Introduction

With so many variables in the building process and the increasing complexity of buildings, construction projects today are notoriously difficult to predict—everything from schedule to cost to the finished form. It’s no surprise that many owners are looking for project delivery methods that will provide more predictable results.

Three of the most important recent developments in construction delivery methods are lean, integrated project delivery (IPD) and building information modeling (BIM). We have found that the most successful projects have used a combination of all three. With a delivery system that is carefully, intentionally designed—eliminating as many unknowns as possible from the entire process—even very complex construction projects can reliably meet cost, schedule and design quality goals.

Like many early adopters, we had no manual to follow when we began implementing lean, IPD, and BIM on DPR projects. Through trial and error on projects incorporating lean, IPD, and BIM over the last decade, we have developed the following eight recommendations on how to facilitate breakthrough results on cost, quality and outcome:

1. Organize the Team

Buildings are designed, built and maintained by people, so it makes sense that people should be the first step in the delivery process. The architecture/engineering/construction (AEC) industry has naturally
responded to complex projects with ever-increasing specialization—many projects involve 10, 15, or more separate companies. The individuals who are assigned to any given project come from different firms, but must work together to build one building.

Before designing the building, the team must design how they will organize themselves and the processes they will use to work together. Crucially, the team must include all members of the delivery team from designers to subcontractors. Bringing downstream players, with deep construction knowledge and experience, on board early in the process means the project has a better chance of meeting quality, cost, and schedule objectives.

DPR's lean specialists developed these "I Get–I Give" sticky notes to help team members determine how each
individual's work and knowledge is connected to everyone else. Without making these dependencies explicit, one individual might think that a certain piece of work isn’t time-sensitive, while in fact another individual can’t progress without it. Developing a “network of commitments” helps make everyone’s expectations and needs clear.

The way the team is organized helps ensure that information and knowledge will flow easily and quickly between team members, and every decision the team makes is for the good of the project—not just any one firm.

When the team intentionally designs a delivery process, they reveal the dependencies and interfaces between teams and groups. For example, where should a design team stop modeling and a subcontractor begin? This is often a line that is not explicitly stated, and can result in confusion and misunderstanding. Talking directly about roles and objectives also enhances transparency.

Especially on large projects, it is important to map out the flow of work towards project milestones and then continue to update the map as the design changes. Through this exercise, team members can uncover the “network of commitments” between each other—who relies on whom for work or information.

Incentives for collaboration can help encourage good behavior among team members. One of the most powerful incentives is tying together each firm’s profit. Typically, the team sets a goal with their collective profit at risk. If the team can accomplish the goal (meet or even reduce the cost), each firm gets a percentage of the remaining contingency plus 100 percent of the profit. However, if it goes the other way, then 100 percent of the profit is at risk. This motivation of shared risk and reward unites the team.

2. Develop a Virtual Organization

An integrated project team can be thought of as a “virtual” organization. It is not necessarily an actual business entity by itself; it is a collection of individual firms who have agreed to work together. But, these firms have agreed to form an artificial, or “virtual,” organization for the duration of the project, working together toward a common goal.

Melding individual firms into a virtual organization is extremely important to the success of a truly breakthrough project. Without a shared vision and shared goals, team members will not easily share knowledge, collaborate, or work in the same ways. A virtual organization requires buy-in from all stakeholders; every person on the project must be committed to integration, and understand the benefits and the challenges.
This team organized themselves into cross-functional clusters, with a senior project board that met on a monthly basis to discuss "big picture" issues, vision, and strategy.

Developing and maintaining a virtual organization is an ongoing process, but one important step is to create clearly defined roles, responsibilities and handoffs. By explicitly defining cross-functional, multi-disciplinary teams within the virtual organization, each individual understands how he or she fits into the larger picture, and what they are responsible for. By developing a virtual organization, team members responsible for specifying value and those delivering value are tied together.

For example, one large-scale hospital project developed a virtual organization that worked together for 18 months in the same space. Each team member had a different role and was responsible for multiple, cross-functional issues. The team was divided into clusters, production and senior leadership (see diagram to right). The team developed a senior project board, which met on a monthly basis and were responsible for "big picture" issues, vision and strategy. The project board worked with project managers and project engineers to develop specific metrics for the team to track, and created an orientation video to explain the methods and goals.

Another team specifically emphasized camaraderie and mutual accountability. Each team member completed a behavioral assessment to help understand personalities and working styles before the project began. Throughout the project, a project manager interviewed key team members, including from trade contractors, on how they felt the project was going every six weeks. They distributed sports referee flags with the project mission statement and core values, using the analogy that if a team member was not operating in line with the project goals, someone else could "throw the flag." They also held events on site for friends and family, dinners for foremen, and comprehensive sessions for team members that explained and reinforced the project mission and core values. The team also installed a field-based interactive survey device in a high traffic area of the project, which asked one question a week to gauge the health of the team and garnered about 300 responses a week.
This project team held an on-site orientation for all new team members. Courtesy of David Cox

Regular lunches with all trades and disciplines help build understanding and trust. Courtesy of David Cox
3. Understand Customer–Supplier Relationships

Understanding who is relying on you and whom you rely on is essential to ensuring work gets done.
efficiently. Because project teams are made up of individuals from many firms who have likely never
worked together, it’s easy for them to work in isolation, never realizing that someone else is waiting for
them. One person might put off completing something they view as a lower priority, not realizing that it’s
causing a team member from a different discipline to sit idle.

Team members must learn to view their interactions from a “customer-supplier” point of view. When
someone is seeking information or work, she is the customer. When she is being asked to produce
information or work, she is the supplier. Viewing the relationship this way, team members can understand
that when acting as a customer, they are expected to clearly state their needs and expectations.
Conversely, when in the supplier role, team members understand they need to know exactly what their
customer needs and when; their “conditions of satisfaction.” Everyone gets a crash course in how to
negotiate to get part of what they need, if their supplier is unable to deliver all of it.

One hospital project was able to drastically reduce their latency, or the time between submitting a
request for information (RFI) and receiving the answer. On that project, 84 percent of RFIs closed within
three days and the team improved productivity from six to 28 percent.

4. Determine How and Why You Will Use BIM

For BIM to be effective, the right people need to be involved at the right time with the right level of detail.
Everyone has different assumptions of how to use BIM: being explicit about who will use it and to what
level allows the team to know what to expect. At DPR, we categorize BIM use into five different levels:
visualization, coordination, constructability, fabrication/installation and total cost of ownership.

It’s best for teams to decide when and how to use BIM as early as possible. Before the BIM process
begins, specify what it will be used for and the level of detail at each step to satisfy these goals.

One reason to decide on BIM use early is prefabrication, or prefab. Prefab opportunities, such as MEP
racks, need to be designed and modeled early on, because they have a long lead time. By the time the
project reaches the design documents stage, it may be too late for prefab.

BIM is also a valuable communication tool, providing another avenue to help ensure everyone is on the
same page. By using detailed and accurate models, the team is able to communicate more clearly and
effectively with each other, and with the owner. Often, what one person asks and another person hears is
not the same. BIM helps eliminate some of the variables in cross-disciplinary communication and help
owners understand how their values might be realized, enabling them to make informed decisions over
compromises or trade-offs where needed.

In our experience, a detailed fabrication-level model is the best indicator of design completion. People
who do the work in the field are best suited to create that portion of the model, because they have
valuable field knowledge to be incorporated.

Remembering the 80/20 rule can be helpful. Not all BIM is created equal. Starting with the top 10
quantities by trade, the majority of the design—about 80 percent—should be modeled. However, the
other 20 percent—very small detail like nuts, bolts and screws—should not be modeled since it means more coordination time without much payoff. In other words, trying to model every single item in a building can take more time than it is worth.

For a more in-depth look at the benefits of BIM, please see “Seeing is Believing—and Building Better.”

5. Create a Big Room but also Allow for Small Breakouts

On a large-scale hospital project, the team used a Big Room, which is an on-site co-location space that brings designers, builders and owner to work together. Most of the 80 to 100 workspaces were in an open office environment, but the team soon learned they needed smaller breakout rooms as well. Including breakout spaces allows team members to meet in a separate space to handle a particular issue that does not involve the rest of the team.

A challenge of the collaborative environments like the Big Room is that certain team members may be reluctant to work in a co-located atmosphere. It can be frustrating and inefficient for some smaller trades if not managed properly. For example, smaller subcontractors (such as fire protection) can easily get frustrated when they are constantly asked to sit in on meetings issues that have nothing to do with their trades.

To combat this, one project team set an agenda for Big Room meetings to deal with fire protection or structural design issues upfront, so that these smaller trades could participate quickly and then leave afterwards. Another tactic is to encourage these trades work on other things during the meeting so they are able to be productive when not engaged, but also available to answer questions when needed. While it was initially a challenge for all team members to accept this concept, DPR reviews and surveys indicate that all involved parties eventually saw the benefit and were satisfied with the setup.

Read more about the Big Room here.

6. Use Pull Planning to Understand Handoffs and Track Commitment Reliability

Planning by working backwards (or “pulling”) from a milestone allows the team to work on an exceptionally efficient schedule, producing more work in less time, with fewer resources. This process, called “pull planning,” outlines specifically what work each individual will produce for whom, so nobody wastes time producing work that is not actually needed.

Tracking plan percent complete (PCC) during design and construction on a weekly basis is one way to measure reliability. If the team isn’t able to maintain a reliable schedule on a weekly basis, the chance of doing so over the duration of the project is low. By measuring PPC, the team can tell if they are on track or not, and take actions to course correct if necessary.

To use pull planning successfully, the team needs to:
- Understand customer-supplier relationships: who is supplying and who is consuming information.
- Understand unconstrained work that can be done by the project. Determine what can be done to free up work for the other trades (for example, excavation) and finish it first, so others do not have to wait longer than necessary.
- Do the work when requested. This means focusing on what is important to the customer rather than what makes sense to one’s own trade. Aligning work is especially critical in the design phase.

Team members developing a pull plan. Courtesy of Ashley Conklin
"I give–I get" cards are useful for determining what information or other work each person needs in order to complete their work. Courtesy of Peter Lockett

A tried and true method–sticky notes work well when developing a complex schedule.

7. Identify and Track Meaningful Metrics
One way to think of project metrics is like the dashboard of a car. The car’s dashboard gives the driver feedback on the state of his vehicle and, crucially, allows him to change the way he is driving before catastrophe strikes. With no speedometer, he might speed straight past a waiting policeman. With no gas gauge, he would run out of gas before he realized there was any danger. Worse problems arise with no engine temperature indicator, no oil, engine, or air bag lights, and so forth. With no dashboard, the only way a driver can know if he is making a mistake is after he experiences the disastrous results; he has had no advance warning and no way to adjust his behavior ahead of time.

Similarly, measuring a variety of key performance indicators (KPIs) on a frequent basis helps the project team understand if they are on track toward their goals or not, and make adjustments to their process as necessary. Metrics must be published and posted in areas that are easily visible to the project team, such as a metrics wall in a site trailer, so there is an accurate and shared understanding of how the team is performing.

Metrics are comparisons of two measures, such as dollars per sq. ft., and are often expressed as ratios. They can be useful as key performance indicators (KPIs) and when used properly can provide critical information to the team. Most projects are driven by three sets of outcome metrics: recordable injuries, budget and schedule conformance. Increasingly, projects are tracking LEED points, which requires designers to analyze water consumption and indoor air quality.

Meaningful metrics, not simply data collected for the sake of having numbers in a chart, must be used both to track how well a team is performing, and also how closely the building conforms to the goals and values of the owner. Metrics are essential to understanding and, if need be, correcting team performance during the process. For example, if a team is aiming for a less than 24-hour turnaround on RFIs, but a month after moving into the Big Room the average turnaround is five days, some sort of adjustment is clearly needed. By identifying and addressing the problem during the process, teams can learn, adapt and become more efficient.

The metrics chosen by the team should be closely related to their goals and be specific. For example, one metric/goal pair could be reducing the time required to answer to questions (latency) by responding
to 90 percent of non-strategic questions in one hour and the remainder within 24 hours. A team could also use commitment scheduling as a measurable goal and track plan percent complete (PPC). Whatever metrics are chosen, they should demonstrate—directly or indirectly—that the stated goals are being achieved.

One metric that all teams track is first cost to construct. Owners are understandably extremely concerned about first cost; however, it is not the only value that should be tracked. We now have the ability to simulate and measure alternative designs, and can track not only first cost, but also energy consumption, workflow, natural light and so forth. Once a team decides how to measure certain aspects of value that are important to the owner, those values can become design criteria as well, in addition to first cost.

An emerging priority for many owners is the total life-cycle cost of their building. Lowering the total cost of ownership (TCO), including reducing operating costs and efficiency goals, is routinely sacrificed to achieve the lowest first cost to construct. This leads to greater facility and personnel costs once the building is in use. A facility with poorly integrated systems, poorly planned workspace, and poorly designed maintenance access will always use more energy, retain fewer employees, and be more complicated and expensive to maintain. But, project teams are traditionally not incentivized to prioritize life-cycle costs. Rather, they are unintentionally encouraged to guard their profit during design and construction, and enhance their fees wherever possible.

As DPR’s Eric Lamb has observed, “Real value is not the low bid on a higher cost design. It’s achieving the lowest true cost on the right design.”

8. Make Everything Transparent
This project team posted key project indicators (KPIs) on the walls of the Big Room in a large, easy-to-read format. Indicators included number of RFIs, weekly average RFI turnaround, number of submittals, and Last Planner data.

Tracking important metrics and making them easily available to the entire team are two important factors that help ensure a breakthrough project.

Establishing protocols for sharing information, metrics and analysis is a prerequisite for teams committed to integrating at a high level. Nobody has a crystal ball; people can only make decisions based on what they know and can see from their perspective. Building a complex facility requires broad and deep knowledge from many disciplines, which can only be fully leveraged if information is available to everyone working on the countless problems that teams confront.

By posting important schedules, graphs, goals and financial results on the Big Room walls, each team member can see where the project is and where it has to go on a daily basis. This kind of transparency focuses the team on their jointly agreed goals. Often, wall charts are sophisticated roll-ups from project finances, but strong and simple can be powerful, too.

For example, on one hospital project, the team publicly published target costs and accomplishments towards making a profit each week. This way, team members could walk into the Big Room and see whether profit goals were made—a very public but effective measure of success. That project ended one month early and on budget.

Conclusion
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Every project delivery team is challenged to overcome technical, schedule, financial and time constraints. At the same time, owners want teams to do more with less. As we have learned at DPR, the effect is magnified the larger and more complex a project is, but each one of these steps can help deliver more predictable results on every project.

In summary, when examining these highly technical hospital projects the overall lessons learned were that the following are required for breakthrough success:

- A shared commitment to owners’ goals;
- Strong owner and team leadership;
- Early involvement of builders in the design process;
- Co-location of the project team;
- Planning and process design for effective communication and collaboration.

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About DPR

DPR CONSTRUCTION is a unique technical builder with a passion for results. Consistently ranked in the top 50 general contractors in the country over the last 15 years, DPR is a national commercial contractor and construction manager specializing in technically challenging and sustainable projects—of all sizes and complexities—for the advanced technology, healthcare, life science and corporate office markets.