

# Integrated Project Delivery: An Overview

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# Table of Contents

Some history .....	6
Alliancing .....	7
IPD .....	8
Integrated Agreements .....	9
Legal relationships among the core team .....	9
Incentives and Goals .....	10
Contingencies .....	11
Profit .....	11
Bonuses .....	11
Constraining litigation .....	12
Not Kumbaya .....	13
Integrated Leadership .....	13
Transparency and Owner engagement .....	13
Management committees .....	14
Types of Committees .....	14
Staff to staff, brass to brass, .....	15
Collaborative selection .....	16
Integrated Information .....	16
BIM .....	16
Reports .....	16
4D and 5D models .....	17
Clash detection .....	17
Plug-ins .....	17
Direct fabrication control .....	17
PMIS .....	17
Components of a PMIS .....	17
Values of a PMIS .....	18
Integrated Processes .....	18
Learning from industrial processes .....	18
Lean construction .....	19
Last Planner™ .....	19
Flow and batch processing .....	20
Commitment-based planning .....	20
The last responsible moment .....	21
Set-based design .....	21
Target Value Design .....	21
Value Stream Mapping .....	22
Plan-do-check-adjust (PDCA) .....	22
A3 Reports .....	22
The big room .....	23
Retrospectives .....	23
Lean behaviors .....	23
Design Assist .....	23
Agility .....	24
Continuous improvement .....	25
Problems with IPD .....	25
A philosophical view of IPD .....	27
When to use IPD .....	28

# FOREWORD

In 2007, the CMAA College of Fellows encouraged the development of a White Paper describing Integrated Project Delivery. We posted *Managing Integrated Project Delivery* on the CMAA website in the fall of 2008.

Subsequently, Joel W. Darrington, Dennis D. Dunne and William A. Lichtig offered edits to that paper and contributed a new chapter entitled “*Organization, Operating System and Commercial Terms.*” We exchanged criticisms and in 2009 I rewrote the rest of the paper, available at [www.cmaanet.org/fellows](http://www.cmaanet.org/fellows) and at [www.charlesthomsen.com](http://www.charlesthomsen.com).

The paper, *Managing Integrated Project Delivery*, runs 108 pages. While it is full of good information, several of the fellows suggested that an additional, shorter paper would be useful. Here it is. It owes much to the previous paper and comments by Joel.

Nevertheless, this is not a summary. The longer version contains additional topics and material not included on the following pages, and this version contains material not in the longer paper. If you find this introduction interesting, you will enjoy the other paper.

In the process of writing these papers, several people provided valuable criticism and contributions. They include Ron and Jon Antevy; Howard Ashcraft, Esq.; Mark R. Berry; Dave Chambers, Kevin A. Delorey, Esq.; George Heery, FAIA, FCMAA; John M. McGinty, FAIA; Don Russell, FCMAA; Carl Sapers, Esq., Hon. AIA; Scott Simpson, FAIA and Bob Wilson, FCMAA;



The 2009 paper includes a thought worth repeating. Leading professionals have fresh and original ideas, believe in them passionately, market them rigorously—and often disagree with equally knowledgeable colleagues. All of us have individual philosophies of how the world of design and construction should work. Our views are shaped by our unique experiences in a vast, diversified industry and our individual perceptions of organizational and individual behavior. It is unlikely that any of the individuals in the College of Fellows would agree with everything that follows in this paper. Indeed, the authors and contributors of the original paper would not always agree with one another.

Diverse thinking contributes to progress. The absence of disagreement is not harmony; it's apathy. The College celebrates debate. And so, while this paper is an initiative of the College, it's not a policy. It's not a manifesto.

New ideas provide enlightened firms with competitive edge. But there's a tendency for true believers to surface, coin new terms, evangelize a concept, market it vigorously and declare what does and does not qualify as the new ideology. Eventually, the practice ossifies and loses the ability to adapt to change.

We will avoid that. CMAA and the College of Fellows have deliberately avoided a position on IPD as a specific contract form or a defined project delivery strategy. Rather, our mission is to provide our members with insight and understanding they can build on and continue our tradition of innovation in the construction industry.

From these innovations, you may choose what is best for the unique needs of your Owners and your project teams—carefully.

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# INTEGRATED PROJECT DELIVERY

*Integrated Project Delivery is a response to the extensive collaboration required for complex 21<sup>st</sup> century projects that must be influenced by tiers of people in multiple organizations. Since it's new, there is a tendency to adjust the approach with each new project. But in general, it works like this: The key firms selected for the project form a core team that includes the Owner, the AE, the CM and it may include other key consultants or builders. They typically sign a single, multi-party contract with the Owner and form one or more management committees. The core team establishes a set of project goals—cost, time and quality. They may add other conditions such as the use of minority firms, community relations and safety. Profits and bonuses may be shared by the core team and may be earned based on the achievement of the project goals. Typically, there is emphasis placed on Lean construction, BIM, PMIS and continuous improvement. IPD is a powerful concept but makes most sense when a high degree of collaboration is wanted, when the project's importance will capture the attention of the prime firms' leaders and when the Owner is a capable leader of project delivery processes.*



## Some history

In the middle of the 20<sup>th</sup> century, the conventional wisdom was that contract language, tight controls and the punitive consequences of non-performance would produce the right results with contractors.

But legal action ricochets. When a client sues a contractor for a mistake, the defense is to identify the client's mistakes or blame it on the AE. By the time the project is done, everyone has made mistakes. So one lawsuit clones itself and propagates through the extended project team like a computer virus.

By the 1980s, professional liability insurance cost was half of the average AE's profit. Few large projects finished without claims—often morphing into lawsuits. The design-bid-build process was sarcastically renamed “design-bid-build-litigate.” The industry, Owners, AEs and CMs begin to realize that a singular focus on punitive contractual requirements delivers the unintended consequence of increasing everybody's liability.

Furthermore, the pain of litigation was usually greater than the pleasure of winning. Legal processes are long, complex and expensive. So warring parties settle most conflicts by mediation, arbitration or on the courthouse steps. Inevitably, the compromise satisfies no one.

Undeterred, some relentless Owners added more pages to their contracts and more consultants for checks and balances to their project teams. But other, more creative industry pundits began to speak of ways to *avoid* conflict. Rather than concentrating on retribution, they argued that aligned self-interest and shared project goals would produce collaborative relationships and a project culture of mutual support. That would improve results.

Many Owners recognized the importance of processes that focus on interpersonal relationships and the human aspects of design and construction recognizing that the sociology is as important as the technology. They looked for ways to enhance performance through collaboration. This shift in attitude took many forms. The Association of General Contractors, and the US Corps of Engineers espoused Partnering. One statistic from the Corps of Engineers was a 50% drop in claims after they started Partnering. Meanwhile, a national movement to quality in manufacturing called Total Quality Management (TQM) had collaboration as one of its shibboleths.

*Some Owners began to treat contractors as professionals*

But to collaborate, the participants have to be at the table. With the traditional process, the builders weren't selected until design was complete. The private sector realized the need for construction input

during design and increased its use of negotiated contracts. Then the public sector turned more often to best value, and qualification-based selection began to replace hard-bid, low-price procedures for awarding contracts. Construction Management, in its many forms, sprouted and blossomed.

Although Partnering and TQM were non-contractual, they helped some. Unfortunately, with traditional adversarial contracts, commitments often waned soon after the Partnering session. The lack of contractual mechanisms to support Partnering often left it ineffectual in the face of a serious conflict. Each ship still rode on its own bottom, and many project players held the belief that there would inevitably be some winners and some losers.

IPD adds contract concepts to support collaboration. There are stipulations that make it more likely that firms will win or lose together.

## Alliancing

The roots of IPD are in the energy industry. In 1990, British Petroleum was struggling with the high cost of building an offshore drilling platform in the Andrew field—a relatively small reservoir in the North Sea lying some 230 km northeast of Aberdeen. It appeared commercially unattractive. The initiative to develop the reservoir had been started and stopped for 16 years.<sup>1</sup>

A BP in-house team became intent on building a collaborative organization from disciplines and contractors that were traditionally adversarial. They formed an integrated group that combined engineering, subsurface and commercial interests. They called it Alliancing and were spectacularly successful. The team drove down the cost from the initial estimate of £450 million to £290 million and finished six months ahead of schedule. In 1997, the UK construction industry presented the project with two awards: “Major Project of the Year” in the Quality in Construction category and “Project of the Year” as the overall winner across all industry sectors.

Despite the success of the BP Andrew field project, Alliancing didn’t become common in the energy industry. Many contractors wanted simple lump-sum contracts that had a chance for larger profits and didn’t need the top management attention required by Alliancing. Investors that financed projects wanted fixed prices. Many Owners

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<sup>1</sup> The project is described in *No business as usual: An extraordinary North Sea result*, copyright 1996 Terry Knott. Published by British Petroleum Company P.L.C. Britannic House, 1 Finsbury Circus London EC2M 7BA United Kingdom.

were skeptical of the benefits of the collaborative approach and felt that Alliancing increased their risk.

The process migrated from the North Sea to Australia. Again, the first projects were in the oil and gas industry. The Wandoo Oil Field Project, a Western Australia offshore project, began in 1994. It was delivered \$13 million under the target budget of \$377 million and in 26.5 months against an industry norm of 34 months.

Then Alliancing migrated to public infrastructure projects and public buildings. The first building project we found that used Alliancing was the National Museum of Australia. Parliament allocated \$155 million for the project. Perhaps, with the agonizing memory of the Sidney Opera House cost overruns still lingering in their psyche, they said: *“Don’t come back. Spend it all if you need to, but don’t ask for more.”*

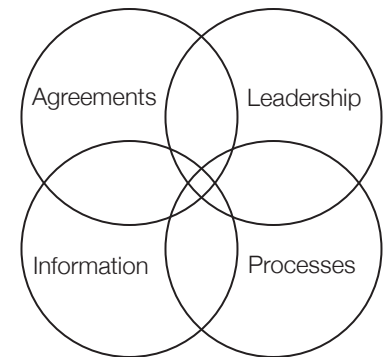
The Alliancing team delivered a high-quality building on time and in budget. Andy Anway (president of Amaze Design, Inc., in Boston, Massachusetts) was the exhibit designer on the museum project. When we talked to him, his comment was in the form of a question: “Have you ever worked on a project where everything seemed to click?”

The National Museum of Australia was funded by the Australian Commonwealth Government as a flagship project to opening the Centenary of Australian Federation celebrations. It was finished within the budget and completed a day before the opening. The project won many awards. You can see photos and read more at [http://www.nma.gov.au/about\\_us/the\\_building/](http://www.nma.gov.au/about_us/the_building/).

*Alliancing produced results on the National Museum of Australia.*

## IPD

Those who have used IPD repeatedly have, true to the spirit of continuous improvement, consistently modified their arrangements. Most IPD projects have had an individual approach, customized by the team, building on previous experiences. There’s no common definition. However, there are common themes. IPD projects typically “integrate” at least four areas of practice.



Although there is considerable variation, IPD projects usually integrate four things.

1. **Agreements:** Usually an IPD project is implemented with a multi-party contract that stipulates the duties core team members owe to one another. Typically, there are shared incentives for the entire team that may include some or all of the profits and contingencies and may include bonuses for meeting or exceeding defined goals. Operations and financial transactions will be transparent. Litigation is constrained by conflict resolution procedures or sharply curtailed by non-sue clauses.

2. **Leadership:** Leaders will be expected to create a project culture that emphasizes openness, trust, mutual respect and collaborative decision-making. Governance strategies will include management committees with the Owner as an essential member of the core team. Key participants who have significant effect on the outcome will be involved early.<sup>2</sup>
3. **Information** There is usually an emphasis on BIM, PMIS and other web-based collaboration tools to support collaboration. The team will have input and access rights to these databases to review and share information.
4. **Processes:** Most IPD projects set ambitious objectives for improvement over traditional project delivery processes. There will be multi-day, multi-company workshops or team co-location. They will embrace innovation, set “stretch” goals and adapt execution processes from theories such as Lean, Agile, Design Assist, Target Value Design and Continuous Improvement

## Integrated Agreements

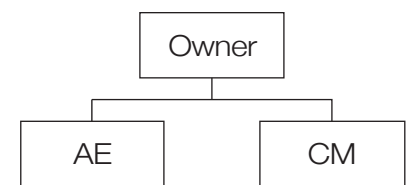
A mantra of IPD is to remove contractual silos. The objective is to align a multi-company, ad hoc project team to operate more like a single company.

### Legal relationships among the core team

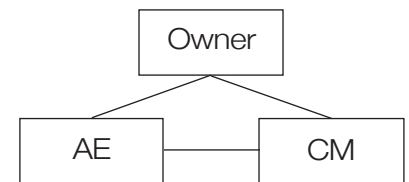
Traditionally, an Owner deconstructs the responsibilities for delivering a building and has independent contracts with the designers and builders. While their work is highly interdependent, their contractual responsibility is to the Owner, not to one another. These silo-like contracts inevitably produce a degree of conflicting incentives and self-interests that hinders collaboration.

IPD projects often have one multi-signature contract for the members of the core team<sup>3</sup> who have stipulated duties to one another as well as to the Owner.

Although it is hard to contract for behavior, these multi-signature agreements add language that is “relational” instead of merely “transactional.” They stipulate the duties team members have to one



With the usual project delivery processes, the designers and builders have separate contracts with the Owner, although they have many interdependent responsibilities to deliver a single project.



With IPD, the designers and builders often sign a single multi-signature agreement that defines mutual responsibilities.

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<sup>2</sup> They may be chosen with a procedure that adds each firm to the selection committee as it is selected, or an Owner may pick firms to assemble the competing teams, or in still other cases, Owners may leave it to firms to self-select.

<sup>3</sup> The core team includes those firms that have significant effect on the project’s outcome and lead other firms—usually the AE and CM. But the core team may include other key consultants or builders.

another that are rooted in their relationship, rather than merely stipulating the transactions expected in traditional contracts.

The legal terms and conditions are aligned and may include provisions for sharing bonuses, profits, incentives and contingencies to improve collaboration. The contract will include provisions for management committees and clauses to manage conflict and constrain litigation.

While a multi-party contract is a basic concept for IPD, a joint venture or an LLC may be used and many Owners are implementing “IPD-ish” concepts with Bridging, Design-Build, CM at Risk and other more traditional project delivery strategies. For instance, a public client may have regulations that prevent the use of a multi-signature contract. If so, a similar result may be achieved by stipulating the duties that each member of the core team owes to the others in each of the independent contracts and ensuring that the contracts are properly aligned with the same terms and conditions.

Some argue that the effective result is similar. Others disagree. They believe that these approaches are sub-optimal and less effective in creating integration. They advance a compelling argument that a single contract enhances a sense of partnership, improves the relational aspects of the agreements, increases the trust among the core team and reduces conflict.<sup>4</sup>

### **Incentives and Goals**

Some of the early Alliancing contracts stated that the mission of the core team is to deliver performance at the highest level that anyone on the team has experienced in the best project of their lives—not business as usual. That statement may be inspirational but contractually difficult to apply.

Such language is uncommon in recent IPD contracts. However, the contract usually defines clear project goals with metrics to measure their achievement. The goals may include the classic cost, schedule and quality, but other goals of safety, sustainability, small business participation, minority employment or community relations may be included. Some goals (often highly important goals) such as collaborative spirit or community relations may not be measurable. Consequently, some Owners will evaluate these matters subjectively.

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<sup>4</sup> The value of trust in a project is well stated in *“The Speed of Trust: The One Thing That Changes Everything”* by Stephen M.R. Covey, Stephen R. Covey, and Rebecca R. Merrill. “In a high-trust society there’s more for everyone. We have more options and opportunities. We interact with less friction, resulting in greater speed and lower cost.”

In traditional design-bid-build arrangements, an AE typically aspired to the best possible design (the “quality” goal), while a builder was often given an incentive to save money (the “cost” goal). Different incentives produced different values and different attitudes. With different goals, conflict is inevitable. IPD projects improve core team alignment by setting the same goals for all the core team members.

The Owner may choose to set financial incentives to motivate performance or highlight the importance of the goals. The incentives may include:

*Contingencies*

The core team may share a single contingency pool. That encourages each member of the team to help other members avoid problems. The core team may share the unused funds with the Owner.<sup>5</sup>

*Profit*

Some or all of the core team profits may be pooled. If the project goals are met, the core team shares the profit based on a predetermined rate. If not, a portion or all is forfeited. The British and the Australians named these “Gainshare” and “Painshare.”

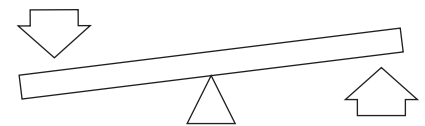
*Bonuses*

There may be bonuses for meeting or exceeding goals. While achievement of some goals can be objective, an Owner is well served by including subjective goals such as community relations, collaboration with users, sustainability or minority mentorship (the list is endless).



All projects have multiple goals. If there is an incentive for only one goal, it will unbalance motives. For instance, if there is only a bonus for saving money, the goals of schedule or quality may suffer.

There are variations on compensation terms. In some cases, each of the prime firms provides a GMP for its services so the project cannot (theoretically) exceed the budget. In other cases, the budget is set and there’s a “painshare-gainshare” formula. Everybody shares in the reward if there are savings, but if the project overruns the budget, everybody’s toes get singed and the team pays into the pool to cover the loss.



A single incentive, such as a shared savings clause, may unbalance performance. If a CM and an AE have different incentives, they will not pull together.

*If the project meets the goals, the core team shares profits.*

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<sup>5</sup> On a cost-reimbursable project, the contingency should also be available to pay for mistakes made by the core team. Inexperienced Owners will do a double take on this point—“Why should I pay for mistakes?” But if an AE negotiates a lump sum contract for services or if a GC bids a lump sum on a design-bid-build project, they will include a contingency within the lump sum for mistakes they know will occur. Such a clause is common because mistakes are common.

The contract stipulates the goals and the metrics for measuring achievement. The Owner or management committee (which includes the Owner) may adjust the goals or the metrics for measuring them as the project progresses.

Most public sector agencies can't use a shared incentive pool. However, they can have award fees and base them on the same set of criteria for each core team member. That will produce a similar result.

*There are lots of workshops.*

### **Constraining litigation**

In some of the early Alliancing projects, the core team members, including the Owner, agreed not to sue other members except for fraud, willful misconduct, willful default or gross negligence (all very hard to prove). Christopher Noble, Noble & Wickersham LLP in Cambridge, is a knowledgeable and nationally respected construction attorney. He helped negotiate the Alliancing contract for the National Museum of Australia and participated in conferences on the subject. When I asked him if this clause was enforceable, he responded, *"Who knows? But it sure encourages people to work out problems."*

However, that clause is less common in current IPD projects. Most Owners would not give up such a right. Furthermore, such a clause may not be enforceable. Joe Horlan, a construction lawyer and head of construction science at Texas A&M, commented that a judge would be unlikely to deny access to the courts.

However, litigation rarely makes sense. It's expensive: juries don't understand construction and courts are slow. What does make sense is establishing an efficient way to settle disputes.

A common approach is for the parties to agree to procedures to avoid disputes and litigation. They commit to notify each other openly of disputes, differences of opinion that affect the project execution or conflicts of interest. They promise to provide decision-makers to strive to a resolution in open discussion. And they agree to do it quickly.

If that doesn't work, they then have well-constructed dispute resolution processes. Such processes may start with fact-finding and a review by the operations or executive committee. From there, a dispute may go to a pre-appointed group of executives who represent the core team firms. The next steps may use a third-party neutral, mediation and/or arbitration. Litigation is a last resort.

## Not Kumbaya<sup>6</sup>

Most of the traditional project delivery processes are based on the assumption that an Owner is best off with checks and balances, adversarial relationships and the delegation of risk inherent in separate contracts for design, construction and management—assumptions embodied in design-bid-build.

The concepts of alignment, collaboration, shared incentives and shared profits appear to reverse that philosophy. Furthermore, some IPD projects have been cost-plus with only profit and bonus at risk for the project team. Consequently, some observers are concerned that IPD lacks accountability.

That's a misconception. Similar incentives or a culture where everyone understands that they are likely to succeed or fail together does not reduce accountability. Nothing in the IPD concept prevents clear responsibilities, assignment of risk or price guarantees. Shared rewards don't mean blurred responsibility. Indeed, they add peer pressure and mutual support to contractual obligations.

The more traditional idea was that a PM, an AE and a CM will keep each other honest and should stay at arm's length from one another.

## Integrated Leadership

### Transparency and Owner engagement

Leadership flows from the Owner who pays the bill, lives with the result and has the ultimate carrot—to pick firms for repeat work. Knowledgeable Owners are in the best position to rearrange the relationships and responsibilities of the participants. They can relax or change requirements to reallocate workflow across traditional contractual silos and adjust compensation. They can improve processes to reduce business risks and therefore reduce costs.

The Owner has the bully pulpit<sup>7</sup> and must use it. If that role isn't filled, the project suffers. An Owner who doesn't have the staff to lead a design and construction program should outsource the responsibility with a Program Management firm—not leave it vacant.

To lead, a leader must know what's going on. Contracts and operations must be transparent with healthy information systems. Without knowledgeable leadership that understands and maintains a

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<sup>6</sup> The song was originally associated with human and spiritual unity, closeness and compassion, and it still is, but more recently it is also cited or alluded to in satirical, sarcastic or even cynical ways that suggest blind or false moralizing, hypocrisy or naively optimistic views of the world and human nature. (From Wikipedia)

<sup>7</sup> A “bully pulpit” is a position of respected authority. Teddy Roosevelt coined the term and used the word “bully” to mean “good” as in “That's bully!” He was not using “bully” in the sense of a “schoolyard bully.”

culture of collaboration, any new process is apt to fail; the team members will run to their corners and will default to old attitudes and traditional roles.

IPD leadership is not reactive management that monitors and reports, but leadership that understands the sequence of decision-making and passes the baton to the right person at the right time. It's leadership that understands the different work ethics and value judgments that have traditionally caused conflict between designers and builders. And it's leadership that understands how to leverage the talents of each.

IPD leadership understands the sequence of decision-making and passes the baton to the right person at the right time.

IPD projects are more responsive to leadership and control than traditional approaches. The IPD objective is collaborative and open relationships among the core team. Furthermore, many participants, including subcontractors and manufacturers, are brought on board early to participate in design. Since their scope of work is not fully known, there must be flexible agreements that may adjusted as the project progresses and the scope is finalized. And so, it is easier to deliberate, decide and adjust. It's easier to make changes. Indeed, many IPD concepts were developed by health care institutions or research facilities (extreme examples of Owners who make changes during design and construction).

Ironically, because they are responsive to leadership, they are more susceptible to failure without it. It's like flying a jet plane instead of a Piper Cub. It can get there faster but without skill it will crash and burn.

### **Management committees**

The core team forms management committees to administer current activities, solve problems, plan the work and anticipate future challenges. The management committee includes the Owner and top executives from each of the prime firms.

#### *Types of Committees*

There may be multiple committees.

- An Executive Committee or Senior Management Team (SMT) may deal with global matters such as project delivery strategy, reallocation of team resources, changes in direction or major problems. They might function as the “court of last resort” for strategic decisions or conflicts.
- An Operations Committee or Project Management Team (PMT) may deal with day-to-day design coordination, a master milestone

schedule, the budget, requirements compliance and quality control, minor change orders.

- The Field Coordination Committee or the Project Implementation Team (PIT) adds Construction Superintendents and Project Managers for the currently active subcontractors to manage short-interval “pull” schedules, submittals and RFIs.

In some IPD projects, the Owner reimburses each firm at cost. The firms may work within a guaranteed maximum. The management committee may adjust the distribution of work within the guaranteed maximum. Everybody’s feet are held to one fire. A single pool of money finances the entire project and is divided into categories for costs, profits and bonuses for the prime firms.

Some Owners have taken this concept further and work to an “EMC” (estimated maximum cost). They argue that the EMC concept increases transparency and collaboration. And because the core team no longer has a guarantee, the Owner no longer bears the cost for a hidden contingency inherent in that guarantee.<sup>8</sup> It is a useful concept for a hands-on Owner with full confidence that as a member of the team he or she has adequate control to manage the cost.

*Staff to staff, brass to brass*

An important function of the management committee is to head off conflicts. In traditional arrangements, when a problem occurs the project staff, driven by job security and human nature, see the problem as the fault of the other organization. They explain their view to middle management. Opposing stories escalate in both organizations and polarize management. Soon the leaders, provoked by biased points of view, are angry at each other.

An IPD project typically engages organizations at multiple levels. If there is a problem at the operating level, middle management gets together to hear both sides of the story and, if necessary, escalates it to the top levels of the organization. If the management committees don’t include the company leaders who are empowered to make decisions, IPD will stumble. Some companies, particularly larger companies eschew projects that require participation from the brass. If they don’t fully delegate authority to their project team, they may not be right for an IPD project. Conversely, many large companies

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<sup>8</sup> Although the core team does not guarantee a maximum cost, the profits, contingencies and bonuses may still be at stake for meeting cost, schedule and other goals.

avoid IPD projects because they require top management participation.

### **Collaborative selection**

IPD selection processes usually begin traditionally. Unless the Owner has continuing relationships, the Owner invites organizations to present their qualifications, shortlists a small group and then holds interviews.

Tradition may end there. Usually the interviews are not the typical wooden, PowerPoint show-and-tell followed by superficial Q&A—where showmanship wins. It's more like a workshop. The firm(s) under consideration may present qualifications for a few minutes, but the rest of the time is spent without props. Discussion turns to the project and how to do it. Among other items of discussion, the firms are asked to evaluate the program and the initial plans. An objective is to use the process to evaluate a firm's inclination to collaborate in innovative processes.

Unless the teams are previously assembled it's common to involve core members in subsequent selections. Whoever is selected first, the AE or the CM, its representative participates in the selection of the other. Then both participate in selecting key subconsultants and subcontractors.

*Team selection is sequential—with each selected team joining the selection committee.*

Public Owners may not be able to include people who are not government employees as voting members of a selection committee, but they can have them sit in on the process and offer opinions. In a collaborative environment that produces the same result.

## **Integrated Information**

Databases that share information among the extended project team describe the project (BIM) and the process (PMIS). They provide a common understanding of the facts: a prerequisite for collaboration. Both are centralized stores of integrated information that serve the project team. Both allow the team to work with the same body of information.

### **BIM**

Currently BIM systems may include the following:

#### *Reports*

BIM is a database. Like any digital database, a BIM model can produce reports—subsets of information in the form of 2D or 3D drawings or a variety of custom alphanumeric reports. The BIM

A BIM model is a database.

model may include the physical configuration, program requirements, functional characteristics, specifications, systems performance, supply chain threads, construction sequence, cost or any other information that might be useful.

*4D and 5D models*

A BIM database can have sequence and duration information (4D) and can animate construction progression (5D). A user can input a date to observe the projected state of completion. Cost can be attached to drawing elements for estimating and value engineering.

BIM can include estimating and scheduling capabilities.

*Clash detection*

Conflicts are often caused when a building system designed by one consultant interferes with a system designed by another. BIM software can reveal the conflict.

BIM software provides sophisticated clash detection routines that indicate where two systems or products occupy the same space.

*Plug-ins*

Software may be “plugged in” with specialized programs to adjust the design if a change is made. For instance, if the building is rotated on the site, the heat gain and loss may be recalculated.

*Direct fabrication control*

A BIM model may include algorithms for CNC<sup>9</sup> direct fabrication of building systems, such as ductwork, curtain wall or millwork.

BIM models can drive fabrication machinery.



Currently, as members of the project team contribute to an integrated BIM model there are concerns about tracking responsibility: who is responsible for what? As these concerns are solved and as the technology is widely accepted, BIM will let us build virtually before building physically, uncovering problems of sequence, interference and constructibility. It will let us integrate the work of the extended project team and the supply chain, and it will provide information for operations and maintenance.

**PMIS**

Like BIM, a PMIS is a centralized database created and used by the project team. A PMIS is to the process what BIM is to the product.

*Components of a PMIS*

The PMIS data defines the program and the projects: cost, time, scope and quality. It defines the team: people, organizations and their roles. It helps manage agreements: contracts, permits, approvals and

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<sup>9</sup> Computer Numerical Control refers to computer instructions that drive machine tools used to fabricate components. The technology is labor efficient, accurate, repeatable and it facilitates the production of complex forms.

commitments. It manages documents. It produces standard and custom reports. It presents vital signs on dashboards. The PMIS guides collaboration and communicates best practices with policies, workflow diagrams and document management.

*Values of a PMIS*

A PMIS is the cheapest way to gather information because it's only done once. And it's the most reliable way to host information because many eyes scrutinize centralized data and mistakes are more likely to be found and corrected. It's the first line of defense against political or legal attack. It's a clear window into the project that leaders can use instead of relying on delayed or biased reports filtered through layers of management. It improves performance because it measures it; it's a report card for both team members and management. And most important, the PMIS educates the team and makes better managers because it tells true stories.

Information is the input and the output of managers who gather, validate, integrate, record, add experience, make judgments and then give directions.

## Integrated Processes

People who initiate IPD projects are characteristically inclined to innovation and typically focus on ideas for improving the processes. Terms like Lean, Agile, Design Assist and Continuous Improvement are used to describe new concepts and resurrect old ideas in new clothing.

### **Learning from industrial processes**

The construction industry learns from production innovations in other industries. But while there is much to learn, building projects are profoundly different. Whenever pundits talk about replicating manufacturing efficiencies in construction, many construction professionals get skeptical. They point out that there are many differences—such as:

- Building projects usually begin with unique requirements rather than filling a customer order for a repetitious product.
- In manufacturing, the customer tends to be a retailer with customers described with abstract statistics. They have no interest in the assembly process. In construction, the customer is face-to-face—an Owner who often leads the project and often understands the needs better than the AE and CM.
- Construction happens in the mud and the rain, not in controlled environments. Assembly is done by an ad hoc set of companies interlaced in and out of the project with down time between their phases of work.

- The supply chain in construction is project specific and intermittent instead of continuous. It is less automated, less routine. The activity on a construction site varies substantially from day to day compared to a steadier manufacturing workflow.
- Construction is done by craft-trained teams moving about a stationary product; typically manufacturing is done with stationary task-trained individuals working on a moving product. Consequently, industrial productivity is improved by adding technology to repetitive tasks—a challenge in construction where repetitious buildings are less common.
- Normally a building project supports the cost of a unique design. and since the design is unique there are more mistakes with minimal opportunity to correct them on subsequent editions.

Nevertheless, it's clear that many good manufacturing concepts can be adapted to construction. Here are some of the concepts that have emerged.

### **Lean construction**

In about 1990, a member of the International Motor Vehicle Research team coined the term “Lean Production” for some of the manufacturing concepts used in Japan—particularly by Toyota. In 1993, Glenn Ballard (University of California, Berkeley) learned of the IMVR and participated in organizing a conference on Lean construction in Espoo, Finland. Other groups held conferences in the 1990s in Chile, Brazil and Denmark. In 1997 Ballard was a founder of The Center for Innovation in Project and Production Management. The Lean Construction Institute, led by Gregory Howell, represents the Center's work and advocates Lean project delivery. The Center is a Lean construction think tank.

The Lean construction philosophy is to eliminate waste, add value and smooth the workflow. Some of the common concepts follow:

#### *Last Planner*<sup>TM</sup>

The Last Planner System<sup>TM</sup> (LPS)<sup>10</sup> increases the control of people working at the scene of the action. It emphasizes the responsibility of the worker level to contribute to improvement, speak up, keep promises and object to directions when the boss is wrong.<sup>11</sup> The Last Planner might be a designer on the boards, a job captain, a

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<sup>10</sup> The Lean Construction Institute holds the trademark for The Last Planner System.<sup>TM</sup> It was conceived by Glenn Ballard and Gregory Howell.

<sup>11</sup> Responsibility-Based Project Delivery<sup>TM</sup> was developed by Lean Project Consulting, Inc., which holds the trademark.

construction superintendent or a trade foreman. The clear thoughts are:

- The “Last Planner” can make the most reliable short-term commitments.
- If the “Last Planner” is the person who makes the commitment, he or she feels a greater responsibility to honor it.

The objective is to increase predictability. Master schedules are never accurate; the more detailed master schedules are the most inaccurate. Productivity varies. There are unforeseen delays, material shortages and changes. No one gets the details of execution right at the start. When a company suspects that the schedule is unreliable, they will delay staffing until they are sure that they can begin. The delays snowball. The schedule slips.

Predictable workflow reduces those delays, increases everyone’s profits and makes it more likely that the project will be done on time.

The Lean approach is to build broad-brush master schedules that can be segmented into milestones, then develop detailed modules (phase schedules) with increasing levels of detail as execution draws near—planning collaboratively with those who do the work.

The master schedule is a milestone schedule, a “push schedule.” The people who do the work meet to define what must be done between the milestones and develop a phase schedule, a “pull schedule.”

#### *Flow and batch processing*

A concept of Lean construction is to replace batch processing with “flow” where it makes sense. Here’s an example: a steel fabricator might fabricate the baseplates, columns and beams in batches and dump them on the site. A more efficient process (but more expensive for the steel fabricator) would be to fabricate the steel as it is needed and erect it by picking it off the delivery truck. The workflow is smoother, the site less cluttered, and an error in the first delivery may be corrected in remaining work.

The extended project team of AEs, CMs and subcontractors can form system teams to examine the mainstream and tributaries that constitute the flow of design, fabrication and construction. The team can take a granular approach to designing workflow and look for places where flow is more efficient than batching.

#### *Commitment-based planning*

Projects are networks of commitments. Many construction problems result from unreliable attitudes about commitments. Honoring them creates trust; friendships form, stereotypes are broken, ideas mix,

Planning never predicts the future accurately, and plans always need adjustment as time passes.

Creating a “flow” rather than a “batch” production process smoothes the workflow, reduces inventories and exposes fabrication mistakes early.

Projects are implemented by thousands of small commitments.

collaboration happens, designs improve, schedules are met and profits appear.<sup>12</sup> A good manager builds a culture of honoring commitments by:

- Honoring his/her own commitments
- Ensuring that a commitment is thorough, understood and documented
- Having adequate discourse to ensure that a committer is genuinely committed
- Avoiding applying pressure that would cause someone to over commit
- Ensuring that the committing party has the resources and authority to make the commitment
- Making the commitment visible to other members of the project team
- Having an understanding that if conditions change there is an opportunity for renegotiation
- Tracking and reminding people of their commitments
- Recognizing honored or failed commitments

### *The last responsible moment*

As a project progresses, there is more information for decision-making. More knowledge means better decisions. The project benefits from decisions that can be delayed without delaying the project. The idea is to gather facts, create alternatives, engage the project team in evaluation, watch the future unfold—and delay until a further delayed decision would threaten the schedule commitments. Meanwhile, it helps when the project team defines “decision-ready information,” the information required for a decision.

### *Set-based design*

Rather than developing a single solution, the team sets multiple concepts and carries them well into the design process with a multi-disciplinary team. The team maintains objectivity and delays a final choice until the last responsible moment.

### *Target Value Design*

Target Value Design is a process that uses a number of enlightened project cost management practices. Before design, the core team builds a cost model assuming a mutually understood hypothetical set of building systems. Constructibility and value engineering are done

Target Value Design is a collaborative strategy and process for designing based on the articulated project values, which become design criteria rather than mere aspirations.

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<sup>12</sup> For more information about this topic see Donald Sull and Charles Spinosa, “Promise-Based Management: The Essence of Execution,” Harvard Business Review, April 2007.

before design to determine the systems that are the most appropriate for the requirements and create value for the Owner.

The result is the project's "expected cost." Then the team sets another, more aggressive target cost as a "stretch" to drive innovation.<sup>13</sup> The process requires builders who are skilled in preconstruction services and can estimate without drawings. It also requires AEs who can define requirements without extensive design.

A healthy part of achieving the cost targets are the collaborative conversations about how systems may beat targets before design. Participants test systems and materials in innovative ways. The team may study shop-built assemblies to reduce field assembly time. By engaging this work before design, stakeholders create innovative solutions.

#### *Value Stream Mapping*

A process may be mapped to identify wasted activities and show how value is produced. The steps may be:

- Specify the desired product (or project characteristic)
- Diagram the current value stream showing material and information flow, steps and common delays
- Identify ways to eliminate waste, such as omitting redundant steps or smoothing workflow
- Draw an improved value stream map
- Implement the future state
- Evaluate the result and repeat the process

Using Value Stream Mapping, teams often discover that steps can be eliminated, reorganized, or deferred in ways that improve schedule, reduce time and improve the quality of the product.

#### *Plan-do-check-adjust (PDCA)*

The idea is to diagram a process in four stages to improve it.

Plan – Propose a process

Do – Implement the plan

Check – Assess the results

Adjust – Look for ways to improve and then repeat the cycle

#### *A3 Reports*

An A3 report gets its name from constraining a study for easy understanding to an 11" by 17" sheet. As in any good study, it states the background, the problem, the current state, the implications of the desired state and the resources required to get there. It requires the effort of distillation by the authors but because it is brief, others will read and understand it.

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<sup>13</sup> The "stretch" target may have incentive awards attached to it.

Packaging concepts in easy to comprehend bites builds understanding and consensus. It is the same idea that engenders “dashboards” in a PMIS, “snow cards” and crisp PowerPoint presentations. As in these other summary forms of communication, backup information is essential.

#### *The big room*

Bringing the extended team together for face-to-face collaboration is effective and productive. On a large project, the team can be co-located. On smaller projects, there can be multi-day “big room” sessions. The idea has had many titles over time, such as squatters, charrettes or workshops.

#### *Retrospectives*

For many, Lean is a rallying cry to *think*—to ponder what is going on, to mull over processes and goals without applying prescribed tools or rules. And so it is a good idea to reflect on a project’s activities with a retrospective. Retrospectives may be a facilitated session for team members to consider what does and does not work, pose new approaches and identify areas for improvement.

#### *Lean behaviors*

Most of the writing and speaking on Lean emphasizes the behaviors discussed in most management tomes on effective teamwork: collaboration, trust and continuous learning. 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.”<sup>14</sup> Cultural change and project leadership are required.

### **Design Assist**

What often exists just beneath the innovative veneer of a CM is the same old clumsy design-bid-*redesign*-build process. Given the increasing sophistication of building systems and materials, even the most experienced CMs are quickly out of their depth on a sophisticated building. And if the AE does complete construction drawings for competitive bid before selecting subcontractors, much will be discarded and redesigned by the subcontractors to facilitate their fabrication processes.

Much of the detailed knowledge of construction cost and technology exists with fabricators, manufacturers and subcontractors. The

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<sup>14</sup> Greg Howell and Glenn Ballard, *Lean Production Theory: Moving Beyond ‘Can Do,’* pages 17-23 in Alarcon, L. (ed.), *Lean Construction*. A.A. Balkema, Rotterdam, The Netherlands (1997); <http://www.leanconstruction.org/pdf/beyond-can-do.pdf>.

sooner they are involved in the decision-making process, the better the design can be.

The concept for Design Assist is straightforward. It replicates the CM selection process and applies it to key Design-Assist subcontractors early in design so the team may engage them for pre-construction services. The intent is for the pre-construction services to evolve into construction contracts for that subcontract.

The goal is to pull technical knowledge forward into the design process. That will produce better design decisions, ensure constructible construction drawings, eliminate design rework in the shop drawings process and facilitate off-site fabrication.

IPD teams that implement the Target Value Design process, consider this no longer “Design Assist,” but rather Lean Design Workflow. The feeling is that the “Assist” term is pejorative. No one is “assisting.” They are collaborative peers searching for the best solution.

### **Agility**

Because just-in-time product delivery, flow concepts and pull scheduling have gained acceptance, manufacturers must be agile. They must switch production responsively. Printing a single book “on-demand” followed by switching a file and printing a different book, changing color in a spray gun on a production line from red to blue without spraying a little purple, changing a chemical production quickly in a refinery to meet new market conditions or customizing a laptop computer for next day delivery are examples of manufacturing agility.

Our Owners must respond to an increasing rate of change in their business models. Weather, economics, supply disruption, labor shortages or decision delays upset plans. The more information systems can be used to link Owner requirements and changing site conditions to service providers and the supply chain the more Agile the project will be.

IPD projects are characterized by assembling an extended team that includes subcontractors, suppliers and manufacturers to contribute knowledge to the design. Since the design is not complete when these parties are engaged, they must have flexible contracts to be adjusted as the project unfolds. Such contracts provide the tools to maximize agility.

### Continuous improvement

Continuous improvement has been a mantra in design and construction long before IPD. It was a theme in Operations Research, Concurrent Engineering, TQM and is repeated in IPD projects. However, it has an important new potential in projects that are part of programs.

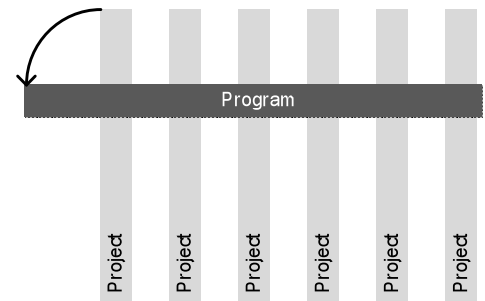
Most buildings in America are constructed by serial builders: real estate developers; national and local governments; education and health care institutions; utilities; manufacturers; hospitality, restaurant, entertainment and retail chains; military and defense organizations. These projects are typically executed by an organization to serve a similar functional purpose. The projects will have a similar process, use similar service providers and have similarities in the product itself.

The similarities offer opportunities for continuous improvement. Program managers can examine their individual projects to find these similarities and “rotate” the similarity from the project workflow to the program. Then there is an opportunity for continuous improvement instead of reinvention on every new project. But the team must think “program” not “project.”

### Problems with IPD

Integrated Project Delivery is a response to the extensive collaboration required for 21<sup>st</sup> century buildings. The vision is of an aligned project team, not partitioned by self-interest, but with a shared responsibility to help one another meet an Owner’s goals. It’s a heady vision. A vision we will never completely achieve—for two reasons:

First, below the AE and CM are cascading tiers of subconsultants, subcontractors, fabricators, suppliers and manufacturers. They constitute most of the resources required by a project. Most will continue within contractual silos. Tradition provides the primary set of operating rules, the functional structure that people in the construction industry understand (albeit imperfectly). Tradition fits the myriad organizations into place and provides guidelines for their relationships. When an Owner abandons tradition, there must be strong leadership and enormous emphasis on communication or everyone will simply default to familiar roles. Then the gears of tradition will strip, grinding against the parties that are implementing the new processes.



*Program managers can identify similarities in their projects and “rotate” the similarity from the project workflow to the program. Then there is an opportunity for continuous improvement.*

Second, self-interest is inevitable. Goal setting, incentive clauses and other alignment strategies are helpful. They work. But projects are delivered by imperfect minds in ambiguous processes influenced by conflicting interests. An Owner, a user, an architect or a CM will engage the project with preconceptions of how design and construction should work: convictions that are individual and idiosyncratic—influenced by personalities, life experience, education, business models, worldviews, random experiences in the industry, professional ambition, self-interest in potential profits and the desire for recognition.

We will never arrange contractual mechanisms to produce perfect total alignment. Despite a core team that agrees on the goals and sets cost, schedule and quality metrics, there will be differences in execution. It's an imperfect world. For instance:

- A user may want to change the design, the architect may feel that the change hurts the aesthetics, the CM may believe that the change will delay the project, the Owner may object to the cost.
- Some designers will still be inclined to study the project more and delay the delivery of drawings. Some constructors will still be production-minded and will want to get the drawings early.
- Typically, the project is cost-reimbursable, sometimes with a GMP. That might minimize the inclination to load people on a job to increase profits. But an organization that has surplus labor may want to park it on the job, while one that is short of labor may short the job.
- If a budget isn't set at the start of the project, and if the project team has the responsibility to define the scope, cost and schedule, the participants are setting the yardstick that will be used to measure their performance. For instance, if they set the budget and then share in savings or participate in overruns, the tendency may be to set a high budget.

Furthermore, these biases aren't always self-interest. Professionals have high-minded differences. The best love their job, draw profound satisfaction from doing good work and will argue passionately for their point of view. These convictions shape individual perceptions of what is right and wrong for both the management processes and the eventual design. Project leaders will interpret the project goals differently and disagree about the ways to reach them. These differences are not solved with contract terms, new procedures or information technology—although they help. They require leadership: a voice in the bully pulpit to keep the team on track.

Indeed, these differences are not a problem that *should* be solved. With the right leadership, aided by the concepts of IPD that encourage trust, candor and transparency, differences stimulate creative thought, introduce new viewpoints and constantly add options for collective consideration.

Complete alignment is not only impossible, it's not a good idea. Disagreement is healthy even within a single business entity. It would be a shame if everyone always agreed; there would be little progress. In a creative process, a lack of disagreement is not harmony, it's apathy.

Ultimately, amid the seemingly unlimited and often conflicting technical, functional and aesthetic aspirations that lead to good buildings, there's no way to eliminate the need for knowledgeable leadership: leadership that knows how to pass the decision responsibility to the best-informed people, create collaborative environments, forage for elusive solutions and settle murky questions. That's the core mission of program and construction management.

## A Philosophical View of IPD

One could argue that IPD is a form of design-build with special contract conditions designed to increase input and control from an Owner, improve transparency, align goals, optimize the value-to-cost ratio, enhance collaboration and minimize conflict among the major project participants that have the greatest effect on the project outcome. What in the world could possibly make more sense?

A century ago, a company like the Austin Company could deliver a building with an integrated team under a single contract. The team goals were aligned because everybody worked for the same company. Because Austin could show the Owner a similar building, the Owner's participation was not so crucial. That kind of company still exists for specialized projects like banks or medical office buildings.

But our industry is specialized and fragmented. And the projects that use IPD tend to be complex and unique facilities. (The serial builders that build prototypes tend to continue to use design-bid-build.) An IPD project is typically an ad hoc assembly of specialized organizations, usually cherry-picked for the project, each operating with its own prejudices and self-interest. Each views the world from its own corner. Each works on its own turf.

The team members must engage one another to produce the result the Owner needs. So organizations are collected into groups and

managed by a handful of traditional players: AEs, CMs, PMs, GCs, etc. Flanging them all together in a unified project contract is a simple and logical next step.

What a great idea! The Owner we've been hired to serve, the people who will either praise or pan us as a reference for future projects, is on the team. We acknowledge the need and the value of their active participation in the planning and management of the delivery process. The simplicity of the concept is compelling.

It's a process and a set of agreements based on incentives rather than punitive consequences, morality rather than legalities. And when you think about it, common sense over stubbornness. There's a powerful and positive message: everybody must sink or swim together. Of course, we always said that, but traditional contract arrangements don't reflect that reality.

### When to Use IPD

Of course, it would be reasonable to use IPD on any project where the Owner was capable and interested, but it's hard to see developers, with many investors looking over their shoulder, or big-box retailers with prototype designs using IPD. It's easy to see a government using IPD for a monumental courthouse or a university using it on a major departmental building or a hospital using it for an innovative, cutting-edge lab building.

*Alliancing is right for prestigious projects that will attract the core team leaders.*

IPD appears to make consummate sense:

- For unique, complex, prestige projects where the need for collaboration is high
- When there are apt to be changes during project delivery
- Where participation of top leadership from the core project teams is likely
- When the Owner is a knowledgeable hands-on manager

Unique, prestige projects are typically characterized by great ambition from the designers to make a unique, prestige design. That inevitably threatens the budget.<sup>15</sup> There's a looming danger of runaway costs. And so there is the constant need for the attention of the top brass from the participating companies—an important role for the management committee.

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<sup>15</sup> The Sydney Opera House blew its budget into the ionosphere. That motivated the Australian Commonwealth Government to find a better way to control costs. They didn't want an encore so they made clear that their appropriation for the National Museum of Australia would not be augmented and used Alliancing.