# INTEGRATED Project Delivery

## 1.3 Integrated Project Delivery

### 1.3.1 What is IPD?

> *Integrated Project Delivery is a philosophic approach for designing a production or delivery system that maximizes value to the owner. The philosophy seeks maximum value to the owner and results in the elimination of waste.*

Simply put, Integrated Project Delivery uses lean construction principles in a process-centered approach to developing and delivering a project. Lean principles were originally implemented in manufacturing and first "discovered" by experts reviewing and documenting the Toyota Production System. Toyota had shown great success with a new and different type of production line that required each step in the process to produce only what was needed by the next step in the process and to view anything else as waste. The behaviors and tools used by Toyota were documented and used to define a *lean system*.

In the 1990s, Greg Howell, Glenn Ballard and Lauri Koskela began developing independent strategies for using lean in the delivery of construction projects. When applied to construction, lean changes a project from a combination of activities to a system of dependent and variable tasks that must be managed based upon the unique human interactions that support work being done. "Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design of product and process, and the application of production control throughout the life of the product from design to delivery."[1]

The idea of a construction project as a system requires all participants to focus on the flow of work on the entire project and not just for activity optimization within their own contractual silo. *Lean Project Delivery*, a term used to describe the application of lean to construction projects, establishes a project where the owner, the design team, the builder and operational personnel work together to design a facility that delivers the owner's identified business and other social goals. Thinking of a construction project as a collective enterprise requires readjusting traditional notions of construction delivery. Like lean manufacturing systems, lean construction and Integrated Project Delivery embraces very specific behaviors and tools, which have a substantially beneficial effect on the entire project.

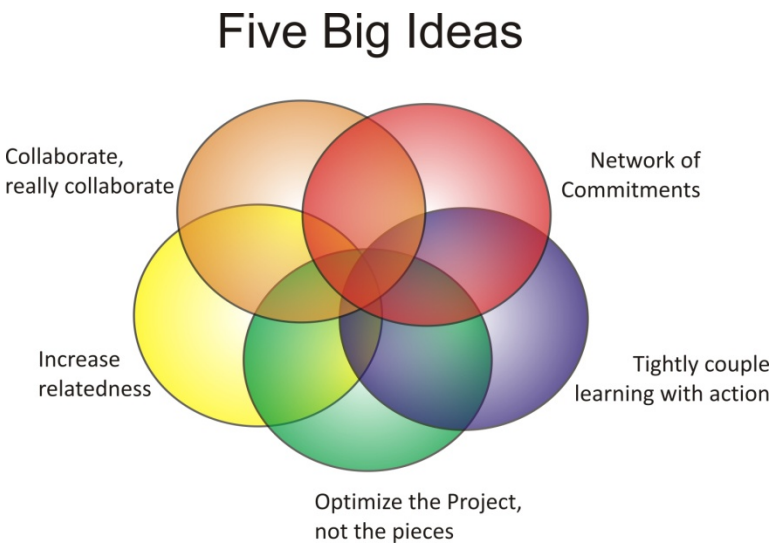
### 1.3.2 The Five Big Ideas

As lean ideas were being implemented in design and construction, a set of foundational principles—the Five Big Ideas—were distilled by a group of national leaders in construction:

1. Collaborate; really collaborate, throughout design, planning, and execution.

[1] Howell, Gregory, "What is Lean Construction?" Proceedings of the International Group for Lean Construction, Berkeley, CA, July 26-28, 1999, available at: http://www.leanconstruction.org/pdf/Howell.pdf.

2. Increase relatedness among all project participants.
3. Projects are networks of commitments.
4. Optimize the project not the pieces.
5. Tightly couple learning with action. [2]




To implement the "five big ideas," a project needs not only a contractual structure but also the commitment of the team participants to engage in the kinds of behavior that will make Integrated Project Delivery possible.

The intent of this chapter is to introduce and describe basic tenets of IPD, describe how those principles are being used on the Program and describe the procedures for implementing IPD/lean principles at each project site. Developed principles can be grouped in three broad categories:

- IPD Behaviors
- IPD and Lean Tools
- The Effects of IPD

### 1.3.3 IPD Behaviors

Integrated Project Delivery requires specific behaviors. These behaviors support a change in mindset from individual contracts to a collective project. Collaboration, trust, commitment-based management and continuous improvement are all behaviors required of each individual on an IPD project. But, as Howell and Ballard point out, it is "relatively easy to contract for the purchase of a thing and relatively difficult to contract for behavior."[3] When required "behaviors" are seen as the tools used to drive value to the project and drive waste out, they become more business strategies than social engineering.

These behaviors are valuable because they lead to the collaboration and communication that is necessary to make a project successful.

> Lean [IPD] supports the development of team work and a willingness to shift burdens along supply chains. Partnering relationships coupled with lean thinking make rapid

[2] http://www.leanconstruction.org/files/I2LD_Proceedings/3%20Big%20Opportunities%20of%20Lean%20Construction%20-%20Dean%20Reed/Five%20Big%20Ideas%20of%20Lean%20Construction.pdf.

[3] Howell, Greg and Ballard, Glenn, "Lean Production Theory: Moving Beyond 'Can Do,'" pages 17-23 in Alarcon, L. (ed.) (1997). *Lean Construction*. A.A. Balkema, Rotterdam, The Netherlands, 497 pp; http://www.leanconstruction.org/pdf/beyond-can-do.pdf.

> implementation possible. Where Partnering is about building trust, lean is about building reliability. Trust is the human attitude that arises in conditions of reliability. We are not likely to trust one another very long if we do not demonstrate reliability. Reliability is the result of the way systems are designed. Of course people manage systems and in current terms they do a fine job. The problem is that production systems just do not work well when every person tries to optimize their performance without understanding how their actions affect the larger web.[4]

IPD requires people to focus on system performance, not just siloed performance. Project reliability is created by people making and keeping commitments to get work done; "lean" views a project as a network of commitments, the fulfillment of each making the follow-on performance possible.[5] Finally, people and systems are not infallible. Outcomes will not always match expectations. Hence, the team must be structured to learn rapidly from variance between expected and actual outcomes.

Critical behaviors necessary for IPD to be successful include:

- Collaboration
- Trust
- Commitment-Based Management
- Continuous Improvement

#### 1.3.3.1 Collaboration

Given the shift in mindset from "silo" to "system," lean requires collaboration between all the parties involved with a project. This includes the owner, program manager, the design team, the contractor, trade partners and operational personnel. Collaboration includes freely sharing information (including real-time budgeting and scheduling concerns) with others and learning from the talents, experiences and performance of others. Real collaboration cannot happen without trust amongst the team members.

#### 1.3.3.2 Trust

Trust, both organizational and individual, is required for Integrated Project Delivery. Trust must be a common thread running through the entire program and will provide the foundation for collaboration. Trust is essentially a decision each person on the project makes every day to trust the other participants:

> To trust people is to count on their sense of responsibility (or perhaps their sense of integrity), believing that they will choose to act in a trustworthy manner, while recognizing the possibility that they may choose to betray the trust.[6]

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[4] *Constructech* Magazine, Vol. 12, No. 5, May, 2009.

[5] Work done by Ballard and Howell indicates that commitment-based work flow delivers a 30% increase in the fulfillment of promises as agreed, as compared to typical projects. Ballard, Glenn and Howell, Gregory "Implementing Lean Construction: Stabilizing Work Flow," http://www.leanconstruction.org/pdf/stabilizingworkflow.pdf

[6] Robert Solomon and Fernando Flores, BUILDING TRUST IN BUSINESS, POLITICS, RELATIONSHIPS AND LIFE, Oxford Press, 2001, pg. 24.

Since each participant is asked to focus on project goals and continuous flow of the project, each must be empowered by his/her company to interweave the short term goals of the company with the long term goals of the project.

Trust is realized through fulfilling commitments. Commitments form the basis of communication between team members. Team members must request clear and realistic commitments, keep their own commitments and timely notify team members if a commitment cannot be met. An IPD project becomes a network of commitments that depends upon all participants keeping their commitments (i.e., being trustworthy and reliable). Because policing of individual activities wastes time and effort, team members must rely upon others to honor commitments or to immediately notify the team when confidence is lost in the ability to deliver as promised.

#### 1.3.3.3 Commitment-Based Management

As stated above, requests and commitments between team members are the basis of communication within Lean Project Delivery. Simply stated, one party makes a request and another commits to fulfilling that request according to mutually agreed upon conditions of satisfaction (i.e., both parties clearly understand what satisfaction of the request actually means). Commitments are tracked from request to completion in order to promote transparency and to allow the team to collectively learn from breakdowns.

#### 1.3.3.4 Continuous Improvement

The "Plan-Do-Check-Act/Adjust" (PDCA) cycle is at the heart of lean problem analysis, resolution and continuous improvement. PDCA starts with examining an existing process, condition or standard procedure and then refining and improving it to create a new standard. PDCA consists of four stages, including:


1. **Plan** – Investigate the cause of a troublesome condition and create a proposal for its modification or resolution.
2. **Do** – Perform a test implementation of the plan.
3. **Check** – Assess the results of the test for effectiveness.
4. **Act/Adjust:**
   - If the results are satisfactory, modify the original condition or define a new standard procedure.
   - If the results are not satisfactory, refine the plan and repeat the cycle until satisfactory results are achieved.
   - The new improvement becomes the standard, when the process may begin again to attain the next improvement.

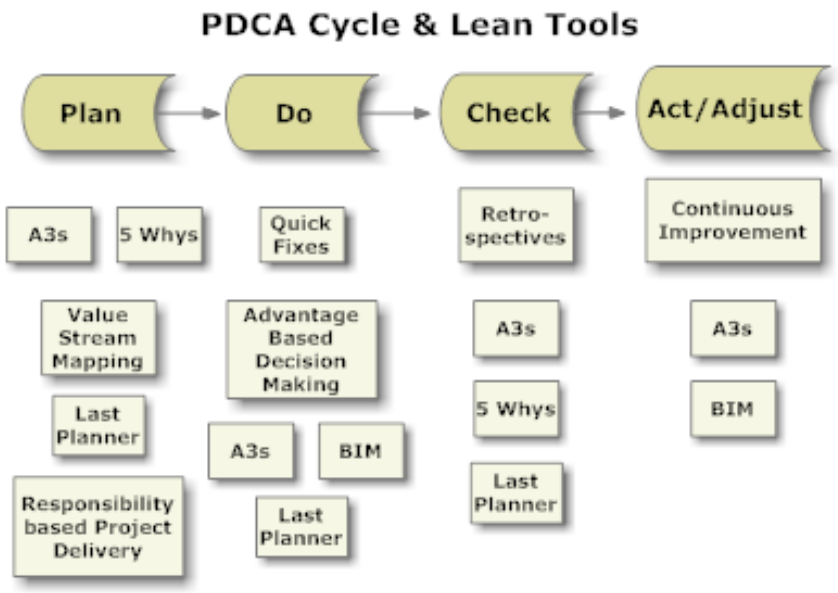
Part of Lean Project Delivery is collecting and sharing information on lessons learned throughout the life of the project. In lean terms, this is described as *continuous learning*.

Continuous learning adds value to the owner as it affects every area of program development and implementation including site selection, prototype design, procurement decisions, fiscal reporting, safety and quality issues, project delivery methods, materials choices, vendor offerings, and operational efficiencies. The idea here is to reflect regularly on circumstances as they develop and to rapidly implement improvement ideas.

Integrated Project Delivery includes the documentation of lessons learned, so that all team members have access to and can share information. Numerous tools are used to document lessons learned. Examples include the use of technology, such as Building Information Modeling (BIM) and cost modeling to continuously capture design choices and update budgets. A3s, a tool used in lean to analyze and document issues, also become a valuable library of information for all team members. Social networking software ensures informal knowledge management between team members.

### 1.3.4 IPD and Lean Tools

Lean projects have adapted tools used by Toyota and other lean practitioners in improving value and minimizing waste through design and production. Tools are only used in lean where they drive value to the project. The use of "mantras" or "slogans" is not lean in itself, and tools improperly used create waste, not value. Thus, lean tools are efficiency tools used to enhance decision making by ensuring transparency and thoroughness. Each tool relates to one or more of the PDCA cycles as indicated in the graphic to the right. Each of these tools is described more fully below:




#### 1.3.4.1 A3 Reports

An A3 report is a way of organizing and analyzing issues that requires the team to implement the discipline of the scientific method represented by the PDCA cycle. This system rigorously distills the background, the problem, the current state, the future desired state and the proposed counter-measures to get to the future state all on a single, 11" by 17" piece of paper. John Shook, the best known "A3" guru has explained the process as follows: ". . . an A3 document structures effective and efficient dialogue that fosters understanding followed by the opportunity for deep agreement. It's a tool that engenders

communication and dialogue in a manner that leads to good decisions, where the proposed countermeasures have a better chance of being effective because they are based on facts and data gathered at the place where the work is performed, from the people who perform it." [7]

#### 1.3.4.2 5-Whys

The 5-Why process is a method of asking enough questions to find the root cause or defect in a system. It is based on the scientific method and in that way resembles the PDCA cycle. By asking "why" a problem exists at least five times often drives the investigator to the real answer. The "real answer" is important so that appropriate countermeasures can be adopted to resolve the issue. However, applying a "rote" 5-why analysis is susceptible to criticism in that people tend to stop at symptoms of the problem rather than delve deeper to the root cause. Moreover, investigators are limited by their current knowledge and often will not find causes that they do not already know about or cannot imagine exist. Finally, the tendency to "isolate a single root cause" may not be appropriate where each question "could elicit many different root causes." Like all lean tools, "5-Whys" is a means to an end, not the end in itself.

#### 1.3.4.3 Value Stream Mapping

Value Stream Mapping is an important tool that analyzes business processes step by step. The "current" state of the process is mapped graphically. Then the participants in that business process eliminate those steps that do not add value to the process (e.g. redundant reviews, additional paper copies, waiting for multiple approvals). VSM not only streamlines processes but also offers tangible benefits in reducing square footage and redundant resources in facilities that house those processes.

#### 1.3.4.4 Planning Systems

Lean Project Delivery presupposes that reliable workflow is based upon commitments being kept. In turn, commitments must be planned and re-planned as events inevitably unfold in ways that are different than the plan. A planning system is a system or process that defines how one will plan. The Program uses Responsibility-based Project Delivery in design. It is a flexible process particularly appropriate for iterative practices. The Program also uses The Last Planner System (LPS), which organizes production processes. LPS presupposes that the person handing off the work is responsible for its completion and its readiness as it transitions to the next skilled craftsman (he/she is thus, the "last planner" before work is taken by the next trade partner). Both systems are described in more depth later in this Guide. (See section 3.3.1.2, page 19)

[7] From John Shook (2008) *Managing to Learn*, The Lean Enterprise Institute, Inc, Cambridge MA p. 107; http://www.lean.org/workshops/WorkshopDescription.cfm?WorkshopId=34

#### 1.3.4.5 Quick Fixes

Team members are encouraged to constantly look for better ways of doing their work.[8] They are empowered by management to make the necessary changes and are encouraged through incentives to implement these quick fixes and report their results to their co-workers and the SLE as part of continuous learning.

#### 1.3.4.6 Advantage Based Decision Making

Advantage based decision making is a process used to isolate advantages and select superior alternatives. The process is recorded for future reference so that a record is developed supporting important decisions. The best known advantage based decision making system is *Choosing by Advantages* ("CBA"), a system that assumes that choices are made based only on the importance of advantages, rather than a calculation of the differences between advantages and disadvantages. CBA recognizes that no decisions are truly objective. Its goal is to establish and record the considerations that lead to important decisions. Graphic records of CBA sessions are maintained as part of the Project Record.

#### 1.3.4.7 BIM & Real-time Estimating

Building Information Modeling (BIM) is an assemblage of software programs that coordinate design and estimation on the Program. Architectural drawing and rendering software coordinates in 3D and 4D to assist planners, designers and contractors to determine inconsistencies and "clashes" in design. It also ensures that changes in a plan change all of the related items in other plans and budgets. This enables the Team to avoid rework and allows real-time estimating as changes to the plans and design occur. (See BIM discussion at section 3.1.5.1 page 97)

#### 1.3.4.8 Retrospectives

Retrospectives are organized, regularly scheduled, facilitated sessions that provide team members the opportunity to identify what works and what does not. The retrospective format ensures that all responsible viewpoints are aired and recorded. Retrospectives proactively focus on developing new approaches to identified problems. Periodically, team members take time to evaluate past activities and identify successes and areas for improvement.

#### 1.3.4.9 Continuous Improvement

Continuous improvement is a philosophy for taking advantage of the lessons learned from planning, design and construction and communicating and preserving the countermeasures devised over time. It creates an institutional value in constantly re-evaluating all systems to see how they can be improved. Many believe continuous improvement is "at the heart of the 'Lean Philosophy.'"[9]

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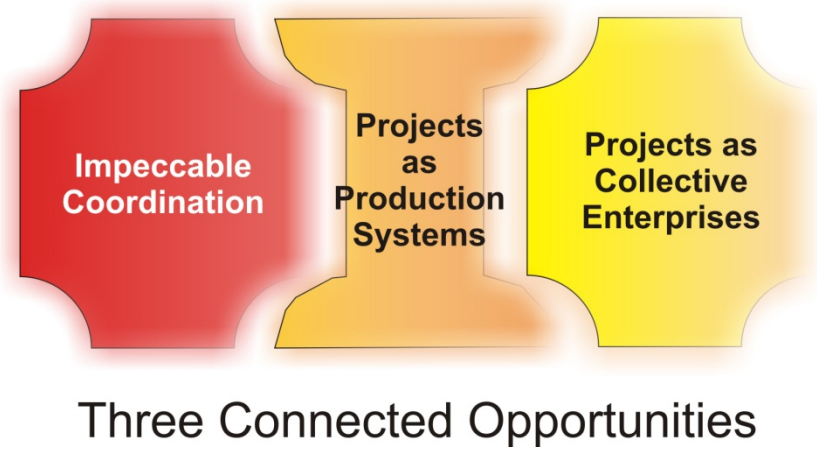
[8] Toyota uses a process called *Kaizen*-- the Japanese word for continuous improvement.

[9] Sepani Senaratne and Duleesha Wijesiri, "Lean Construction as a Strategic Option: Testing its Suitability and Acceptability in Sri Lanka," , LEAN CONSTRUCTION JOURNAL, 2008, pg. 38 (http://www.leanconstruction.org/lcj/2008/LCJ_07_006.pdf)

## 1.4 The Business Case for Integrated Project Delivery

A purpose of this Guide is to instruct on-site workers and trade partners in how the Program is to be delivered. Because lean construction principles and Integrated Project Delivery processes are relatively new to the construction trade, it is important to understand that there are more than contractual reasons for implementing these principles.

Traditionally, projects have been delivered by separate groups of companies held together by a series of contracts. The interest of each company was in fulfilling its distinct contractual obligations and earning as much money as it could within the confines of its discrete contract. The emphasis has been on the self-interested completion of dozens of distinct and separate tasks without any eye towards overall project quality, cost or safety. Waste, cost overruns, death and injury on such jobs is relatively predictable.




The Integrated Project Delivery model changes the focus of the discrete teams. It creates a single team from the planning stages of the contract that carries on through design, construction and activation. It provides for three connected opportunities on projects. First, it allows all members of the project team (owner, designer, constructor and trade partners) the opportunity for impeccable coordination of the work between them. Second, it views projects not as discrete tasks to be accomplished, but rather as a large production system that can be as efficient and predictable as a manufacturing assembly line. Finally, it gives the parties the opportunity to view the project as a collective enterprise, one in which they all have a stake.

IPD makes projects more predictable and hence safer. It uses cost up-front as design criterion rather than as support for a back-end claim. It drives efficiency into the process, thus increasing value to the owner and driving out wasteful redundancy (rework, trade damage, etc.). It improves quality by making each trade responsible for assuring that the work of the trade that came before it meets the Project's quality standards. All project participants have a joint financial interest in assuring that the project is delivered on time, on or under budget and without claims. Those are the promises of lean and IPD, but how do these principles work to make that happen?

Lean construction seeks to eliminate non value-adding activities, promote "flow" and make "conversion" activities more efficient.[10] "Flow" is "the movement of materials and information through networks of interdependent specialists . . .," exactly what happens on construction

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[10] Senaratne, supra fn 11.

projects. "Conversion" activities are the many different transformations that occur on projects: framing converted to drywall, etc. Lean construction concentrates on flow control—to "prevent work waiting on workers and to prevent workers waiting on work" [11] —rather than conversion control. It adapts the concept of continuous improvement to constantly improve these flows.

Concurrent design of the project and the process means that the design of "what" is to be built reflects deep consideration and optimization of "how" it will be built. Thus, lean design incorporates work structuring, strategic sourcing, materials procurement and flow, built-in quality and safety as design elements. Finally, production control through the Last Planner System and lessons learned will continually inform project delivery so no "conversion" is lost or missing but so that every failure in "conversion" is immediately fixed by adjusting the flow on the project.

Planning and the promising of what work will be completed is done every day, at the work place through the Last Planner System. Commitments that cannot be met mean that the team meets to adjust the plan and the subsequent hand-offs of the work. The master schedule is not adjusted in the traditional way of adding six days to the end date when six days are lost in any one "conversion." Rather, schedule items are de-coupled and the work re-planned in ways to maximize flow across the project.

Project participants must understand how and why these processes work and be skilled in making them happen. Mentorship and training of new trade partners and new hires is addressed at the site and on the Program. But the essential responsibility to participate in these processes—to make the project a success and thereby ensure the success of all participants—lies with each individual on the Project. The network of commitments starts and ends with the performance of the thousands of every day promises made by people on the Project.

### 1.4.1 Target Value Design

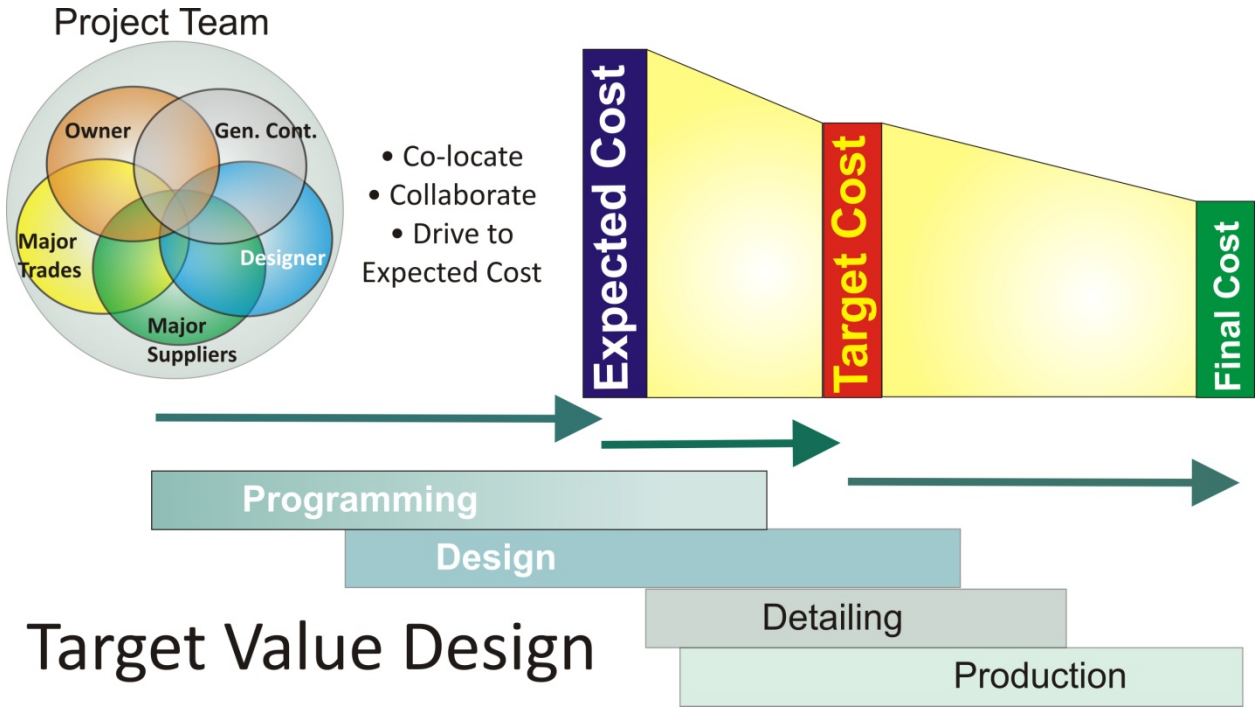
One of the most important processes in the Program's design is the use of budget as a design criterion. That process is implemented through Target Value Design (TVD), a collaborative design process involving designers, builders, suppliers, estimators, and owners co-located in one place to collaboratively produce a design that provides the best value for the owner. The team designs to the budget instead of the conventional process of estimating the cost of the design, and then re-designing to eliminate overruns.

Once the expected cost is validated, a target cost is set to create a sense of necessity in driving further costs out of the project through a Target Value Design process. According to Paul Reiser, one of the industry leaders in implementing TVD, the TVD process evolves through four phases with four different goals:

[11] Ballard and Howell, "Competing Construction Management Paradigms," LEAN CONSTRUCTION JOURNAL 2004, pg. 38, http://www.leanconstruction.org/lcj/LCJ_04_0008.pdf.

| Phase | Goal |
|---|---|
| 1. Planning/Programming | Right size, right fit |
| 2. Design | Optimizing systems |
| 3. Detailing | Optimizing parts |
| 4. Production Planning | Optimizing work flow, productivity and pre-fabrication |

Research has shown that the Target Value Cost is often as much as 19% below market (expected) costs.[12] Incentives continue to play a role in project delivery where teams are often able to drive additional costs (up to 10%) out of the overall project cost.




Further details on Target Value Design are provided in the Project Delivery Planning section.

Lean/IPD is not just a "new" and "improved" project delivery method. It is a valuable process for maximizing value to all participants on the project while simultaneously eliminating waste. Given the current state of the California State Budget, it is a process that is necessary and timely.

[12] Glenn Ballard, *Update on Target Value Design*, Lean Design Forum, St. Louis, Mo., 2009.