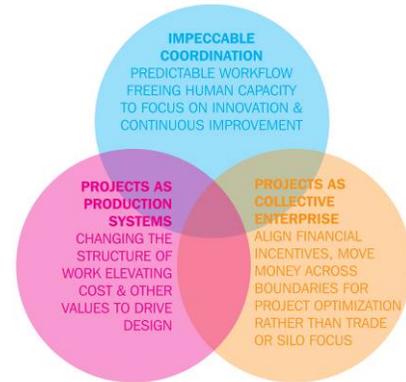


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Greg Howell, of the Lean Construction Institute, and Will Lichtig, author of Sutter Health's Integrated Form Agreement, describe the "Three Linked Opportunities" provided by Lean project delivery. They are:

1. Impeccable Coordination
2. Projects as Production Systems, and
3. Projects as Collective Exercises



THREE LINKED OPPORTUNITIES

I believe that their argument is clear, accurate and useful.

Greg and Will describe projects as “nearly chaotic” and point out that an average of only 55% of work promised in a week is actually completed as promised. They go on to say “‘Impeccable coordination’ creates predictable workflow within trades and disciplines...taking action to produce predictable workflow stabilizes the project environment and reduces both time and cost without sacrificing quality. It also frees up human capacity to focus on innovation and continuous improvement.”

Greg Howell and Will Lichtig maintain that “Approaching ‘Projects as Production Systems’ opens the possibility of changing the structure of work in both design and construction—who does what, when, where and how. Changing the structure to maximize project performance includes elevating cost and other owner values to explicitly drive design. It also recasts the role of specialty contractors in that effort. During construction, production system design coupled with impeccable coordination makes possible modularization, off-site fabrication, and multi-trade composition of work, with the goal of improving system-wide performance.”

Greg and Will believe that seeing “‘Projects as Collective Enterprise’ aligns financial incentives and gives the team the ability to move money across commercial boundaries, with the goal of project-wide optimization, rather than a trade-level or silo focus. Rearview control is replaced by the ability and willingness to invest here and now for returns there and then. The goal is to create an ‘all for one, one for all’ mentality.”

Greg Howell and Will Lichtig end by boldly stating that “Exploiting these opportunities requires new leadership, thinking and practice at every level of the organization and over the life of the project. Organizations must reflect and consider their level of ambition.”

The question for this session is just what are the ideas and practices that Lean leadership must explain and promote once an organization has decided just how high it wants to climb.

Lean is a continuing effort to eliminate waste from a production system in order to deliver ever more value to the customer. The best example is Toyota's work over the last 60 years. Taiichi Onno, Toyota's Chief Engineer from the late 40's all the way through the mid-70's (?), is credited with inspiring and leading development of the Toyota Production System (TPS). Onno explained that the objective of TPS is: “To produce the right product at the right time in the right quantity for the customer and to produce exactly what you need and nothing more...”

An American autoworker could produce 10 times as much as his or her counterpart in Japan in 1948. Onno and other Toyota leaders concluded that they must be wasting considerable resources for that to be the case. They identified 7 wastes: overproduction, waiting, inventory, movement, effort, rework of errors

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and processing. Ohno believed that overproduction was the cause or a contributor to all the other wastes. Jim Womack and Daniel Jones, in their book "Lean Thinking" proposed unused human potential as the 8th waste.

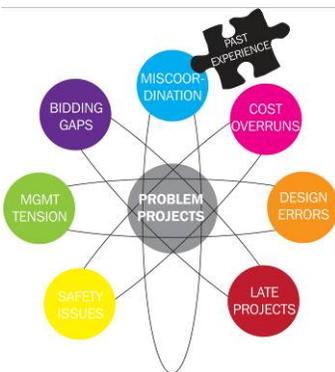
The objective of Lean is clear enough; the big question; however, is how to do it. Womack and Jones describe 5 basic steps to eliminate waste. They are:

1. Identify value
2. Map the value stream
3. Make value creating steps flow
4. At the pull of the customer
5. Strive for perfection

Michael Kennedy in his book "Ready Set Dominate" cites this advice from the President of Toyota North America:

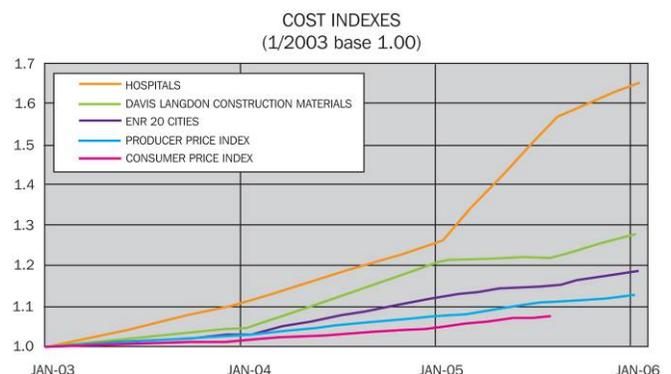
- Keep everything simple
- Make it visible
- Trust your people to do the right thing

GM and Ford have been working diligently to apply Lean in their manufacturing operations for 20 years with mixed results. Many U.S. manufacturers like Steelcase and Boeing have chosen to follow Toyota's lead. Virginia Mason, the Mayo Clinic, Massachusetts General and the Pittsburgh Regional Healthcare Initiative under former Secretary of the Treasury Paul O'Neill, are rethinking and reorganizing the way they deliver healthcare using Lean principles. Ships are being built Lean. We are witnessing a strong and growing movement towards Lean Construction. In each case, Lean implementations are being crafted to meet the challenges presented by the industry, market sector and character of the organization.



Owners, particularly large healthcare providers, have become frustrated with what we can call "conventional project delivery." This can be described as current best project management practice in which facilities are designed in painstaking detail, then bid in the market place, and carefully managed so that every nickel and minute is accounted for. Though the approach makes perfect sense, the results are mixed at best

and horrible at worst with persistent cost and schedule overruns, accidents, less than expected quality and inadequate functionality.

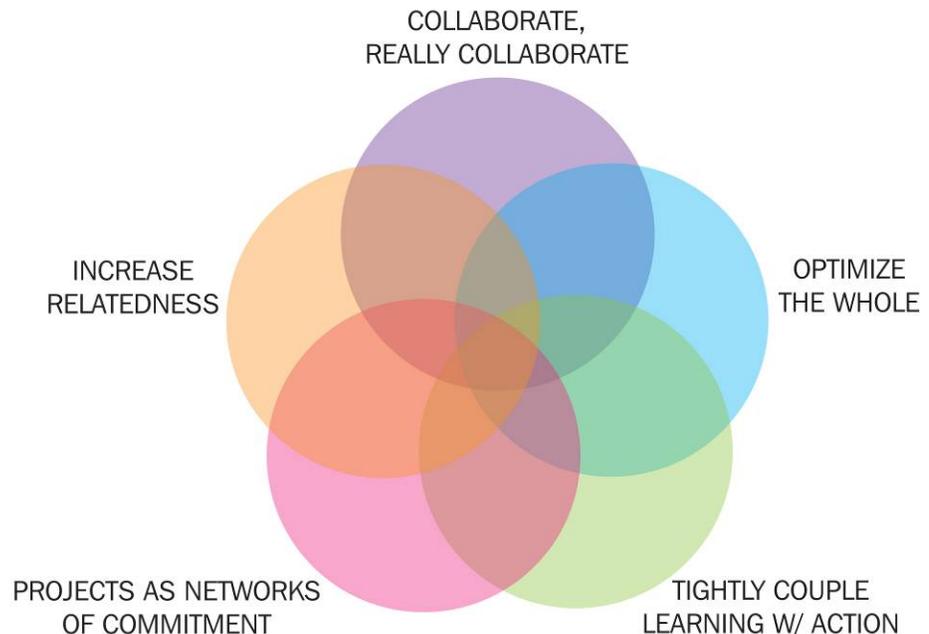


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Various attempts to improve the outcomes have been and are being tried: Construction Management at Risk, Design Build, and various combinations seem to be the most common. While gains have been made, these approaches have not delivered the expected results. Sutter Health, in Northern California, was the first major organization to throw up their hands and opt for a new approach—Lean Project Delivery. The University of California San Francisco, ThetaCare in upper Wisconsin, and Sisters of Saint Mary and BCJ Healthcare in St. Louis have all recently mounted Lean capital facility initiatives.

Sutter Health has formulated and promoted "Five Big Ideas for Lean Project Delivery." They have collectively functioned as a True North for the efforts of dozens of companies striving to meet Sutter's high expectations. These ideas are worth considering for any organization because they serve as a very useful translation and application of Lean Thinking to the delivery of large, complex projects.



The first big idea is "Collaborate, really collaborate, throughout design, planning and execution." Sutter Health says "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."

The second big idea is "Increase relatedness among all project participants." Sutter Health states "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."

The third big idea is "Projects are networks of commitments." Sutter Health explains "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 commonsense understanding that planning is predicting, managing is controlling, and leadership is setting direction."

The fourth big idea is "Optimize the project, not the pieces." Sutter Health says "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."

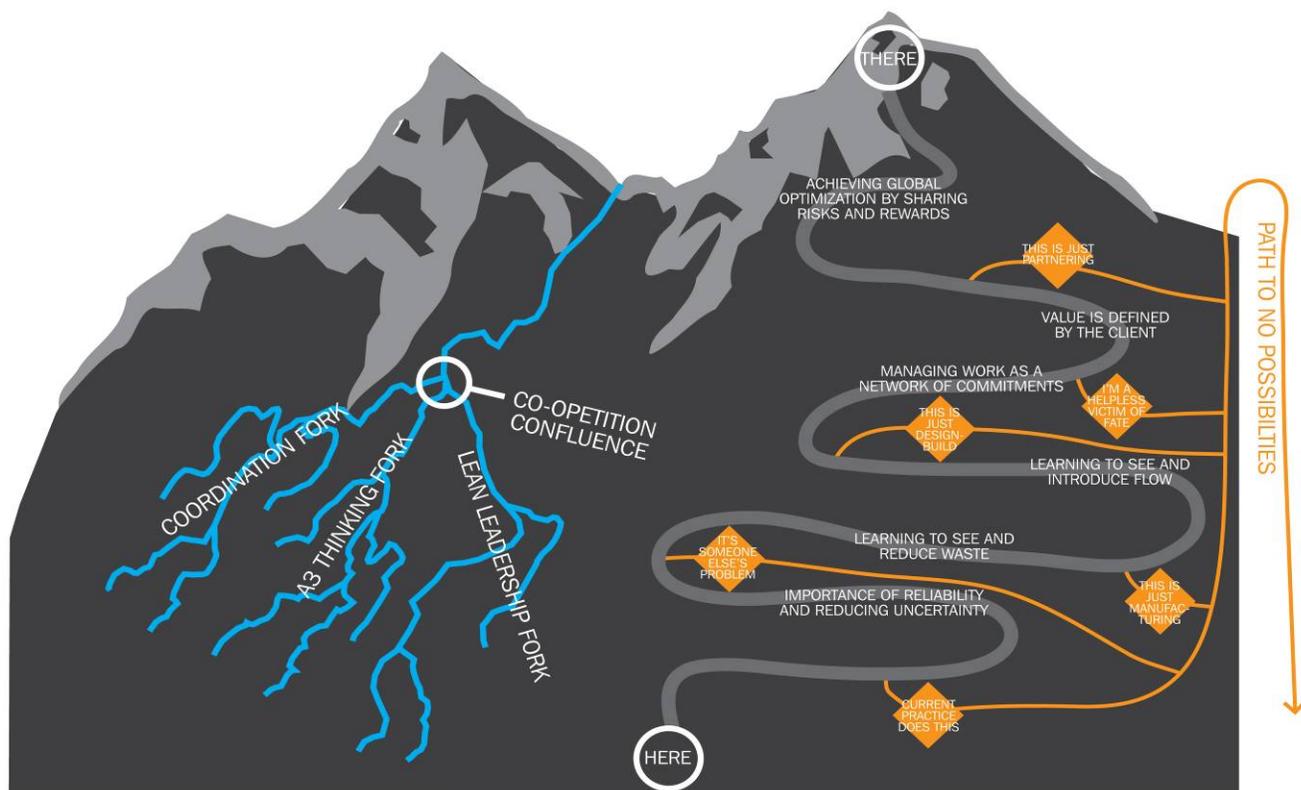
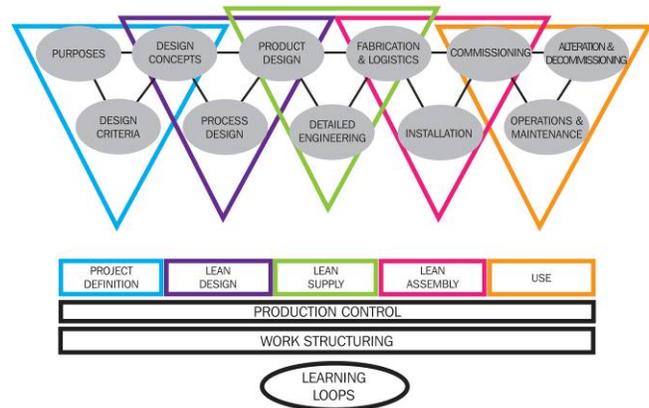
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The fifth big idea is "Tightly couple action with learning." Sutter Health says "Continuous improvement of costs, schedule, and overall project value is possible when project performers learn in action. Work can be performed so that the performer gets immediate feedback on how well it matched the intended conditions of satisfaction."

Owners like Sutter Health have shown leadership and vision in describing the kind of behaviors they want. But what exactly is Lean Project Delivery (IPD)? The Lean Construction Institute (LCI) has described a schema around which practices are being built. Lean Project Delivery extends through the full life cycle of a facility. We are finding the LCI model to be a useful guide from the very start of the project when we've formed a team to validate that the facility can be designed and built to meet the program for funds available. This is because every aspect of delivery must be considered in order to understand what the customer stakeholders really want. We are finding that project delivery teams' understanding of customer value is tested at every step as we struggle to balance aesthetics, efficiency, quality, cost and schedule.

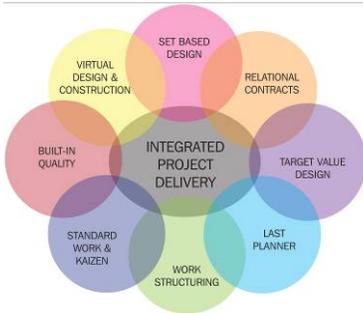
New processes, practices, and behaviors are being developed to overcome the challenges posed in each phase. Various leaders in the Lean Construction community have tried to describe how the practices relate to each other. Will Lichtig has created a drainage map. Greg Howell has drawn various road maps showing junctures, with the option of taking a wrong turn at any point. Cynthia Tsao of the University of Cincinnati pictures a road winding up a mountain, with the possibility of veering off and ending up at the "Hotel Know It All" at every turn. That's not a good place to end up because the rooms are always full in that hotel with



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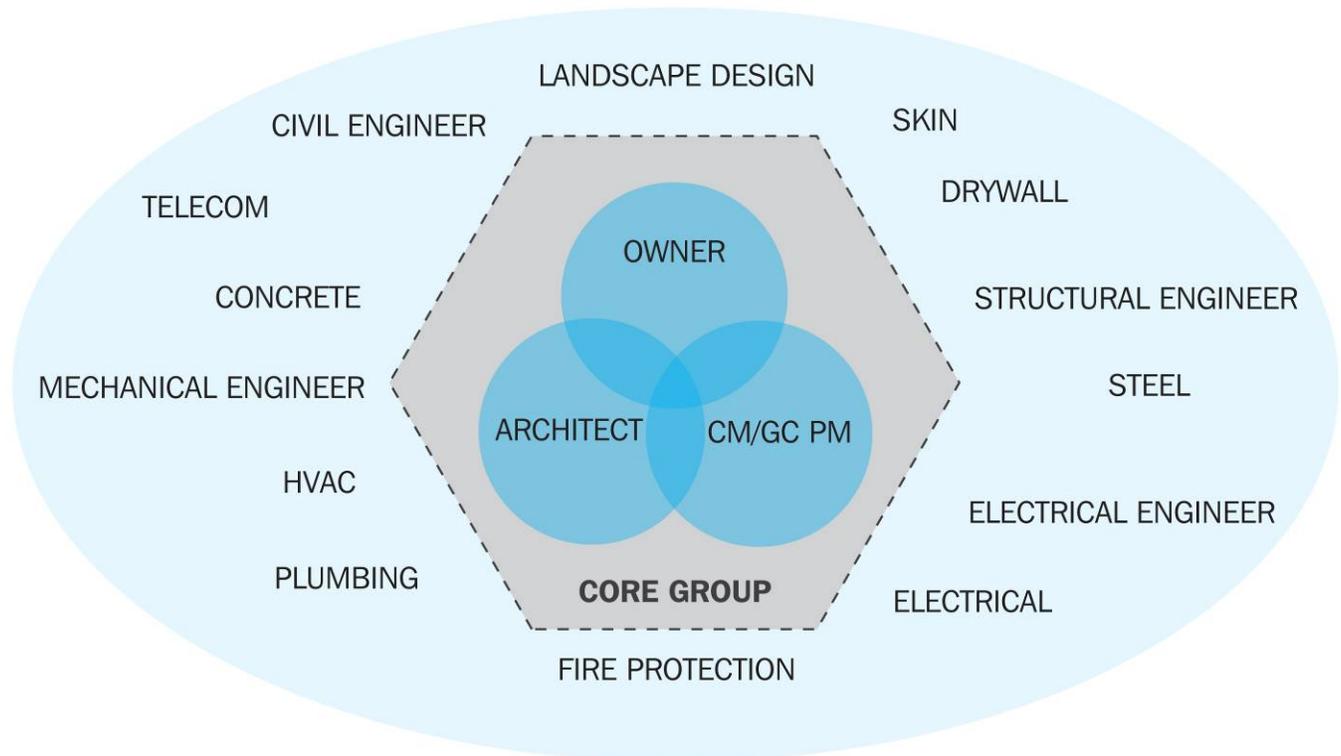
people who don’t need to learn anything new.



I prefer, at least for today’s purposes, to depict the practices and behaviors of Lean Project Delivery as a constellation. I’d like to spend my remaining time explaining and describing how these practices look in real-life on the Lean Projects I have worked on.

Assembling and empowering all of the resources required to “collaborate, really collaborate” is a prerequisite for Lean Project Delivery— which is why Integrated Project Delivery is at the center of the constellation. Sutter’s practice is to bring together the team of architects, engineers, contractors and specialists at the very inception as purposes are being considered.

Member companies are selected based on experience, technical expertise, and ability to communicate freely and work collaboratively. The Owner, Architect and General Contractor typically comprise the decision making “Core Group,” with selected consulting engineers, and specialty contractors with design responsibility filling out the Integrated Project Delivery team.



The biggest concern in breaking from the past for many owners is how to take the leap from selecting specialty contractors on any other basis than cost. This break can only come from understanding that, as Eric Lamb, DPR’s Executive Vice President, says “Real value is not the low bid on a higher cost design. It’s achieving the lowest true cost on the right design.” This can only be achieved through co-creating design with the people who construct it. All other industries have been doing this for years under the mantle of “Design for Manufacturing.” This is a pre-condition for the “Three Linked Opportunities” and the organizational foundation for Lean Project Delivery.

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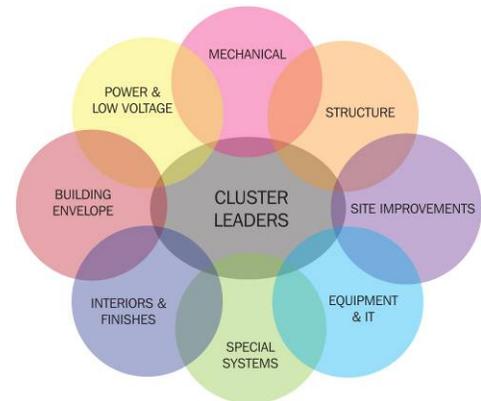
Virtually every Lean product manufacturing company employs a target costing strategy in which the selling price is established after careful analysis of market conditions. The desired profit is then subtracted, leaving the total cost of production as a goal. The product is then designed to that target number.

Sutter health has adapted the methodology but changed the name to “Target Value Design” (TVD) to emphasize the objective of creating the best design for a facility that can be built for the funds available. Target Value Design requires that the facility owner provide the Integrate Project Delivery team with a description of what is wanted along with the money available for design and construction. The team, with contractors on board who operate in the marketplace and thoroughly understand cost, is challenged to work with the customer to develop the best possible design that can be constructed for the target cost. Cost becomes a design criterion and is considered along with form and function. Cost cannot and must not chase design.

Everyone who seriously engages in Target Value Design sees the benefit and is quickly confronted with the challenges of taking a completely new and different approach to managing cost. Contractor staff must include people who can estimate cost from concept descriptions and sketches rather than plans and specifications. Architects and consulting engineers must be willing and able to listen to contractors critique the constructability and cost of their designs. Equally as challenging, owner representatives must be ready and able of help other team members understand customer value in order to make decisions that inevitably involve trade-offs of form, function, time and both first, life-cycle and operating costs.



Toyota can design and bring a new model to market in less than half the time of its competitors. That is because their engineers follow a discipline that promotes deep thinking to support considerations of several possible design solutions as long as possible. They do this at each level of design for systems, sub-systems, assemblies and components. While this seems counter-intuitive and wasteful, Toyota and other practitioners of “Set Based Design” have learned that the best solutions are hybrids of the original design options. Most important, Toyota avoids the large negative loop-backs that occur when a decision taken early in the interests of speed must be reconsidered because of cost or other considerations.



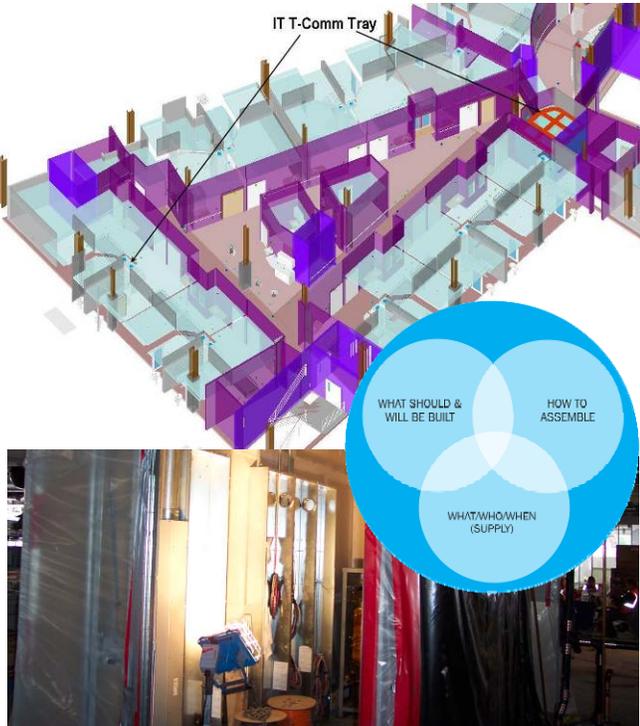
The challenge of a Set Based Design is to identify the “Last Responsible Movement” for converging on solutions. We have learned how to apply one of the main tools of Lean Manufacturing—“Value Stream Mapping”— to understand when decisions must be made. It is, as Sutter Health says, “messy work” to bring together design professionals and contractors with a wide range of histories and experience to map how they believe design should proceed. It

| SET-BASED CONCURRENT ENGINEERING | | | DESIGN | | | | |
|---------------------------------------|-----------------------------------|---|-----------------------------------|---|-----------------------------------|-----------------|--------------------------|
| TEST/CAPTURE KNOWLEDGE IN A3/K-BRIEFS | 1 ST INTEGRATION EVENT | FILL KNOWLEDGE GAPS FOR SOLUTIONS STILL IN PLAY | 2 ND INTEGRATION EVENT | FILL KNOWLEDGE GAPS FOR SOLUTIONS STILL IN PLAY | 3 RD INTEGRATION EVENT | DETAILED DESIGN | IMPLEMENTATION DOCUMENTS |
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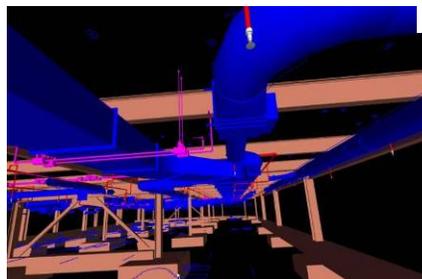
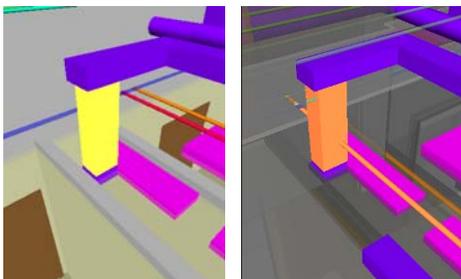
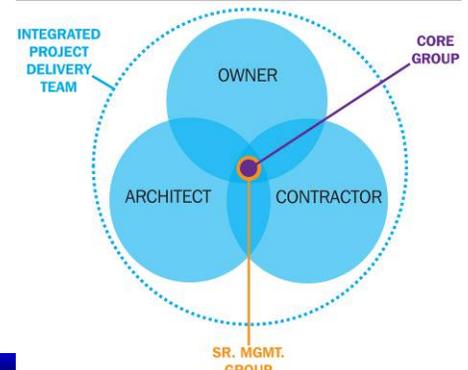
takes time and effort for team members to discuss and sometimes debate how things should be done. The end result is always a much greater collective understanding and more efficient sequence of design work because unnecessary churning is avoided.



Work structuring is changing the structure of work both in design and construction. It requires IPD team members to put aside the way they've always done things in order to focus on how best to organize and execute work for the benefit of the project as a whole.

This is not an abstraction. It is as real as the drywall contractor, DPR, framing the main electrical rooms on each floor of the Camino Medical Center first thing to allow the electrical contractor to install the sub-panels much earlier than usual. On that same project, only designated walls were framed with the rest held until the overhead mechanical and electrical work could be installed. This slowed framing production, but resulted in much higher productivity for the sheet metal, piping and electrical crews. The net was lower labor costs overall and savings for the project. Again on that same project, the mechanical contractor and engineer agreed that the contractor was in the best position to produce the construction documents out of his 3D model even though the mechanical engineer was the designer of record. Modular construction of bathrooms, hotel suites, residential apartments, and even bio-pharmaceutical laboratories are examples of aggressive work structuring.

Relational contracts were first developed and have been used extensively in England for North Sea oil exploration, and later in Australia for large infrastructure and building projects. Sutter Health's "Integrated Form of Agreement;" "Consensus DOCS 300" issued by the Construction Users Roundtable, Associated General Contractors and Associated Specialty Contractors; and the American Institute of Architects' "Single Purpose Entity" provide the framework for teams to collaborate deeply to implement Target Value Design, Set Based Design, and Work Structuring. These contracts enable Integrated Project Delivery companies to share in both the risks and rewards so



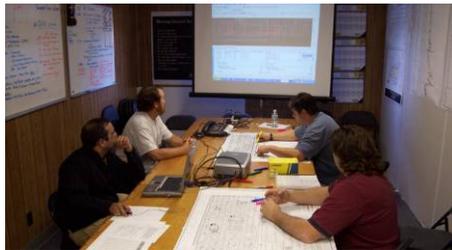
that everyone wins or loses together.

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Virtual Design and Construction is not the technology solution that many observers and even practitioners see it. It is an enabler of Lean because teams can see existing conditions, test their designs, report quantities, predict energy use, and simulate construction. None of these capabilities were available without a considerable investment 10 years ago.

Design firms and contractors such as DPR are doing all these things concurrently. We at DPR agree with the notion that the process of creating models and prototypes shapes the behavior of teams and leads to much richer interaction. As Michael Schrage suggests in his book, "Serious Play," smart simulations can make teams smarter as people learn what and how to build early on in the project—long before the work begins on the job site.



Greg Howell and Glen Ballard conceived the Last Planner System[®] to create reliable work flow. They argued for a collaborative approach in which performers identify what they need from others as they plan how to achieve milestone; a method they described as "pull planning." Greg and Glenn sought to remedy the chaos fostered by traditional project management and over-reliance on CPM to schedule activities in detail, far in advance of when conditions on site can be known. This new and radically different approach called on managers to think in terms of flow rather than optimizing discrete activities. And it took a page from Toyota's practice of making it every line worker's responsibility to stop production if they encountered a problem. The Last Planner System asks the trade foremen, the "Last Planners," to look ahead and plan to do only work that is or can be made ready to perform safely, efficiently and to quality standards. Last Planners were to refuse defective assignments just as Toyota workers were required not to install components that did not fit as they should.



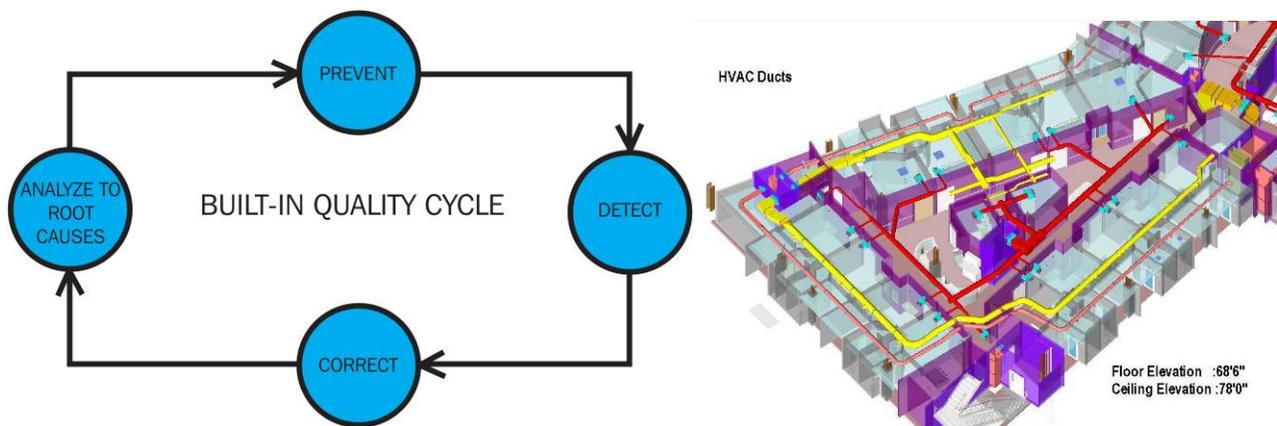
Initially, the Last Planner System was greeted with disbelief. This has changed as more and more construction companies have deployed the system in response to owner demands to improve project delivery.

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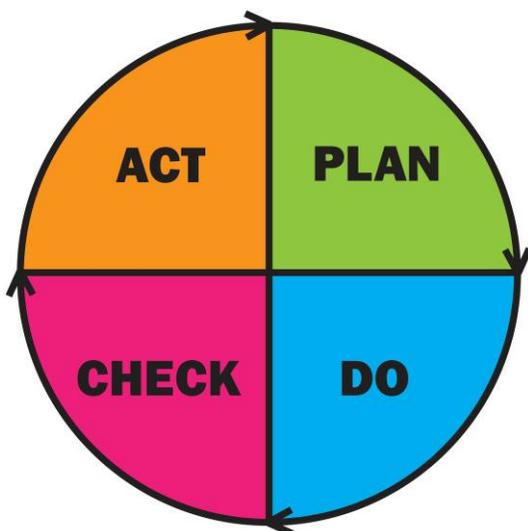
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IPD teams have found that the Last Planner System facilitates much more reliable workflow in design as workgroup leads adopt practices that trade foremen have learned. Teams are using pull planning to schedule the work identified through Value Stream Mapping. The Last Planner System, perhaps more than any other Lean practice, strengthens the network of commitments as performers learn to make clear requests and reliable promises in executing their work plans.

Creating the conditions for error free installation begins in design and continues all the way through construction. The result is that quality is built-in rather than correcting substandard installations after defects have been found during inspections. Builders working in Integrated Project Delivery teams have a special responsibility to make sure that whatever is modeled or drawn can be constructed safely and efficiently by work crews. This requires that the construction documents are clear and can be easily understood by craft workers. The completed installation must fit and interface with other components and assemblies to meet the customer purposes.



Work Structuring and Virtual Design and Construction establish the condition for Built-In Quality. One of the criteria for executing work in the Last Planner System is that trade foremen are confident their crews can put the work in place properly, without defects of any sort. Quality becomes the responsibility of every designer, manager and trade worker, not just the inspector and pick-up crews.



“Kaizen” is the Japanese word for continuous improvement. Close observers of Toyota describe the company as a learning organization from top to bottom through design and final assembly of its cars and trucks. Workers, not industrial engineers, define safe and efficient standard work practices. Workers are trained in these practices and how to improve them by applying the scientific method in the form of the “Plan Do Check Act” cycle that W. Edwards Deming taught to Japanese industry. Toyota workers, engineers, managers are taught to ask “why” at least five times in order to understand the root cause of breakdowns and failures.

Kaizen, as practiced by Toyota, is not intuitive or easy for design professionals, construction managers and workers used to “just getting it done” and moving on. We have convinced

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ourselves that we will never get our work done if we stop to consider problems. The result is that they persist, get worse, and take huge amounts of time for someone to unravel at the end of the project or after the building has been turned over to the customer.

The Last Planner System requires performers to check whether they were able to accomplish what they planned. As part of the "Check" step and a precondition for the "Act" or "Adjust" step, Last Planners are asked to describe and categorize the reasons for plan failures. At the end of meetings Integrated Project Delivery teams are routinely listing "Pluses," things that went well, and "Deltas," things that didn't work and need to be improved.

The big ideas, practices and behaviors of Lean make the "Three Linked Opportunities" possible—but only through determined and wise leadership coupled with disciplined and thoughtful action by every team member. The benefit of "Impeccable Coordination", "Projects as Production Systems" and "Projects as Collective Enterprise" are certainly worth the effort.

OPTIMIZE THE WHOLE...

