# Facing the Challenges of Integrated Design and Project Delivery

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ABSTRACT

There is a new movement in the building industry that calls for sustainable planning and design. Energy costs are consistently rising, and the cost of maintaining a building and its systems will eat away at profits the building owner expects to realize. In effect these seemingly simple concepts can make or break the success of a project for the owner.

Additionally, it is known that buildings *"consume more than 30% of the total energy and more than 60% of the electricity used in the US. Each day five billion gallons of potable water is used solely to flush toilets. A typical North American commercial construction project generates up to 2.5 pounds of solid waster per square foot of completed floor space*."[1] This is significant! This will change our landscape and the way we live if action is not taken to address this constant waste of resources.

On an international scale, efforts such as Architecture 2030[2] and 2030 Carbon Neutral Challenge, and the United States Green Building Council's [3] Leadership in Energy and Environment Design (LEED) rating system are two significant market drivers promoting change. Regionally, the Northwest Energy Efficiency Alliance's BetterBricks program has funded the Pacific Northwest University Design Lab Network (Lab Network) to promote market transformation for sustainable and

energy efficient buildings.

This article outlines how the owner and design team, along with the contractor and sub-contactors (the team), were able to break through the old design and construction paradigm and enter into a challenging process called integrated design. Through this integrated design process and an integrated delivery method, the Banner Bank, a LEED Platinum CS building was built. And through this process, the team members were transformed into more effective owners, designers, and builders.

## INTEGRATED DESIGN & PROJECT DELIVERY

To provide a building that has limited impact to our environment, while striving for carbon neutral and zero net energy goals, the standard methods of project delivery must change to accommodate the exchange of ideas from *all* parties involved, from beginning to end design, and throughout occupancy. Architects and project managers use proven project delivery methods that, when overlaid with the integrated design process, create a holistic approach; this is called integrated design and project delivery. Integrated design and project delivery is the mechanism for successfully providing a comprehensive sustainable project from start to finish.

The Integrated Design Lab in Boise (IDL-Boise), a function of the University of Idaho College of Art and Architecture, is part of the Lab Network that worked together to develop the following definition of the integrated design process. "Integrated design synthesizes *climate, use, loads and systems* resulting in a more *comfortable* and *productive* environment, and a building that is more *energy-efficient* than current *best* practices." [4] We believe that this process will produce buildings that are more comfortable for people, require less energy to maintain and operate, and enhance the health and productivity of their inhabitants. We know that design alone does not produce sustainable buildings; project delivery methods also need to be considered. Integrated design process is a major component of overall integrated project delivery. Design can be integrated without full-integrated delivery; however, integrated delivery cannot happen without integrated design.

There are many isolated examples of buildings that were designed and constructed with the intention of sustainability throughout history and the 20th century. However, the cultural and climatic context in

which those structures were constructed differs greatly from the urgency and therefore widespread concern for building more sustainable structures found today. From the late 1990s through the first decade of the 21st century, the design and construction community witnessed a dramatic shift toward building sustainable structures. The learning curve has been steep, and tough lessons have been endured. Many recent efforts in sustainable building focused on improving design. There are many hurdles that still need to be addressed in the area of design, but it has become abundantly clear that good design alone does not produce sustainable buildings. The project delivery process must also be considered.

The integrated design and project delivery process can be like the process of building a house of cards. If one component is removed or inappropriately modified, either a major architectural element (shading devices, glazing, orientation etc.) or the commitment from a major team member (owner, designer, user, contractor), the house of cards topples. Other obvious obstacles, such as the experience and expertise of design team members, also play important roles. From these experiences, we know that rapid progress toward more sustainable buildings requires complete integration, not just design integration. Integrated design and delivery requires early and consistent commitment from all team members. There are many obstacles within typical practice that must be overcome for project success, not the least of which is the project contractual delivery mechanism. However, integrated design process, as defined above, is flexible enough to adapt to various contractual delivery mechanisms. By overlaying the integrated design process to the chosen "delivery mechanism" the contractual basis for the project can still follow design-build or contractor-at-risk contracts mechanisms.

## PROJECT DELIVERY MECHANISMS

For the purposes of clear understanding, the American Institute of Architects, along with the Associated General Contractors of America, has defined the three major methods of design and project delivery. All other variations fall into one of these categories.

1. *Design-bid-build* is the traditional method of design and project delivery. This model is a lineal progression of events, as the name

suggests, and the owner has two contracts, one with the architect and one with the general contractor (GC), after the award of the bid. Design-bid-build is not ideal for integrated design practices due to the lack of any pre-construction services from the GC. It is only after the design and documentation have been completed and the project is sent to bid that a GC will have knowledge of the design.

2. *Construction Manager at Risk* (CM@R) involves the GC earlier in the design process. The owner has two contracts—one with the construction manager (CM) and one with the architect/design team. The term "at risk" can denote the contractor is held responsible for the performance risk for construction and/or it can signify the construction manager is held to the *gross maximum price* of their agreement with the owner. The benefit of this arrangement allows for overlapping phases (design and build or fast track). Additionally, this method has some advantages over the design-bid-build model because the contractor is offering pre-construction services that aid in the constructability of design, the current bid climate, and management of the bid process. However, the assumptions made when establishing a gross maximum price can handcuff a free-flowing design process where new ideas can be considered free of presuppositions.

3. *Design-build* method uses a single entity contract between the owner and the designer-builder for both design and construction. Owners sometimes prefer the single point responsibility for both design and construction services. This arrangement also accommodates the overlay of integrated design.

Iterative building performance modeling, lifecycle cost exercises, cost and value estimating as well as commissioning often support the integrated design and project delivery process. While these components of integrated design and project delivery can theoretically be achieved by any of the delivery mechanisms listed above, they can more easily overlay the CM@R or design-build project delivery mechanisms.

Why is this? In our opinion, during the typical design-bid-build process the architect and the development/owner team are typically designing without benefit of input from the full design/construction team (who have not yet been selected). Therefore, the opportunity to interact with those players who could be providing critical input during design is

lost. This especially includes the cost-value and lifecycle cost assessment available only with solid cost data provided by the general contractor.

## LEADING BY INTEGRATION EXAMPLE

Deciding to design an LEED certified building was the catalyst for us to introduce the overlay of the integrated design process to our standard design team charrette for the Banner Bank Building in Boise, ID. Rick Hunter, project designer, and Amy Hellmund, project architect, had often utilized the CM@R project delivery method in past projects, bringing the negotiated general contractor early into the process for collaboration with the architect/design team, so we were comfortable with adding the integrated design piece. However, we were unfamiliar with how the overlay of integrated design would effectively change our design process.

Fortunately we had an ally in the Integrated Design Lab (IDL) in Boise, Idaho, and the Northwest Energy Efficiency Alliance's Better Bricks program. With the guidance of the IDL and the projects' designated LEED professional, we added to our process an independent commissioning authority (CxA) to review mechanical, electrical, and plumbing systems from design through the start-up of building operations. The CxA joined us for the building system design charrette where all possible system configurations were discussed, even if just briefly, and voted out. Through this process of elimination, we found the ideal system for the building that would provide the occupants with the best comfort, and an energy benefit to the owner. Throughout the entire design and construction timeline of the project, the CxA was responsible for providing guidance and verifying that the building's energy-related systems were designed, installed, calibrated, and performed according to the owner's project requirements and construction documents.

Energy modeling during design by the mechanical engineer was new to our design process. This tool would help quantify the energy performance of the building's envelope based on our selection of materials, construction assemblies, and size of fenestrations. The information from the model became interlaced with the final architectural design of the building. This iterative process, where feedback from the model is considered during design, and design modifications are subsequently fed back to the model, is core to good integrated design.

The Leadership in Energy and Environmental Design (LEED)—Core and Shell Design Manual by the USGBC became part of the project requirements for the design and build team to follow throughout the course of the project. Having a manual to help define the performance and intention for sustainable design strategies gave the team a basis to measure design strategies against, so the team could understand how much benefit was provided by various strategies. By keeping score, the team could make small adjustments that would make large impacts to the efficiency of the building without adding unnecessary costs. The LEED rating system also helped the team approach sustainability from a variety of perspectives, and helped get the major areas on the table for consideration.

Finally, the process of open discussion and respect for everyone's contribution during the design charrette provided the collaborative freedom for ideas to be traded across disciplines. The best example of this was the desire for a column-free floor plate. Columns within an office plan account for the majority of layout inefficiencies and compromises. These inefficiencies in layout translate directly to the owner's value proposition. The structural engineer had worked with castellated beams before, and knew that they could handle the spans needed to keep the interior space column free.

The fire alarm designer, upon hearing about the beams, realized there was no need for smoke detectors in each of the beam pockets, as typically required, because the holes in the castellated beams provided an open plenum, as opposed to the pockets created by standard wide-flange beams.

The sprinkler and electrical designers realized they could utilize the large round openings in the castellated beams to route piping and electrical runs; thus, the acoustical ceiling could be hung closer to the bottom of the beams. This meant we could decrease the floor-to-floor height of the building since the runs could happen through the holes of the beams rather than below the beams. All of these design efficiencies came about through one meeting at which all parties were in attendance. Decisions that either would never have been realized or would have taken weeks of discussion, by phone or e-mail between design disciplines, happened in one meeting because all of the design disciplines were present and had mutual respect for each other's ideas.

## CHALLENGES OF INTEGRATED DESIGN & PROJECT DELIVERY

Change always comes with great effort and several challenges. As is the case with any new process, integrated design brings some new challenges for the owner and the design and contracting teams. Fortunately, education and familiarity are the largest challenges to face in integrated design and project delivery. These can be readily met through early goal setting sessions and owner/design/builder team discussions of project expectations, budgets, and life cycle costs. The next major challenge is understanding each other's roles, skill sets, and communication protocols.

It's very important that owners understand that design fees can increase as a result of the integrated design process. In addition to design fees, there is at least one new team member, the commissioning agent, and the design can include process and fees for certification through the USGBC or the Green Building Initiative. Thus, we must always remember to educate owners regarding the long-term financial benefits of integrated design and project delivery, so they can readily understand that the increased value far surpasses the potential increased first costs. It is also important to understand that spending more during design and planning, and use of integrated delivery techniques, can substantially reduce construction process costs, and change orders and requests for information. Since all team members have gained familiarity during design and planning stages, everyone is on the same boat and sailing in the same direction.

Other issues arise when contractors and sub-contractors are asked to revise their construction management and processes to more fully execute integrated project delivery. For example, contractors may not have the mechanisms in place to manage the waste and material documentation, and therefore incorrectly estimate the cost and perceived hassle of implementing these measures.

Design team members may not understand how critical it is to utilize the tools of energy modeling and the LEED Checklist at the very beginning of design. Additionally, "greening" your specifications, or adding green language for material installation, is no small task. However, the major revamp only needs to be done once per material type, and will carryover and be updated and maintained in future projects.

Fortunately there is help out there through groups like BetterBricks[5], the Lab Network, and professional organizations to lead you

through the process.

The larger goals of the 2030 Challenge and the popularity of the USGBC's LEED rating system are two significant market drivers for change. These market drivers generally mesh well with the intentions of the integrated design and delivery process. However, occasionally the excitement generated by these market drivers can sugarcoat the incremental challenges and changes that need to take place in order that overall success and real progress occur.

The authors have observed the following important components of the integrated design and delivery process:

- Set high goals for energy savings, daylighting, passive systems.
- Appoint an empowered champion.
- Understand and perhaps modify user expectations for visual and thermal comfort.
- Set visual and thermal comfort criteria in response to users' needs by space type.
- Reduce building loads during design stages through the use of iterative building performance modeling.
- Study daylighting design decisions iteratively with modeling during design stages.
- Identify lifecycle cost benefits that support decision making.
- Include third-party commissioning agents in design stages.
- Educate users about design intents of new or unusual systems.
- Measure and verify savings and identify areas for continuous improvement.
- Involve the entire design and construction team from the beginning of design.

Where do the roadblocks pop up in integrated design?

- Poor design capabilities for passive systems.
- Poor design capabilities for integrated systems.
- Inexperience with building performance modeling tools.
- Lag time of building performance modeling tools to feedback to design decisions.
- Inexperience with complete team integration process.
- Low owner and user expectations for design quality.
- Highly prioritizing first cost.
- Short-sighted or improper *value engineering*.
- Poor understanding of building value vs. building cost.
- Inexperience with installation of new technology.

- Unwillingness to trust building performance modeling for right-sizing systems.
- Fear of change.
- High bids due to inexperience.
- Overlapping bids from subcontractors for new systems (such as UFAD).
- Unexpected or unknown performance from new technologies (such as UFAD or daylighting controls).
- Lack of commissioning.

## STRIVING FOR ZERO

Looking back at the Banner Bank Building process, the authors do not believe we would do anything differently in our general approach toward the integrated process; however, we would like to add more specific processes and more iterations. We feel it is important to drive as deeply as possible with the design tools in response to design and construction process questions. There is no end to the detail and depth of questions that can be asked and perspectives gained from various integrated team members. A couple of examples for continual improvement are to include a process to elicit more input from sub-consultants, and a process that would help the design team and contractor to utilize the efficiencies of building information modeling (BIM).

It is Gary Christensen's idea, the developer and building owner for the Banner Bank Building, to obtain the knowledge of the prime sub-contractors during design stages on the next project. Who better than those in the field installing the actual systems to contribute to the discussion of efficient design? These skilled professionals have the hands-on experience of cost, appropriateness of product, installation issues, and application. If the owner and subs can negotiate up front to a set profit for a job, no longer will the subs' profit be tied to the amount of material or man-hours involved, and therefore they may be more willing to aid in a design that will shorten time and materials while recognizing the agreed-to profit. Having the subs involved in the discussions throughout design not only gives them ownership of the design, it also gives them the understanding of importance of *why* something was designed as shown in the documents. We anticipate that this integrated knowledge gained before installation will have the direct result of decreasing material cost and installation time, and will help eliminate change orders based on misunderstanding the design.

Secondly, our team is anxious to use BIM for the next project. At the time we started the Banner Bank Building project, BIM was in its infancy. The available software did not adequately overlay with other design disciplines' 3D software. As a result, the team produced drawings using AutoCAD and 2D "dumb" lines. Over the last couple of years, BIM software has become quite sophisticated in integrating the mechanical, electrical, and plumbing with the architectural/structural designs. The advantage of using BIM stems from the fact that there is just one project model for the entire building that is updated in real-time for everyone to access. There is "conflict checking" within the program that will alert the designers to potential coordination issues. The cost estimator can accurately quantify material even as modifications are made to the design, and the builder has accurate material take-offs for ordering. BIM software theoretically allows a design team to quickly create daylighting and energy modeling to test design options for clients. It can also automatically create schedules from the model, eliminating costly human errors of data entry.

## MARKET TRANSFORMATION

The role of key projects like the Banner Bank Building in market transformation is significant in both educating design and contracting teams, as well as creating higher user expectations and general public support and demand for high-performance buildings.

During the past seven years, the Northwest Energy Efficiency Alliance's BetterBricks program has provided targeted education and training to commercial building sectors, dollars for direct implementation of many design team innovations, and support for subsequent case studies for distribution to the markets. This educational effort seems to be having an impact on design, and changes in the market approach to design are visible.

The Integrated Design Lab in Boise is a function of the University of Idaho College of Art and Architecture. The mission of IDL-Boise is to work with *integrated teams* (owner, user, designer, contractor, verifier) to promote the successful implementation of the integrated design, construction, verification and occupancy process. IDL-Boise is part of the Lab Network including several sister academic institutions in the Pacific northwest. The Lab Network plays a unique role in the design and

construction community. By working on a daily basis with local design teams as well as graduate students in architecture and mechanical engineering, the Lab Network creates opportunities for cross-fertilization. Experiences from academia can be applied to benefit professionals, and learning from professional building projects strengthens pedagogical delivery in the classroom.

IDL-Boise has witnessed a real shift in perspectives in the past five years. We used to talk about why owners should think about building sustainably, and tried to convince them to do it. Now we talk about how far we can go toward zero net energy use and carbon-neutral buildings. Design teams used to point out all the roadblocks; now, they are pointing out all the opportunities. Contractors used to operate with the business-as-usual mentality; now, they are meaningfully contributing early in the design process. Building users used to accept the hand they were dealt and did not think much about their building; now, they are proactively engaged in the design process and are consciously manipulating their visual and thermal environment to optimize their comfort. Real progress has been made, but there are several improvements still desperately needed.

## SUMMARY

The implementation of integrated project delivery takes commitment and, above all, a willingness to move toward new process. It is very challenging for a design team to make changes in its approach to design. Add to that the challenge that integrated project delivery may not be the same process from one design firm to another. Integrated design is a continuous improvement process and requires a willingness and intent to communicate better with each new job.

The Banner Bank Building project has been a rewarding and educating endeavor into the real possibilities of sustainable design. This was the first experience for all the members of the design and construction team to deliver a sustainable LEED certified building. It wasn't luck that enabled the team to finish with a platinum rating. Most important was the aspiration of our client to explore sustainable design for this project. Then, by using the integrated design process, guidance from our LEED professional, and through assistance from Better Bricks and the University of Idaho IDL-Boise, we were able to succeed and build

a wonderful building that truly is green.

## References

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2. Edward Mazria, "Architecture 2030," 2006, http://www.architecture2030.org.
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5. Better Bricks is the commercial sector initiative of the Northwest Energy Efficiency Alliance. They assist integrated project delivery through education and training, technical support, and through the Northwest network of integrated design labs.

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## ABOUT THE AUTHORS

**Kevin Van Den Wymelenberg** is an assistant professor at the University of Idaho and director of DL-Boise. He has degrees in architecture from the University of Wisconsin-Milwaukee and University of Washington. He teaches classes in daylighting and simulation techniques for integrated design to graduate students and design professionals in Boise. Kevin opened IDL-Boise in 2004 for the University of Idaho and has successfully secured/completed grants for the Northwest Energy Efficiency Alliance, United States Environment Protection Agency, Idaho Power Company, and the Lighting Research Center totaling over $1,000,000. As part of the Lab Network, Kevin has consulted on over 400 projects with architects, engineers, and owners regarding daylight, energy in buildings, and the integrated design process, since 2000.

**Amy Hellmund** is an architect/project designer in the State of Idaho with over 15 years of experience. Early in her career she joined HDR Architecture which afforded her opportunity to work and travel on a variety of project types including co-location facilities, hatcheries, healthcare, corporate office buildings, federal/military buildings and microelectronic facilities across the United States. Along with these projects, she has been involved with a diverse range of design processes including the standard model of design-bid-build, contractor bid-design-build, and the integrated design method. Amy was the project architect for the nationally known LEED Platinum Banner Bank Building in Boise, Idaho. She has since started her own architecture firm in Boise, Idaho, "Architecture H2A," and teamed up with Gary Christensen and his development group to pursue the continued development and benefits of using the integrated design approach.

**Ken Baker** has been working in building energy efficiency for over 25 years. His 1982 Master of Architecture degree from the University of Idaho focused on energy and resource efficient construction techniques and the use of local-based materials to create vernacular and sustainable buildings. He is an experienced educator, facilitator, and mediator. Ken is a co-founder and advisory board member of the U of I Idaho Integrated Design Lab. During 2006 Ken served on Idaho's legislative sub-committee for energy and conservation in development of a new Idaho energy plan and is currently actively providing education and advocacy for legislation that will enact the plan. He recently coauthored a book with Jana Kemp, *Building Community in Buildings; the Design and Culture of Dynamic Workplaces*. The book was published through Greenwood Publishing Company and became available on November 30, 2006.