Eastman, *supra* note 11.

[19]Jack Hallman et al., 3D Enabled Lean, Collaborative Design-Build Delivery: General Motors Flint V6 Engine Assembly Plant, DESIGN-BUILD DATELINE, December 2006, at 17-23.

[20]Tom Sawyer, "Build It First Digitally: Soaring into the Virtual World," *Engineering News Record*, Oct. 10, 2005, at 2-5.

[21]John Egan, "3D Problem Solvers," *National Real Estate Investor*, Feb. 1, 2007, at 73-76, **www.nreionline.com/mag/real_estate_problem_solvers**.

[22]Robert L. Mitchell, "Virtual Building Blocks," *Computerworld*, Dec. 9, 2006, at 40, **www.computerworld.com.au/article/163667/ virtual_building_blocks?pp=1**.

[23]SanvidoANVIDO, *supra* note 7, at 51.

[24]Toyota has used what it refers to as "obeya" or " big room" meetings to gain the synergy that develops when cross-functional teams are brought together under one roof to explore problems. As noted by Toyota executive Takeshi Yoshida, "There are no taboos in obeya. Everyone in that room is an expert. They all have a part to play in building the car. With everyone being equally important to the process, we don't confine ourselves to just one way of thinking our way out of a problem." Fara Warner, "In a Word, Toyota Drives Innovation," *Fast Company*, July 2002, **www.fastcompany.com/magazine/ 61/toyota.html**.

[25]Target Value Design is similar to Target Costing, but may be broadened to encompass additional design criteria beyond cost, including time, work structuring, buildability, and similar issues. For a discussion of Target Costing, *see* Glenn Ballard & Paul Reiser, "The St. Olaf College Fieldhouse Project: A Case Study in Designing to Target Cost," presented at 12th Annual IGLC Conference (2004), **www.iglc2004.dk/_root/media/13103_107-ballard-reiser-final.pdf**.

[26]Womack, *supra* note 10, at 167-168.

[27]Toyota Motor Corporation, The Toyota Production System (International Public Affairs Division, 1992).