AIA

Practice Management Digest

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By Jason Edic and Gary Cunningham

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By Kelly Cone

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By Micheal J. Lough, AIA, Principal, Integral Consulting and Jonathan L. Fischel, FAIA, Senior Consultant, Integral Consulting

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By Volker Mueller, Assoc. AIA, LEED AP, Research Director, Bentley Systems, Incorporated

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Collaborative BIM for Eco-Effective Project Delivery

By Zigmund Rubel, AIA

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Integrated Project Management -- Tools and Training

By Christopher Martersteck, AIA, LEED AP, DBIA

Integrated practice continues to take on added importance as projects are faster, clients more demanding, with tighter budgets than ever before, and as increasing use of new technologies and collaborative teaming strategies are embraced by clients and architecture, engineering and construction (A/E/C) firms alike… Continue Reading.

Beyond IPD: The Integrated Enterprise Challenge
By Henry C. (Peter) Beck III

As I engage in various AEC forums, I'm struck by the similarities between our industry and others going through massive changes. While we struggle with the legal barriers to integration including file sharing, insurance issues, assigning liabilities through evolving integration contracts, the patchwork of state licensing requirements, etc., customers demand that we redefine our practices and business models… Continue Reading.

The Use of Green Materials in the Construction of Buildings' Structure
By Bradford Russell, AIA, P.E., S.E., BR Architects, Inc.

We must begin by understanding the environmental cost of the cement used in concrete construction. It is estimated for each ton of cement produced an equal amount of carbon dioxide is released into the atmosphere… Continue Reading.

Combine and Conquer—Long-Distance Collaborative Teaming for Small Design Firms
By J. Michael Leinback, AIA, NCARB

Inside every design firm, there exists a constant struggle to find a balance between the current workload and its staff's capacity to produce work. Rarely is there an equal balance between the two… Continue Reading.

Finding Pearls in the Process: Leveraging the Information Created by BIM
By Bradley C. Horst, AIA, NCARB, CIO, Einhorn Yaffee Prescott and Erin Rae Hoffer, AIA, LEED AP, Industry Programs, Autodesk Inc.

A design practitioners' knowledge is a competitive differentiator - exceedingly precious in today's challenging economy. Traditionally, architectural practice is built upon mentorship as a means to inculcate knowledge… Continue Reading.

News

Changing Times I Time for Change: Practice, Productivity, and Effectiveness
September 24–26, 2009, Chicago, Illinois 17.5 LUs

Explore the major challenges and opportunities that are reshaping architecture practice in a world that is changing at a breathtaking rate including BIM, sustainability, and interoperability. Visit the networking site... Can't Attend? Join us for these sessions which will be offered virtually.

Beyond the Horizon: The Next Generation of Justice
October 7–10, 2009, Chicago, Illinois

Designing Learning Environments to Rebuild Urban America
October 23–25, 2009, New York City, New York

Healthcare Design 09
October 31–November 3, 2009, Orlando, Florida

Letter from the Editor

This issue of the *Practice Management Digest* looks to our annual PMKC Fall Conference. This year please visit us in Chicago from September 24 through 26. Our theme is Changing Times|Time for Change, and it promises to be an exciting three days. In addition to our stimulating programs and sessions, we have receptions and city tours planned. Please visit the conference site to register. We look forward to meeting our active and engaged membership.

The contributors to this issue are some of our presenters, who have written articles around their presentations.

Gary Cunningham and Jason Edic write on *Emerging Trends: Constructability through Design Review & Collaboration*. They take up the issue of designing in safety (for the construction worker as well as the life-cycle for the building). Gary is a Senior Safety Engineer in the Harvard University Environmental Health and Safety Department. Mr. Cunningham is responsible for managing the University's Occupational Safety Program. His metrics-driven approach to safety management establishes occupational safety as a fundamental business consideration such as accounting, budget, procurement and scheduling.

Mr. Edic is the Construction Safety Manager for Harvard University's Construction Services Group in Cambridge, Massachusetts. As Safety Manager, he has developed a comprehensive EH&S program for the University's capital construction and renovation projects. In addition to the program, Mr. Edic is focused on moving safety to the conceptual and design phase, where he works with University project managers to address constructability challenges and maintenance operations.

Kelly Cone, the Director of Innovation at Beck Architecture in Dallas, writes about the symbiotic relationship between Sustainability and BIM. In his current role, he oversees the implementation of BIM software nationwide in our Architecture, Estimating, and Construction groups. The list of software includes Revit, Innovaya, Navisworks, and DProfiler – our own in-house macroBIM applications.

Micheal J. Lough discusses *How to Differentiate Yourself: A Focus on Quality*. Mike has been a practicing architect for 30 years and has experience in managing large commercial projects across a broad range of building types, including high-rise residential, office buildings, schools, hotels, retail, mixed-use projects, and residence halls. Mike has also focused on project quality assurance and project efficiency since 1994, when he authored the Working Drawing Standards and Guidelines as a vice president at Solomon Cordwell Buenz. In 2006 Mike established Integral Consulting, a consulting practice specifically providing Quality Assurance and Risk Management services to architects, development managers and contractors.

Volker Mueller, Research Director, Bentley Systems writes about his presentation: *Change Design with Parametric Methods*. In his article he explains how he introduces participants to concepts of parametric design through case studies, and describes how he uses exercises to let participants experience the potential of parametric methods.

Zigmund Rubel, principal at Anshen and Allen in San Francisco, is a frequent presenter on BIM and Integrated Practice methodologies. His article, *Collaborative BIM for Eco-Effective* project delivery, describes how team collaboration, a fundamental requirement of integration, is still evolving.

Christopher Martersteck, a project delivery consultant for PSMJ Resources, an international consulting and training firm serving the A/E/C industry, writes about his presentation, *Integrated Project Management -- Tools and Training*, where he describes the requirements of top-down executive support and developing project delivery excellence strategies.

Peter Beck, outlines his presentation; *Beyond IPD: The Integrated Enterprise Challenge*. Peter has been involved with his firm, The Beck Group, since 1978. One of the most forward looking global design and construction firms it has been recognized as one of the "100 Best Companies to Work For" by *Fortune Magazine*. Beck's mission is to integrate the building disciplines, through unique processes and technologies, resulting in order

of magnitude improvements in design, cost and schedule.

Bradford Russell writes about *The Use of Green Materials in the Construction of Buildings' Structure*. In his presentation, Bradford explores the successful use of "green" and "biodegradable" materials in construction. He will outline what impact use of naturally renewable materials have on a building's performance. Bradford holds professional licenses as an architect and a structural engineer and was one of the first LEED Accredited Professionals in the US and Texas. He is currently working towards a PhD from Southern Methodist University in the subject matter of incorporating 'green' design in the practice of structural engineering.

Mike Leinbeck discusses *Combine and Conquer*—*Long-Distance Collaborative Teaming for Small Design Firms*. Mike explores how to run a "collective" architectural practice. Under this scenario, several sole practioneers and small firms each practice as independent architects to deliver small projects until such time as schedule or the sheer magnitude of a single project dictated a need to seek assistance from some or all of the "collaborative". Mike has been an architect since 1986. In 1992, after he founded JML Architects. Since its inception, Mike has sought to leverage technology to the greatest extent possible. Through this methodology, the firm has been able to reduce staff to an absolute minimum (and thus reducing overhead costs by approximately 1200%) while responding to a considerable increase in project workload. Since implementing *Combine and Conquer*, JML has been able to meet numerous deadlines for simultaneous projects with a full-time staff of three including the principal.

Brad Horst and Erin Rae Hoffer write about *Finding Pearls in the Process: Leveraging the Information Created by BIM*. Brad Horst is Principal and CIO at Einhorn Yaffee Prescott Architecture and Engineering. Previously he Brad was a Product Marketing Manager for architectural solutions at Autodesk where he was responsible for product marketing of the Revit Architecture software application.

Erin Rae Hoffer is the Industry Programs Manager with Autodesk. Her career also includes Hollywood experience where she created award-winning effects on "The Last Starfighter." Prior to joining Autodesk, Erin served as Executive Vice-President with the Boston Architectural College and served on the board of directors of the Boston Society of Architects as Commissioner of Technology.

Cliff S. Moser, AIA, MSQA, LEED® AP

Emerging Trends: Constructability through Design Review & Collaboration

By Jason Edic and Gary Cunningham

The word safety has various applications in many areas of our lives. The word is applied to public safety, as in police and fire and life safety as defined by the National Fire Protection Association but in this article it relates to occupational safety, the safety of people at work. The many strategies that exist in the workplace, that are intended to mitigate or eliminate hazards and reduce or prevent injuries, have also been referred to collectively under the generic name of safety. The word has come to encompass areas of interest from housekeeping to process management and safety initiatives apply in varying degrees across every industry in the United States. The safety standards promulgated by the Occupational Safety and Health Administration focus on the relationship between an employee and the direct employer of that worker, with an emphasis on safety at the point of operation or at a point closest to the actual accomplishment of work. Beyond simple government enforcement it is understood that considering safety in advance of the actual task to be accomplished can produce a work environment that mitigates hazards in general and provides for greater worker safety at the point of operation. The initial stages of any effort allow for the most careful analysis of issues and a broader safety strategy for the mitigation of hazards. Inversely, the closer to the accomplishment of work that safety is considered, the more reactive and necessarily more narrow the application of safety principles will be.

The concept of Safety in Design and Construction: A Lifecycle Approach considers safety over the entire lifecycle of a workplace from demolition of an existing structure through the concept, design, construction and operation phases of a new facility. Designers, graphic artists, engineers, architects, construction managers and facilities managers find applications to their work and an analysis of safety issues before and after their involvement. The European Union and the United Kingdom in particular, have codified the need for designers to consider worker safety in their design. Design firms there have provided certain architects with construction and occupational safety training in order for them to meet the requirements of this legislation. In the United States no such requirement exists but applying the principles of designer involvement in the well-being of constructors and maintainers can still be accomplished.

Design review as it is currently practiced by many organizations is ineffective and no single entity advocates directly or solely for worker safety during the process. Studies indicate that design decisions have a direct impact on the well being of builders, building maintainers and of course building occupants. Design features that result in hazardous conditions during construction or for the life of a building can be identified during design review if systems exist that formalize the design review process related to safety. Safety professionals require design review knowledge and designers need occupational safety knowledge in order to bridge the gap that currently exists.

The constituents that a designer must satisfy are many and adding another set of pressures may at first seem unreasonable. The challenges that face architects and engineers as they balance space, site, building codes, aesthetics, sustainability and budgets is that those areas of interest already have adequate representation in the design process. The very fact that designers pay so much attention to those areas indicates that they have a place in the process. The list of entities that currently have a voice during design though does not include safety and without a place in the design, a voice being heard, worker safety is being overlooked. A decision to place mechanical equipment on a roof should not be made without a safety professional being part of the process. Design elements such as elevators, stairways, and fixed ladders should not be considered without input from a safety professional. A discussion on walking and working surfaces would benefit from the inclusion of a safety professional. As in the UK, an architect can fill that role with the proper training but regardless of which profession the advocate for safety is drawn from, they should have no other role on the design team. In other words, advocating for safety during design is a primary responsibility, not a secondary responsibility.

Sustainability has recently become more important to building owners and there are lessons learned there that can be applied to design for safety. Our social conscience is fascinated by concepts that are intended to minimize our impact on the planet. We are determined to find the benefit in cogeneration, geothermal wells,

solar energy and recycling and to rationalize the investment, the expenditure on these technologies and industries. If the atrium that brings natural light into a building comes in at a cost that exceeds our budget we review the numbers again and again, looking for ultimate savings and estimating the increase in the quality of life for building occupants. When the cost of renting a lift to clean the atrium exceeds our budget we install a boson's chair. The effort to justify the added expense of safety is too often a half-hearted one and the compromises that are based on dollars during construction translate into compromises of safety for workers. The same zeal to seek out new technologies and innovative designs must be applied to construction, safety equipment and building maintainability. The drive toward sustainability is an important one but so also is sustaining the lives and well-being of the people that build, maintain and occupy those facilities.

Sustainability + BIM + Integration, a Symbiotic Relationship

By Kelly Cone

This presentation looks at the changes affecting our industry today from a holistic frame of mind rather than attempting to divide and conquer the forces that are driving these changes. Sustainability, Building Information Modeling (BIM), and Integration are each such significant changes to our practice that many firms are attempting to focus on adopting just one or two into their practice. This "take it one at a time" strategy is by far the most common one being used today to adapt to our changing markets, but we believe this just isn't good enough if you want to remain truly competitive. The premise of this presentation is that these changes are complimentary, or even perhaps symbiotic, rather than just three separate influences on our processes. The implication behind such a statement is that we cannot capitalize on the full potential of any of these forces without simultaneously taking advantage of the others as well. Or, inversely, by only focusing our attention on any one we will fail to maximize the benefit to either us or our clients. Bear with us as we explore the complex relationship between these three changes and piece together a delivery strategy that incorporates them all. At the end, we hope you'll walk away with a few ideas to take home.

Our first goal is to have the audience leave able to explain the relationship between sustainability, BIM, and Integrated Project Delivery (IPD). This isn't a simple binary relationship. Sustainable design and construction is assisted by both BIM and IPD, not just one or the other. BIM makes the decisions required for sustainability easier to design, understand, and cost. IPD makes delivering these decisions and handling the repercussions throughout the construction process easier to execute, and helps the owner fine-tune the value for the cost. IPD meanwhile benefits from both sustainability and BIM. BIM provides a platform for better communication sorely needed by integrated teams. Sustainable design also facilitates this communication by requiring more parties being involved earlier in the process thus bringing additional decision makers to the conceptual design table. Last, BIM is being driven by both IPD and sustainability. As more and more sustainable and integrated projects get started both these trends are pushing BIM software and methodology to its limit and driving the improvement and development of these tools. Without IPD or sustainable design, BIM just wouldn't be necessary like it is today.

Our second goal is help the audience evaluate which BIM programs will best fit their design and communication needs on their next project, and encourage those who haven't made that leap to get going. This will not be a sales pitch for one particular program. We have our own BIM toolkit we're successful with, but the key isn't any individual software but in building a suite of software that can interoperate across disciplines, companies, and project phases. Covering our particular solution is meant to help the audience figure out what connections are important so they can build their own BIM toolkit that will work for any project.

Our third goal is to help the attendees understand some of the soft integration required to bring their project team together when using IPD. Integration is a contradictory force in our extremely fragmented industry. Despite various forms of IPD such as design build and integrated enterprises having been around for decades, this isn't something that just works once you throw a couple of Architects, Engineers, and Contractors into a room together. Whether it is incentives in contracts, co-location, frequent team meetings, or high tech communication tools; the key point to learn here is that integration doesn't just happen when you sign that contract. It takes a lot of work and a whole lot of learning from all parties involved to make a truly effective integrated project team.

Our fourth goal is to cover some of the techniques we use to help maximize the sustainable value for a given cost on our integrated projects. While we use a variety of high tech and low tech solutions, we'll focus on early conceptual level decision making for this presentation since this is where the most critical sustainability and cost decisions are made, and where changes in the plan can be accommodated with little to no cost to the owner. These same methods can be used throughout the project life cycle to continue refining the building performance and the sustainable strategy.

Of course, we hope the audience will pick up a few more things along the way, but if you leave our session with those four nuggets in your brain, we'll be happy. Come ready to ask questions, and we look forward to

seeing you at *Changing Times|Time for Change* in Chicago.

Submission Information for Conference:

Sustainability, Building Information Modeling, and Integrated Project Delivery are complimentary process changes, such that none of these changes can be fully realized without the others. In this presentation, we will describe our practice of merging these three issues to form a truly integrated and sustainable integrated process.

To fully illustrate this hybrid process, we will follow a hypothetical project along the integrated project delivery timeline from project planning into operation showing how BIM and IPD can be used to maximize the sustainability of any project. From early energy modeling, costing, and scheduling to updating building information models with field changes to create an as built building information model for operation, the speakers will describe the shift in methodology and the changes in practice that are required to implement any or all of these trends effectively. We will cover the use of a variety of BIM technologies:

- DProfiler - running iterative analyses to maximize the design and energy performance of a building for a budget.
- Revit/Ecotect/GBS – designing and documenting projects from SD through CA, and how to build a BIM for architecture AND construction.
- Innovaya/Timberline – quantifying and costing BIMs to capture design intent and reduce value engineering.
- Navisworks – 3D coordination, 4D scheduling, and FM in design and construction.

Speakers will reference project case studies of active or completed projects along the way to provide concrete examples of how these process and technology changes can create exemplary successes for sustainable design and construction.

- Explain the relationship between BIM, IPD, and Sustainable design and construction practices.
- Evaluate which BIM programs to use on their next project in order to overcome the lack of interoperability between software and meet the project's BIM implementation goals.
- Integrate the project team and tools on their next integrated project to enable cost-effective sustainable design and construction
- Analyze sustainable design alternatives with team feedback and BIM analysis tools to ensure design decision maximize performance improvements for the cost.

How to Differentiate Yourself: A Focus on Quality

By Micheal J. Lough, AIA, Principal, Integral Consulting and Jonathan L. Fischel, FAIA, Senior Consultant, Integral Consulting

In 1974, Robert Persig wrote Zen and the Art of Motorcycle Maintenance, a philosophical work that was widely read in the 1970s. The focus of his book is on quality. Persig states *"Quality isn't method. It's the goal toward which method is aimed."* If this is correct, what is the goal for professional service firms, such as our architectural practices? Is it excellent architecture? If so, what constitutes excellence in architecture? Examining the contractual obligations for architects as outlined in the AIA Owner-Architect Agreement, one finds both "Architect's Scope of Basic Services", and "Architect's Responsibilities"; together these clauses include performance of services that meet a standard of care.

To achieve quality architecture, a holistic approach of the entirety of the design process must be considered, commencing with programming and needs assessment, through the design phases, and include preparation of contract documents and construction administration services. Quality design and excellent architecture takes place in every phase of a project, and is the responsibility of every member of the project team. Quality lives in every element of the process, and caring, and concern for how such excellence is integrated into each element and achieved for the project is the responsibility of each member of the project team, and must be supported by a firm's leadership. One can describe the presentation drawings that include plans, elevations, and renderings as excellent architecture; such excellence must be expanded into every aspect of the process, and be joined by the detailing of the building, in order to be acclaimed in the completed and occupied building as excellent architecture.

Pirsig also ties quality to caring. *"A person who sees Quality and feels it as he works is a person who cares. A person who cares about what he sees and does is a person who's bound to have some characteristics of Quality."* It is essential that all members of the project team care a great deal about the overall design solution. Conceptual design excellence occurs when it recognizes and addresses how the building will be organized, detailed, and constructed; technical design excellence is achieved when it recognizes and addresses the importance of implementing the original design concept within the detailing and construction of the building. Thus design and technical areas are inter-dependent: Their success is mutual, and each part must achieve a high level of mastery and excellence for the whole to also achieve excellence.

Thus an architectural firm, whether a firm of one or a firm of one hundred, must care about the quality of design through every phase and detail of the project, the quality of technical execution of the work, and the quality of the full range of services as spelled out in the architect's agreement with the owner.

The presentation "How to Differentiate Yourself: A Focus on Quality Integral Consulting" will provide an outline of components and topics that may be used to develop a firm's Quality Management Program. What we are not attempting to do is to provide a prescriptive program for Quality Management that is a one size fits all. There are Quality Management guide structures available, such as ISO 9001, Six Sigma, Total Quality Management (TQM), and the American Council of Engineering Companies Organizational Peer Review. While quality architecture cannot be achieved simply via strict adherence to some quality management formula, the structure of a firm-specific quality management program, implemented with discipline, can improve the quality of the architecture, the quality of the design and documentation, and the quality of services performed. Benefits of quality management programs also result in reducing a firm's exposure to claims and improving client relations. Quality management, if structured properly, should never be an obstacle, but instead a means to improving the efficiency of executing services required under contract.

There will be a brief background discussion of Quality Management pioneers such as Edward Deming, Joseph Juran, and Philip Crosby. There are many sources which can be referenced in developing a Quality Management program. Among those that will be referenced in the presentation will be the International Standard ISO 9001 Quality Management System, CAN/Schinnerer's Risk Mitigation Credit for Architects, the 2009 ICC Performance Code, Building/Accessibility and other Codes and Standards, and LEED. Our focus will be on a topic-based outline adaptable to large or small architectural firms, identifying potential components which can be the basis

for a firm-specific Quality Management program.

A true Quality Management system requires commitment by the firm's leadership. In fact, one of the key requirements of ISO 9001 is that top management makes a commitment to a quality management system. An intelligent and practical approach may be to work towards Quality Management in stages, and provide a framework for a full Quality Management system to evolve within the firm: Develop a customized outline and get comfortable with a few components of Quality Management, rather than approach Quality Management as an overhaul of the firm's processes.

This session will provide an outline of components that could be used to formulate a firm's Quality Assurance / Quality Control Program. The session will briefly touch on various topics in the outline. Finally, the session will expand upon the "Document Quality" section of the outline, and conclude with Q & A.

- Agreements and Contracts
- Leadership
- Commitment
- Mission / Vision Statement
- The Firm's Human Factor: Staff
- Mentoring and staff development
- Elevate understanding and goal-sharing
- Pre-Project Planning:
- Staffing / manpower / responsibilities
- Project scheduling
- Project monitoring and control procedures
- Establishing Design Team Objectives for Each Design Phase
- Establish General Objectives for each Phase
- Clearly articulate specific tasks and responsibilities to be achieved in each phase by responsible party including Owner and consultants
- Define upfront the Deliverables for each Phase
- Processes:
- Team member responsibilities and communication processes
- Architectural team communications – team progress meeting
- Consultant communications
- Owner communications
- Bring back the "cartoon" or "mock-up set"
- Document Quality: (More developed session for discussion)
- Establish project Performance Requirements early in the process
- Technical development
- Constructability review
- Peer Reviews
- Completeness for Phase
- Project coordination
- Technical detailing
- Specifications
- Construction
- Observations
- Submittals
- RFI's and Change Orders
- Project Close-out
- Continual Improvement
- SWOT (Strengths, Weaknesses, Opportunities, and Threats)

- **Feedback and measurement**

Change Design with Parametric Methods

By Volker Mueller, Assoc. AIA, LEED AP, Research Director, Bentley Systems, Incorporated

The increased availability of parametric tools for building design offers new opportunities in the design process, provides designers with high levels of responsiveness to changing project conditions, and lets project teams explore innovative approaches to inter-disciplinary collaboration throughout project design and delivery. “Change Design with Parametric Methods” introduces participants to concepts of parametric design in theory and through case studies, uses exercises to let participants experience the potential of parametric methods, and offers opportunities for discussion.

While Heraclitus of Ephesus observed more than two thousand years ago that “change is the only constant” one could argue that change is not constant: it is accelerating. The seminar examines approaches to employing the very nature of change in order to expand design exploration while responding to the current and future demands of our changing times.

Especially in recent practice, well-conceived design processes have supported change at multiple levels. Change can and will occur at the level of major project parameters, like budget, timeline, program, or desired building performance. Project goals may change depending on changes in economic conditions, shifts in client goals and design team interests, new insights provided by consultants, contractor and sub-contractor input, availability of resources on regional, national, or international markets, technological progress, regulatory changes, etc. Progressively, information technologies employed in design practice have supported change in various forms. For more than two decades ideas and related technologies like the virtual building model, virtual design and construction, object oriented design, and lately Building Information Modeling (BIM) which as a term appears to subsume all preceding technologies, have matured and support change to some extent in the majority of implementations.

Primary focus of these technologies has been on consistency throughout all design documents which was difficult to achieve before these technologies were adopted in architectural practice. With BIM, practitioners can now easily achieve consistency between three-dimensional, attributed digital models and two-dimensional drawings, as well as other related documentation, because all these are views into the same set of data. Modifications in one view are modifications to the data set and accordingly will be reflected in all other views. Due to the unified nature of the data set, e.g. drawings are dependent on the model as representations of it; change management is greatly simplified compared to the past practice of manually updating all drawings whenever the design changed.

While views into a model by definition depend on the current state of the model and are showing it in a consistent and predictable fashion, there are other behaviors of the building model that may be expected in reaction to changes, especially predictable behaviors of elements or components in relation to each other. Therefore, some of the available systems exceed the simple view- or report-related change management by implementing higher levels of dependency. The entity types between which the designer may wish to establish dependencies that can be captured in and propagated through the building model vary greatly between BIM implementations. The seminar considers an implementation that supports very different entity types between which dependencies may be established, or which perhaps in concept has no preconceived limitations. Using as a basis an implementation without severe preconceived limitations allows this seminar to emphasize the utilization of concepts underlying parametric systems for the purpose of design, in short to emphasize using the specific strengths of parametric design methods.

Parametric design uses digital models defined by parameters and driven by variables to move beyond BIM by enabling a high degree of model adaptability. The basic idea of parametric building models is that relationships to or between building components can be established and maintained. These relationships can be of geometric nature and may extend to any other computable relationship, for example to dependencies between project-specific building systems components on one side and building performance goals influenced by climate and other site conditions on the other side. Using well-developed mathematical concepts the design team can define the behavior of these non-geometrical relationships, even though ultimately a substantial part

of parametric modeling is in the dynamic and variable control of the geometric expression of these behaviors and relationships.

Obviously, such model adaptability will be helpful when the need arises to react to changing project parameters. More importantly, even without such changes occurring, capture of the design concepts in a parametric system will allow the exploration of the design through the generation of model variations by changing variables or parameters. The design team can observe and evaluate the resulting behavior of the design, thus gaining deeper insight into the consequences of design decisions. By changing parameters, or by modifying the parametric concept, the design team can continue to explore more fundamental changes in the design without having to rebuild the building model because those changes or modifications will propagate through the parametric model.

"Change Design with Parametric Methods" will introduce attendees to the fundamental concepts of parametric design. The seminar intends to achieve four learning goals:

1. Based on the theoretical overview and presented case studies participants will learn to identify a design goal with a measurable performance related to sustainable design that they will be able to evaluate with computational methods. **Identification of a design goal and its translation into a measurable performance is a first step towards creating a parametric concept of the design. Determination of the details of measurement, how the performance could be incorporated in a digital building model, and how it could be evaluated computationally are sub-steps that often require some insight from experts in the respective disciplines. Obviously, the opportunity for easy access to the required cross-disciplinary insights appears significantly increased when using an integrated practice approach.**

2. Using the identified design problem, participants will learn to analyze performance goals for opportunities of parametric control, so that they will be able to identify parameters that will allow them to explore part of the design's solution space. **Parameters that may offer themselves to variation are determined by their potential variability as attributes of architectural elements or components; by how they will have to be implemented in the digital building model; and by how they are anticipated to influence the results of the simulations used to predict their performance. Because of the different loci where these opportunities for variation arise it may be worthwhile considering alternating which of these perspectives drives the selection in order to expand the design space for possible discovery of further opportunities for design improvement. In parametric design exploration the design space is defined directly by the variables that are examined. The number of variables establishes the dimensionality of the design space and their respective range establishes the size of the design space. Design spaces are easy to visualize in two and three dimensions, which may constitute another design consideration when using a parametric design approach.**

3. Participants will design a component with variably controlled behavior incorporating identified parameters, so that the component exhibits a measurable sustainable performance characteristic. **With the preceding considerations in mind, a minimalist and economic approach is advised. In terms of conventional practice, this level of parametric component design is concept design or sketching, even though in this methodology the sketch captures the design in terms of parametric concepts. The shared characteristic is the iterative process which may require abandoning a design and restarting from scratch with a changed perspective.**

4. Using the designed component, participants will investigate possible modifications of the component behavior that could improve its performance, will learn to apply modifications to the component, compute its changed performance, and verify whether the predicted performance improvement occurred. **The aim of parametric design is to find a design response that satisfies, meets, or exceeds the project goals. As such, parametric design suffers from the general handicap that design problems are very often ill-defined or ill-bound problems. In short, a design more often than not leaves room for improvement. Parametric design allows exploring the solution space in a systematic fashion; expanding or narrowing the solution space by modifying the range of variables; or redefine the solution space altogether by changing parameters and their dependencies.**

Compared to rather static BIM models which capture only a specific design state and may help illuminate it through documentation and reports, a parametric design model allows the design team to explore a wider variety of design responses. The design team may gain deeper insights in the consequences of design decisions, and, therefore, may arrive at a design that better meets the project goals.

Collaborative BIM for Eco-Effective Project Delivery

By Zigmund Rubel, AIA

Collaborative BIM for Eco-Effective project delivery will discuss and demonstrate that harnessing the collaborative power of technology for sustainable design requires an integrated team. Collaboration is a fundamental requirement of integration. Harvesting technology for the design and construction process requires teamwork because it is still evolving. Collaborative projects have fewer claims, shorter schedules and more job satisfaction than those projects that do not demonstrated by research from the Construction Industry Institute, University Texas, Austin. Building Information Modeling (BIM) enhances the team through digital collaboration and integration of models. Anyone considering putting a team together should consider how collaboration and digital integration can further enhance the team's performance and outcome when delivering their project for eco responsive design.

All IPD projects are custom responses to their unique requirements. There are some projects that can be done effectively and efficiently in a design bid and build environment. These projects need a market response to prescriptive requirements. Some of these projects may not be using BIM to its fullest potential. IPD is best applied to projects where there is flexibility in process, utilization of BIM where speed and cost containment are of greater concerns (*figure 1* Courtesy Anshen + Allen Architects).

As we look at embracing building information modeling, or BIM, there is no clear structure of who owns the model or which model governs in a particular situation. There are two basic model types--design and fabrication—each type of model has a different purpose, although they share the desired outcome of facilitating the design and construction of a project as well as to optimize efficiency. There are many software solutions that help the architect orient a building and study how energy interacts with the building's façade. We are not at the level of computer modeling that can inform how the actual materials selected and how they are fabricated help or hinder the initial design goal. MEP models, which are probably the most sophisticated of the building fabrication models, are not at the level of development to have dialogue between design and fabrication. In order for the designer to have influence on the design and fabrication models they need to be compatible to give the project the value they both have.

The logical benefit of the technological application to project delivery is added value. We have found that projects that are delivered with collaborative methodologies last longer and cost less to operate. IPD leveraging technology can ensure that energy performance is met. Preliminary data from the Energy Star program indicates that buildings with an Energy Star rating can garner higher leasing rates than those with no rating, according to RICS research. Energy efficiency in both design and usage are the easiest to perform and typically provide immediate results. Energy is only one of the criteria sought for eco-effective design. The USGBC LEED certification process requires several broad criteria's to be addressed, including energy, to deem a project certified. Can our BIM's provide the information needed to inform material choices? Can the "I" in BIM be the primary driver for its use? This session will show how one such project used the intelligent portion of our model to help inform our choices.

The University of California, San Francisco, Mission Bay Medical Center is the exemplar that this session will demonstrate that Collaborative BIM for Eco-Effective outcomes can be achieved *(figures 2 and 3)*.

FIGURE 2: (Courtesy Anshen + Allen Architects)

The project has an aggressive goal to use 50% less energy than the average US Hospital. The complex is a 900,000 sf development with a 289 bed Women, Children's and Cancer Hospital, an Out Patient Building, Central Plant and related site improvements. The owner knew that the traditional model of design bid build would not guarantee a project success on both a delivery and sustainability perspective.

Particular project strategies that will be discussed that made this a success include:

- All parties are developing the design in the same space using design and fabrication BIM's:
- Allowing most responsible party to make the decisions and drive innovation
- Tiered Integrated Management
    - o Collaborative Leadership
    - o Monitoring progress through Clusters and Control Groups:
    - o Scope trending supporting Concurrent Estimating
    - o Change Management through Project Modifications and or Innovations processes

Teaming strategies, model usages, information extraction methodologies, and co-location benefits that support our broader agenda for Eco-Effective project delivery will be the broad discussion points of the session. The session will differentiate design services into four basic categories that our professional services fall into. The session will focus on the latter two of:

- Code Minimum – Probably working in a silo
- Best Practice / Optimized – Possibly working in a silo or probably not with the builder
- Owner willing to spend extra money for a better outcome – Collaboration is required but possibly not integration
- Innovation is desired – Integration of the team is required to develop a ground breaking design

Owners are recognizing that then cannot spend the least acceptable amount on their buildings if they want their investment to be eco-effective. Technology and collaboration will allow our profession to lead this shift.

As the conference announcement describes, *"Our practice is changing at a breathtaking rate, requiring near-constant reassessment of business models and practices".* In our new world of accountability and predictability, we need the constructor and the designers working together to reduce reactivity and allow us to model once and get the detail right from the outset. In order to leverage the unique skills of the architect as "generalist," it is logical to expand the team with a specialist focused on building- and system-specific know-how. This broader team and integration is essential in a building that aspires to be an eco-effective success.

Integrated Project Management -- Tools and Training

By Christopher Martersteck, AIA, LEED AP, DBIA

Integrated practice continues to take on added importance as projects are faster, clients more demanding, with tighter budgets than ever before, and as increasing use of new technologies and collaborative teaming strategies are embraced by clients and architecture, engineering and construction (A/E/C) firms alike.

Many recent conferences which strongly suggest the importance to our profession of such teaming and leadership concepts as Integrated Project Delivery, as well as writings such as *The Next Architect*, articulate how architects need to establish clearer goals to guide design, and work to lead the entire A/E/C process. We also need to do a better job of supporting our team leaders and team members with easy to use methods to achieve these critical goals through providing simple tools, templates, and training, thus acting to maximize the value, design quality and bottom-line results for our clients and our teams.

Though it is evident that the future of A/E/C practice is not only integrated and collaborative, it also is providing more opportunities as well as needs for architects to re-assume more of the leadership role that we have legitimately had for thousands of years. Architects' strong and typically enduring connections to clients and understandings of client and team members' goals and capabilities, provide the underpinning for much of this natural leadership role. However in many cases we have abdicated much of that responsibility – and with it the benefits and ability to better manage risks and reap higher rewards – over the last fifty years.

Many examples are also available however – though not apparently readily known – of architects who have achieved great success through expanding their capabilities beyond design, to lead more of the A/E/C process. But we need to work to play to our natural strengths to most readily focus on ways to grow that role, by connecting better to client and team goals. We also need to emphasize our natural inclination to function as servant-leaders, supporting the needs of our clients, our team members, as well as society and the environment. After all, if through our efforts in serving other team members' needs, all of our team members are more successful, and do we not also become more successful as well?

So as a result, to achieve these goals, it becomes absolutely critical that we provide to our teams simple and easily accessible tools, as well as training and mentoring and ongoing support, for our architect-leaders to more effectively manage -- and lead -- more of the integrated project delivery process. We can all do this through the natural connections and strong trust relationships we have with our clients as an outgrowth of our pivotal design role, and as we function as their agents and advocates to achieve their critical functional, aesthetic, budget and schedule goals.

Part of this effort must necessarily involve a top-down support and stronger focus on project delivery excellence. As much as we are in this profession to develop great and innovative design results, we must also work at enhancing our delivery process focus and our client relationships. And maintaining and growing bottom-line profitability – never more critical than right now – is another significant benefit of this process orientation.

Another powerful aspect of this effort is clearly articulating organizational core values, and combining that cultural framework with consistent and simple project management tools as well as ongoing project leadership training that together lead to long-term firm success.

Using the above structure and focus, one of the most basic tools that the most successful A/E firms consistently employ includes project work planning in a focused way with our in-house teams as well as with our clients. This is a central aspect of the project initiation phase, but it should not be thought of as only an initial effort. Once the project is appropriately launched, we also need to work to insure this team-building and goal-setting process is at the forefront of the team's consciousness throughout the entire project, rather than simply treated as an initial deliverable. Employed correctly, this activity evolves and then becomes continuous throughout the project's life and beyond, acting to connect us better to client and team member goals and ultimately leading to expanded service opportunities.

Additionally, we need to also appreciate how work planning supports development of another technique that the best firms consistently develop but which many fail to make part of every project, namely a bottom-up budget. This breakdown of the project work structure lets us understand the planned and engaged project scope and progress through forming the foundation of a simple method of earned value analysis. Additionally, it also allows us to easily understand the actual progress we have made on our project, rather than just looking at expended fee or schedule resources. As a result, it maximizes our understanding – and that of all our team members -- of how to most effectively monitor and meet -- and take corrective action when necessary and sometimes even exceed when possible -- our profitability and schedule goals.

Other project tracking tools are also important of course. Some of the most valuable – and easy to use – also incorporate communication tools such as simple yet invaluable project status reports and status review sessions.

All of the above methods and strategies for success will be presented in the intensive and densely-packed seminar session "Integrated Project Management -- Tools and Training". Participants will hear about real case studies and see templates and tools which support and illustrate the above process and core values. These tools have been distilled from the essence of multi-day project management training seminars incorporating A/E/C process delivery best practices. They are critical resources that every firm – no matter how big or small, no matter what size projects you do -- should have in some form appropriate for your work, to support stronger client relationships, grow bottom-line profitability, and achieve higher design results, all through a strong project management focus on project delivery excellence.

Christopher Martersteck AIA, LEED AP, DBIA ***has been a progressive leader in the A/E Design and Construction Industry for most of his 33+ years in the profession. As VP/Director of Project Management & Integrated Project Delivery for several of North America's larger AEC firms, he has led and trained staff and teams in Project, Program and Construction Management as well as Architect-Led Design-Build engagements. Responsibilities have included direct management of technically complex and highly accelerated at-risk design-led design-build projects as well as conventional A/E projects, ranging from smaller projects to ones exceeding $150 million. He has also been responsible for development of project management and delivery systems for fully integrated architect-led design-build as well as unbundled A/E/C services across firms' commercial, corporate, healthcare and educational business sectors.***

Mr. Martersteck is currently a project delivery consultant for PSMJ Resources, an international consulting and training firm serving the A/E/C industry. He leads multi-day Project Management Bootcamps for A/E/C and planning firms and lectures internationally on project management. He develops presentations and manuals on project management and project delivery methodologies for the complete A/E/C process, utilizing lessons learned from his experiences as a client as well as a consultant leading highly collaborative integrated project teams. To discuss this issue with the author send an email to cpmartersteck@yahoo.com.

Beyond IPD: The Integrated Enterprise Challenge

By Henry C. (Peter) Beck III

As I engage in various AEC forums, I'm struck by the similarities between our industry and others going through massive changes. While we struggle with the legal barriers to integration including file sharing, insurance issues, assigning liabilities through evolving integration contracts, the patchwork of state licensing requirements, etc., customers demand that we redefine our practices and business models. They insist that we radically improve our value proposition by capitalizing on recently innovated tools. Other industries, including music recording, publishing, residential brokerage, and now car dealers, etc. have all gone through monumental changes despite the legal barriers they faced at various points in their evolution. So what can we learn from them?

First of all, we have repeatedly observed that despite the legal barriers, innovative participants ultimately prevail in changing the practices and business models of any industry in order to meet the evolving needs of new and existing customers. Secondly, such transformations are usually enabled by the invention of some innovative technology which opens up the possibilities. But, the technology alone is rarely sufficient to drive the change as we have observed so often in the past. Retailers were slow to adopt credit card readers during the 1970's because they received little benefit while absorbing all of the cost, just as movie theaters are reluctant to adopt digital technology today. Therefore, the third lesson that we can learn from other industries is that transformative change must be driven by consumer demand usually involving some combination of improved quality, lower price, and/or greater convenience.

An excellent example of these characteristics is the explosive growth in music distribution through iPods and similar devices. This transformation has completely disrupted the recording and music distribution businesses, despite the legal barriers. Through innovations in storage technology and digital transmission, we can not only acquire the same quality of music as we've come to expect, but can do so at a far lower price, in the greater convenience of our own home, and without being required to purchase a lot of other songs (on an album) that we are hardly interested in.

So let's first look at our own industry and study the drivers of change before evaluating the enabling technologies. What keeps participants in our industry up at night? What are their strategic nerves? Judging from articles generated by the Construction Users Roundtable (CURT) as well as from the Annual Survey of Owners conducted by Fails Management Institute (FMI), owners are intensely frustrated by the waste generated in the delivery process due to both the lack of coordinated and complete information as well as by poor alignment between practitioners. Completing and coordinating design continues to be pushed into the shop drawing review phase, or even worse, into construction, causing change orders and delays that aggravate customers. Architects feel pain around insufficient information from contractors to perform their work correctly the first time as well from the responsibility they assume for the accuracy of the documents when they are not sufficiently compensated to coordinate or complete them; even if they had sufficient knowledge to do so. Finally, look into the eyes of a project superintendent at the end of a project, after several sleepless nights, and you will find a deep motivation for change. When asked the cause, superintendents are quick to respond that too little of the project was properly defined early enough to avoid confusion among the subcontractors, resulting in poor quality and additional costs. So, with such deep motivations to change why has so little happened?

Up until this point, we have not had the means to resolve these problems. With the advent of BIM technology, we now have the opportunity to rethink both the processes and the business models. No longer must we rely on clouding changes or using light boxes to resolve design coordination errors after the fact. Emerging Macro BIM tools enable us to evaluate building models during programming to optimize the solution by rapidly studying a myriad of alternatives before design begins. Micro BIM tools such as Revit and MicroStation enable us to define very accurate models of the project, with appropriate input from all participants, to significantly improve both the coordination and completeness of the resulting information. In essence, Macro BIM tools will answer the question of "if" we want to proceed with the project by optimizing the building through inference modeling, while Micro BIM tools define "how" to build the building by accurately defining and coordinating

nearly every detail for construction. Then, we also have the bridging tools such as Innovaya and Navisworks which "bridge" across platforms by overcoming the lack of industry standards for design details and estimating formats. All of these tools are rapidly developing our capacity to optimize the design for a better return on investment (Macro BIM), while improving project definition before construction (Micro BIM) to enhance coordination and completeness and thereby minimize subcontractor contingencies, change orders, and delays.

So how will our industry evolve given the drivers and enabling technologies described above? Recently, the industry has advocated the virtues of Integrated Project Delivery (IPD) in which project participants engage earlier in the process through new types of agreements which promote cooperation. While certainly an improvement, such models are merely half-steps designed to preserve the status quo in permitting disciplines to remain independent. One model promoted by the AIA creates an LLC incorporating the key disciplines, but then allocates risk and reward in the conventional manner resulting in traditional behaviors. Another IPD model promoted by the AGC and others shares the risk and reward among disciplines (Article 11) to motivate cooperation and mutual responsibility among the owner and the various practitioners. This is a step forward, but with few exceptions, architects and owners are reluctant to assume partial responsibility for the contractor's cost and schedule risks, resulting in slow adoption of this form of IPD. Can you imagine many owners or architects willing to assume some of the risk for the accuracy of the contractor's foundation estimate? For that matter, why should any owner assume responsibility for the obligations of either discipline just to foster some form of cooperation between them?

Instead, owners have a right to demand that the disciplines live up to their own commitments and assume responsibility for each others' performance. By capitalizing on these new technologies, contractors can and should begin assuming responsibility for the completeness and accuracy of the architect's design. Architects can and should start to assume responsibility for the contractor's costs and schedule, including means and methods. However, architects and contractors are unlikely to do so as independent entities in an IPD environment where integration occurs only at the project level. The ultimate opportunity is to overcome the status quo and to merge the disciplines into one firm thereby assuming responsibility for the complete design and delivery of the project and mitigating the perceived risk through the sophisticated use of these emerging technologies. Not only will the combined disciplines cooperate at levels never seen before to ensure complete and timely information along with accurate pricing and scheduling, but such an Integrated Enterprise will also be motivated to invest in mutually accepted design components for detailing and estimating, common mapping protocols between different BIM technologies, necessary cross-training to radically improve efficiencies at the project level, and so on. Such investments are expensive and must be amortized over many projects through an Integrated Enterprise Model (IEM) and cannot be cost effective in an IPD environment with no assurance that the parties will work together enough times to sufficiently amortize the investment. These emerging technologies offer the opportunity to improve across the disciplines, not simply within them.

If, as mentioned earlier, adoption depends on improvements in price, quality, and/or convenience, can you imagine the response from clients when one firm guarantees the performance of all disciplines along with no change orders? In order to make such commitments, the Integrated Enterprise must complete and coordinate building information to a much higher level than industry standard (which the new technologies make possible) resulting in significantly lower project costs as subcontractors reduce their contingencies. These are precisely the kinds of goals to which an Integrated Enterprise should aspire.

Most industry participants are very reluctant to merge both disciplines within the same firm. However, there is increasing evidence that some AEC firms may be motivated to change given new options enabled by these technologies. There may be a classic, up-market disruption brewing here as defined by Clayton Christensen in his book, *The Innovators Dilemma*. As contractors seek to limit their risk and gain more control over the completeness, accuracy, and timing of project information, they are naturally motivated to assume more of the design production process and perhaps even become the architect of record. As architects seek to improve their margins and limit their risk, they are motivated to turn over responsibility for design production to the contractor. Architects will increasingly seek to limit their scope of services to the initial phases of the design process (schematics and design development) wherein the margins are far greater and the risk much less than that incurred in the latter phases. In contrast, design production looks ever more attractive to the contractor, who is increasingly required to assume most of the delivery risk anyway. As contractors begin to move upstream, they will take the first steps towards an Integrated Enterprise which may eventually result in such firms assuming the creative design function as well. This may well be a moment of transformation for the industry and particularly, for the architectural profession.

It doesn't have to be this way. Personally, I wish that architects would lead this transformation given their deep knowledge of design and their understanding of how buildings are put together. Otherwise, the design profession may continue down the same, slippery slope experienced over the last several decades; yielding their influence over the delivery process.

Regardless, all architects must reconsider their current role in the delivery process. Here are a few steps to reflect on as you think about how to position yourself for the future:

- First decide whether you want to become a pure designer delegating production to others or an architect leading the entire process. These are quite different paths in that the first turns most of the risk over to

another party while the second seeks to mitigate risk through greater and more effective control of the process.

- The first path is pretty well defined today with many successful examples. But the second path requires a fundamental change in your business model. Before choosing to lead the entire process, you must be prepared to take on new responsibilities and learn to effectively manage more of the delivery process.
- The first step along the latter path is to build capital within the firm instead of distributing it annually. Builders require risk capital for a variety of reasons.
- carefully select a contractor with the right culture to venture design/build projects together with a goal towards merging the firms at a specific time. Contractor selection is by far the most important and challenging step in the entire process. Culture assessments of both firms can be very helpful.
- One can merge the firms by forming a small, separate group to move forward as the ultimate, surviving entity, or to combine both firms completely. Each has its pros and cons which must be carefully thought through. Regardless of which method you choose, the merging entity must co-locate as quickly as possible.
- Finally, the combined leadership team must adopt an investment strategy to differentiate the merged entity as an Integrated Enterprise. This strategy must cover technology adoption, cross-training, common formats for details and assemblies, mapping protocols between internal technologies, branding, and all other facets of the Integrated Enterprise. These are the opportunities which add significant value in the delivery process and that no two firms can afford to adopt by integrating a few times at the project level (IPD).

Offering no change orders, jointly guaranteeing design and construction performance, and even merging with a contractor sound scary at first. Break the problem down into its pieces. You may find that in controlling more of the risk, you can actually reduce your exposure and enjoy better opportunities with fewer competitors...at least initially...if you begin now.

We cannot stop the impending transformation of the AEC industry as so many have learned before us in other industries. Witness the medical profession where control and profits migrated from doctors to administrators to insurance companies...and now perhaps to Washington D.C. But we each have a choice in deciding where and how to compete in the future. Let us choose wisely and not let our traditional fears and adherence to norms blind us from seeing the wonderful opportunities which lie ahead!

About the author: ***Henry C. (Peter) Beck III has been associated with Beck and its affiliates since 1978. During this period, he has held various positions within the firm, and since 1991, has served as Managing Director. The Beck Group is an integrated builder offering project finance, design, construction, and development services through nine offices across the United States and Mexico. The firm completed transactions in excess of $976 million in 2008. Among other distinctions, The Beck Group has been recognized as one of the "100 Best Companies to Work For" by Fortune magazine. Beck's mission is to integrate the building disciplines, through unique processes and technologies, resulting in order of magnitude improvements in design, cost and schedule.***

The Use of Green Materials in the Construction of Buildings' Structure

By Bradford Russell, AIA, P.E., S.E., BR Architects, Inc.

Green Materials to Offset Seismic and Other Natural Disaster Events

Abstract: **'Green' materials include those which are renewable and/or cause the least impact on the environment. In design, it is the creative initial layout (both of the spaces and the structure) and building design that takes full advantage of building 'green'. With this, 'Green' materials can be considered waste products, which hold no harmful effects, are considered at the end of their useful life, and can be used in conjunction with other construction materials for a building's construction. We will explore the use of fly ash in concrete, biodegradable materials in concrete, and the use of natural faster renewable materials as a new means of construction. In addition, we will look into what impact these materials can have on the building's performance in extreme conditions.**

Fly Ash in Concrete

We must begin by understanding the environmental cost of the cement used in concrete construction. It is estimated for each ton of cement produced an equal amount of carbon dioxide is released into the atmosphere. More than 600 million tons of fly ash is generated each year worldwide with 80% disposed of in landfills. The pozzuolanic and cementitious properties of fly ash make it ideal as a substitute for cement in concrete and thus remove the need for disposal. It has been found that high performance fly ash concrete can improve the workability, ultimate strength and durability of the concrete.

There has been data published to show fly ash added to concrete can increase the ductility and other mechanical properties of the concrete mix. As Fly ash reacts with the free lime in the concrete mix it creates more efficient Portland cement. Fly ash particles are smaller and almost totally spherical in shape, allowing them to fill voids, flow easily, and blend freely in mixtures and thus creating a more efficient durable section. The class of fly ash to be chosen for the concrete depends on the desired qualities in the mix.

Concrete is a material which has tremendous compression strength and is relied upon in distributing loads to the sub-grade. The use of fly ash in concrete has been shown to increase the compressive strength over time. However, the early strength of concrete with flyash has approximately a 25% reduction in compressive strength. But after the 28th day, the strength of the fly ash concrete exceeds that of Plain Cement Concrete.

The enhanced mechanical properties due to fly ash substitute include a higher elastic modulus, lower shrinkage and creep, excellent freeze-and-thawing resistance, lower water permeability, and lower chloride-ion penetration, all sustainable issues. In addition, these properties will have a substantial positive impact on the structure in extreme events. The ability of fly ash to control the crack width and free drying shrinkage may also add to the long-term durability of the structure under extreme conditions.

It is imperative for us to take advantage of other products, including fly ash for achieving the same or greater benefits of concrete performance in use. Note that the substitution of fly ash for a portion of the cement in concrete could chip away the harmful effects we are having on the environment, and offer advantages needed in the performance of buildings under extreme conditions.

Biodegradable Materials in Concrete

Concrete is a material which has tremendous compression strength, but needs another material to help in tension. In the past, steel has been the material used in strengthening concrete under tensile loading. In addition, other materials have also been used i.e. fiber reinforcement. In today's 'green' construction, we look to limit the embodied energy of the physical structure. We need to find materials which can be high-performing, fast-renewing, and serve as reinforcing. At the same time, these materials will need to function properly in extreme conditions.

In 1966, the U.S. Naval Civil Engineering Laboratory released a document entitled '**Bamboo Reinforced Concrete Construction**' and noted design properties for bamboo used as structural elements and ultimately as reinforcing in concrete. The differing varieties of bamboo in the world will offer a range of mechanical properties for this use. Bamboo might replace steel in light construction as the tensile source in concrete design if coated with a decay-resistant cover.

As with steel, bamboo can be bent and formed when heat is applied during forming pressure. This procedure can be used in forming the splints into C-shaped stirrups used as anchorage reinforcing. This can take place with either wet or dry bamboo. To protect the bamboo from moisture rotting, the bamboo must have waterproof coatings added to the exterior. These waterproof coatings are added to reduce the swelling of the bamboo when in contact with the moisture of young concrete. Without such protection, the bamboo will swell before the concrete has developed sufficient strength to prevent cracking, and the member may be damaged.

The same techniques for the design of reinforced concrete are used for bamboo reinforced concrete with only the properties and techniques changing. Due to the low modulus of elasticity of bamboo, flexural members will nearly always develop some cracking under normal service loads. With this, above grade reinforcing of concrete structures with bamboo treated by today's standards will not handle the loading expected from extreme conditions. However, buildings using concrete foundation structures only, the massing of concrete might generate acceptable conditions for normal use, and during a natural disaster event.

Natural Faster Renewable Materials

Bamboo is generally found in temperate and tropical regions of the World, can grow up to 36" in a single day, and offer a great source for replenishing of materials. In addition to fast growth and enhanced structural performance, growing bamboo removes carbon dioxide from the air and can be sufficiently grown in a large area of the USA. In addition to use in concrete, bamboo offers structural qualities lending itself to above grade construction. The strength per weight of bamboo can offer as much as twice that of steel, showing an advantage where weight is critical. Much thought is required in the connections between the members to keep the forces in the acceptable range. Because of the tendency of bamboo to swell, the connections must allow for expansion in the joint.

The influence of seismic events on buildings is due to the weight of the building and distance above grade of the building elements. Bamboo can serve as a light structural element for buildings, which can be limited in height, and serve to lower the seismic impact associated with the dead load of buildings during seismic events. In 1992 Costa Rica was hit by an earthquake which registered 7.5 in magnitude on the Richter scale. The only buildings which survived were homes built of bamboo construction, while all other homes and buildings surrounding were demolished. The use of bamboo as a construction material may never come to acceptance in this country because of the different skilled labor needed, and lack of understanding of how to incorporate the new material properties and details into the building product. This is our opportunity to broaden our use of 'green' materials in the construction of buildings and help minimize their impact on the environment.

Bradford Russell ***holds professional licenses as an architect and a structural engineer and was one of the first LEED Accredited Professionals in the US and Texas. In the late '90's, Mr. Russell started Bradford Russell Architects which has evolved to BR Architects & Engineers working on a wide variety of project types. Mr. Russell is currently working towards a PhD from Southern Methodist University in the subject matter of incorporating 'green' design / materials into the practice of structural engineering.***

Combine and Conquer—Long-Distance Collaborative Teaming for Small Design Firms

By J. Michael Leinback, AIA, NCARB

Inside every design firm, there exists a constant struggle to find a balance between the current workload and its staff's capacity to produce work. Rarely is there an equal balance between the two. We've all heard and lived the phrase, feast or famine. This is especially true of small firms who must often forego marketing efforts while the sole principal and the staff (if there are any) work feverishly to meet a project deadline. Suddenly, the project is finished and everything comes to a screeching halt, because no one has had the time to pursue new work. Now the overhead skyrockets because the staff is sitting on its collective hands. If the lull is too lengthy, layoffs may become necessary. After several weeks or months, a number of projects roll in. Unfortunately, the deadlines are compressed and the reduced staff must now work overtime to meet the firm's obligations. Overtime pay once again increases the firm's overhead. So the feast-famine cycle repeats, over and over. What a life!!

When I founded my small architectural firm 17 years ago, I fully intended to be the only employee —ever. But, I was very fortunate, and suddenly found myself with more work than I could produce alone. Very reluctantly, I hired one employee, and then another, and then another. For the next 10 years, I struggled to balance the load. I was constantly on the lookout for new talent, but there were few qualified applicants. And even then, only half of my hires actually panned out. About the time that the staff reached 10, we experienced an 18-month period during which we had an almost perfect balance between workload and staff. The calm was short-lived. Over the next 24 months or so, we experienced the most significant downturn in the firm's 12-year history. During that time, we lost several key employees; some left out of fear of the future, others were laid off and still others resigned due to cutbacks in benefits or reduced hours. At that time, just as we reached an all-time low in staff count, our backlog of work suddenly exploded, and we were without the necessary staff to produce the work. The only logical solution was to enlist the services of other design professionals. While I am acquainted with several architects who were willing to assist us, it quickly became obvious that they too, were experiencing the same feast portion of the cycle, and thus, our projects "sucked wind".

Collaboration is nothing new. It's been around for a long, long time; but, now it has taken on a completely new and different meaning. Design professionals have often reviewed one another's work and have offered constructive critcism as well as alternative ideas. The term might also apply to the relationship that exists between architects and their consultants where each design professional contributes his specific expertise to the project. There is generally a spirit of give and take between the participants as they each compromise for the greater good of the project.

Given the technology available to design firms today, the term, collaboration, takes on a whole new meaning. Two or more designers are able to communicate directly and immediately by phone while viewing a drawing (or better yet, a 3D model) in real time, via online meeting applications. The "lead" design firm can conceivably function as the project manager, perhaps developing the architectural program, while a secondary firm develops the actual design by means of a 3D model. The model can then be accessed by the lead firm who reviews the design and presents it to the client. Should it become necessary, a third firm can become involved at any point in time as dictated by schedule, expertise, etc.

The idea of the collective architectural practice has been around a while, if only in a very loosely organized manner. Under this scenario, several sole practioneers and small firms would each practice as independent architects to deliver small projects until such time as schedule or the sheer magnitude of a single project dictated a need to seek assistance from some or all of the collaborative. In the old days, with communication being limited to phone calls and overnight delivery services, these collaboratives were comprised of designers who practiced in very close geographic proximity to one another. Often, these designers actually shared office space, equipment, and perhaps expenses. Unfortunately, due to their close proximity to one another, these same designers might often be in direct competition with one another for certain projects, possibly creating tension within the collaborative.

In today's design collective, it is perfectly reasonable to assemble a group of firms, individuals, or a

combination of the two who may be scattered all over the country, if not the entire world. Not only does this eliminate the issue of competition for a local project (for all but the largest of firms), but it allows for an expanded design vision given the varying regional design vocabularies that each designer brings to the table.

Furthermore, the labor pool is expanded to include candidates with no regard for phyical, geographic location. While large firms are in a position to recruit talent from across the entire country, small firms may find it can difficult to entice a candidate to leave his or her home and move across the country in hopes of developing a working relationship. Both the firm and the employee must invest substantially in monetary terms. Remote collaboration, on the other hand, allows for a trial period to determine if the two firms or individuals can cement a relationship that may carry beyond a single project. If either party is uncomfortable with the relationship, dissolution of the temporary arrangement is a very simple matter — "Thanks, but, no thanks." If both parties feel that the match is a good one, the relationship can easily continue on a project-by-project basis for an indefinite period.

Not surprisingly, independent collaborators, too, enjoy a number of benefits in the collaborative environment—value-based compensation, freedom of choice of geographic location, flexibility of work schedule, ability to gain experience on various project types, sizes, climates/locales, etc. Even clients, perhaps unknowingly, benefit considerably from the collaborative configuration. Schedules can be met regardless of the lead firm's workload; experts can be matched to specific building types, project types, and software applications. Clients may also recognize improved designs given the expanded palette that extends beyond local and regional limitations and experience.

Finally, numerous advantages can be recognized for all parties whenever a remote collaborative configuration is implemented. The concept solves many of the typical problems faced by designers and architects, especially during periods of uncertainty brought on by a tenuous economy.

Finding Pearls in the Process: Leveraging the Information Created by BIM

By Bradley C. Horst AIA NCARB, CIO, Einhorn Yaffee Prescott andErin Rae Hoffer AIA LEED AP, Industry Programs, Autodesk Inc.

"As design and construction moves increasingly to a Building Information Modeling process, architects will realize the benefits of accurate building information as a definitive asset and expand their skills to leverage this information in new ways."

A design practitioners' knowledge is a competitive differentiator - exceedingly precious in today's challenging economy. Traditionally, architectural practice is built upon mentorship as a means to inculcate knowledge. Architects suffuse their firms with competency and pass on the knowledge and judgment of senior practitioners while coaching junior design teams to solve project-based problems. Unique design ideas and insights developed for specific projects are likely to have inherent value for future projects and in today's economy; these insights must be leveraged to meet clients' demand for creativity, expertise and superior project delivery.

The growing adoption of building information modeling (BIM) provides opportunities for innovation in the way that architectural knowledge is developed, captured and leveraged. Yet to capitalize on the opportunities to leverage information through BIM, firms must begin to think differently about their business model and their means for capturing critical practice content.

Architectural knowledge is developed and maintained throughout a project in the form of contract documents and specifications (*figure 1*). Along with these legal documents project information includes allied artifacts such as meeting notes, sketches, email archives, reports and many other information sources some of which are difficult or inefficient to archive or retain. Firms will habitually retain libraries of details, listings of vendors, or material collections which have been applied successfully in the past while side-stepping the opportunity to capture critical information about team collaboration and project workflow.

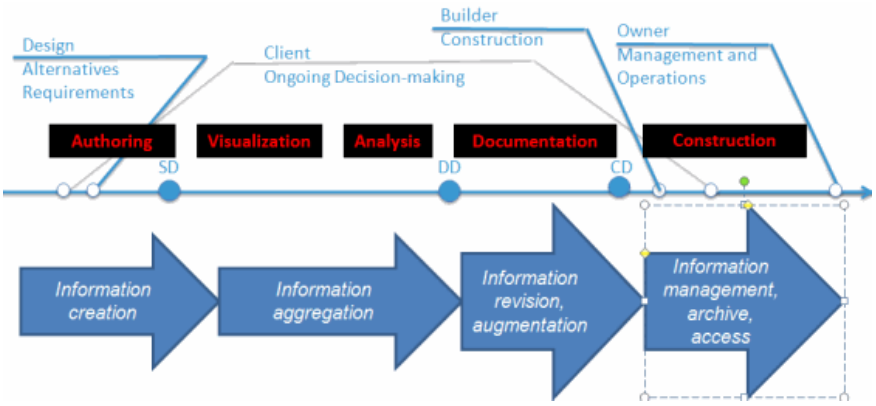

FIGURE 1: Timeline of Information throughout traditional project delivery. (Courtesy EYP)

The structure and use of information throughout the building lifecycle follows a pattern of Create / Capture / Share. For each of these steps, extra care is needed to anticipate the rest of the information lifecycle which can be leveraged with BIM. In the BIM-enabled version of the "Create" phase, practitioners rethink how to structure and organize data authoring activities. How can information be packaged in a format which enables key insights to be accessed by the extended project team or by future project teams, and ultimately, which can be monetized to provide compounding rewards for the firm?

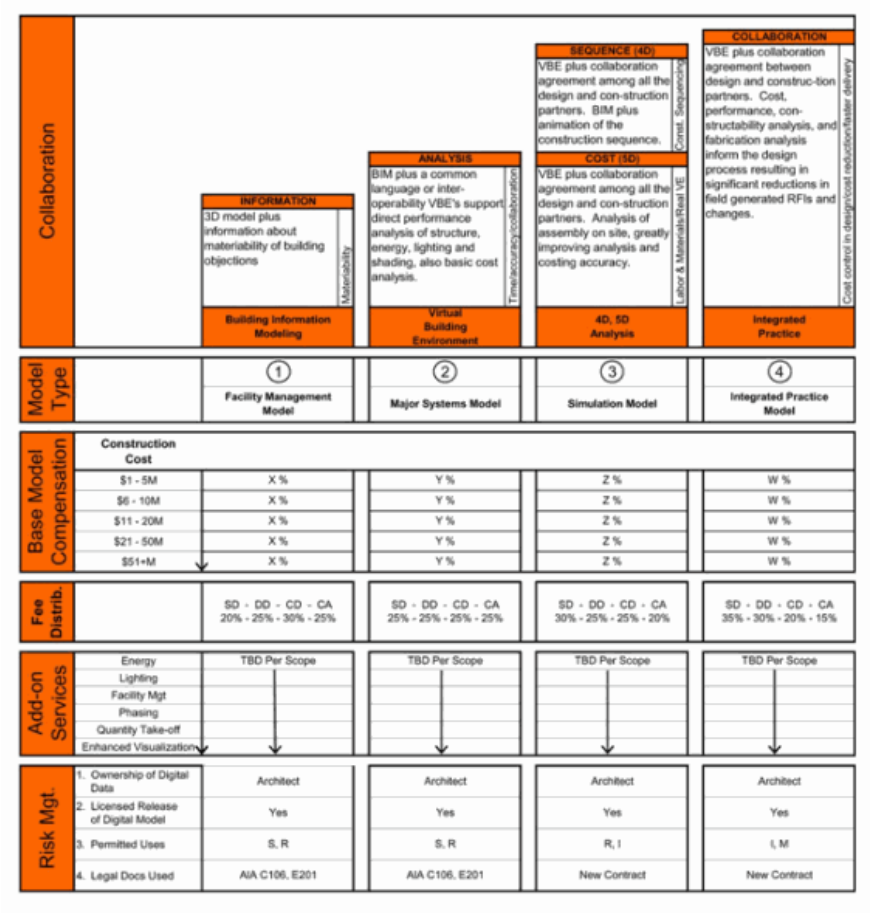

FIGURE 2: Mapping of Building Information Models to Sources of Value (BIM Map courtesy EYP)

BIM models offer a collection of assets each with a lifecycle of value, similar to the physical element of the building which they are designed to represent. The firm of Einhorn Yaffee Prescott Architecture and Engineering P. C. (EYP) has developed a framework which maps the model creation effort in BIM to a range of project opportunities (figure 2). As models evolve with greater complexity throughout design, construction and operations, they increase in value from a Facility Management Model (Level 1) - a 3D model plus information about materials and building objects which is used for construction and potentially for facility management, to a Major Systems Model (Level 2) – which extends the facility foundation with deeper quantitative insight through interoperability with analytical tools. The Simulation Model (Level 3) adds information related to sequencing of construction phases and costing of building elements (4D, 5D). Finally, the Integrated Practice Model (Level 4) represents data which supports the complete collaboration effort between designers, builders and owners in an Integrated Project Delivery (IPD) process. Ultimately, whether a team is creating a Level 1, 2, 3 or 4 model, this matrix and methodology maps the content creation effort with the appropriate project needs. In addition, the EYP BIM Map offers a guide for how and when to expand the list of potential services offered to include energy, lighting, facility management, phasing, quantity take-off and enhanced visualization all within an integrated building information modeling paradigm.

In the "Capture" phase, design information can be augmented or analyzed and packaged for future access by different individuals seeking varied uses. Besides content which records decisions relevant for the legal definition of a project, there are other important project outcomes which could be leveraged to improve performance on future projects – understanding of the governing codes and regulatory environments for projects in specific regions, reflections on the decision-making process and suggestions for improvements. For EYP, their recent master plan of the historic Massachusetts State House offered an opportunity to develop a comprehensive spatial model which helped the owner and design team to better understand the existing space inventory as well as the modern technology requirements throughout the facility. As a vital part of the process, EYP created a virtual armature of historic fabric, systems, usage data and recommendations which would help guide future renovation and restoration project efforts (*figure 3*).

FIGURE 3: Axonometric/Section of the Massachusetts State House. *(Courtesy EYP).*

Increasing emphasis on sustainable design and energy reduction throughout the globe suggest that the results of design-oriented energy and water analysis will provide critical insights for future work, as will better insight into the sourcing of materials and other factors important to sustainable certification such as the USGBC's LEED rating system. Firms with expertise in completing sustainable projects can use post-occupancy analysis to narrow the gap between prediction and results. Similarly, insights about building product, material or vendor performance throughout the construction process could be captured in a more rigorous way to better inform future specifications development.

The "Share" phase requires firms to think about systems for managing content access by firm members in varying roles and into the future. The design of this system requires careful consideration about which data will be useful, for which purposes and in which formats. One can imagine that the definition of any particular asset might include content about design and construction specifications, strategic project information, manufacturers' information and even software interoperability information; all of which are layered together make each asset or component more valuable for today and for future applications. Just as firms carefully track the billable hours being expended on a project relative to project budget, or track expenses against project budgets, the development and careful management of information assets should be a high priority for architects, whose core competency is the ability to execute built projects based on experience and expertise.

Autodesk's corporate offices at Trapelo Road in Waltham Massachusetts are an example of the application of BIM to the effective creation, capture and sharing of data in innovative ways. The project was designed and built by an integrated team which included KlingStubbins and Tocci Building Companies. It was executed under an integrated project delivery agreement which linked the owner, architect, contractor and a number of key consultants and sub-contractors. BIM was an integral component of the communication and decision-making process for this successful project. The partitions for the Trapelo Road project were initially modeled as simplified double-walled elements in the programming phase by the architect (*figure 4*). As the design evolved, the contractor was responsible for model development which added data about construction elements. Further development was completed by the architect, as details about reveal locations and wallboard joints were added. Ultimately, the model was coordinated with an onsite system for precision layout. This project also made use of Vela Systems field BIM application - using RFID tags attached to fixtures (cubicle elements) to track progress against delivery, off-gassing, and installation milestones which could be incorporated into a modeling system for visualization of project completion status.

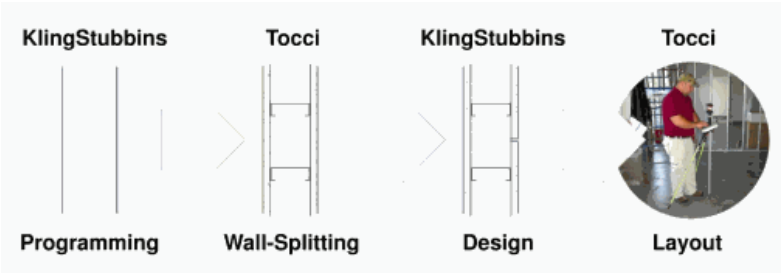

FIGURE 4: Building Information Model sequence – partition design from programming through construction.

(Courtesy KlingStubbins and Tocci Building Companies).

These illustrations suggest how BIM, once incorporated into firm practice, provides opportunities for firms to leverage investment in new processes and competencies and restructure approaches to Create/Capture/Share. But how can firms maximize the retention and re-use of project information? Should there be an incentive built into a firm's compensation system so that individuals are rewarded for adding to a knowledge base retained by the firm? Should metrics about project quality, schedule, profitability, client satisfaction be retained in a new way linked to models? Ultimately, the question is - how can information be transformed into long-lived assets for a building and for a design organization? Each firm must consider how their corporate strategy and approach to differentiation in a crowded market can be crystallized into a system of creation, capture and sharing.