

Integrated Design

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Photo: Alex Wilson/BuildingGreen

An integrated design process contributed to the success of the Chesapeake Bay Foundation's Philip Merrill Environmental Center in Annapolis, Maryland.

The Chesapeake Bay Foundation's (CBF) Philip Merrill Environmental Center—the first LEED® Platinum project—is widely featured as an icon of green building. Although the project isn't perfect, on the whole it is a remarkable achievement, especially since most of the designers involved were new to green building. The success of the Merrill Center can be attributed, at least in part, to an effective integrated design process that was kicked off with a strong educational and bonding experience for the project team. This kick-off event included a boat tour of CBF's environmental education centers, an overnight stay at one of the lodges, and an onsite design charrette.

One of the least successful—and least integrated—aspects of the Merrill Center's design was its plumbing system. As previously reported in *EBN* (see "Austin Session Highlights," **Vol. 11, No. 12**), the pumps were so mismatched for the facility's super-low water use that they didn't work at all, and the water treatment system was grossly oversized. It should come as no surprise that the project's plumbing engineer was the one consultant who missed that get-with-the-program tour.

Dozens of successful projects now attest to the fact that integrated design is an effective approach—perhaps the only effective approach—for creating comprehensive green buildings on a reasonable budget. There is no denying that, when it works, remarkable things can be achieved. All too often, however, in spite of the best intentions on the part of owners and designers, the integrated design process falls apart or fails to carry through to a successful project. There are also concerns, especially among those who do not have much experience with the process, that integrated design takes a lot more time and is therefore more expensive. So what does it take to make it work? And does it have to cost more?

Defining Integrated Design

Integrated design is distinguished from conventional design by its use of a highly

collaborative, multidisciplinary project team. It is not the sequential, relay-race model by which most buildings are designed today. All designers understand their work, at least to some extent, as an iterative process—an idea emerges, it is developed and tested, and then refined or discarded in favor of another idea. This sort of iteration, however, is most often done separately within each area of expertise: the architect works out the massing, layout, and facades of the building, then a structural engineer figures out how to keep it standing, a mechanical engineer develops strategies for making it comfortable, and so on. The various designers on a project meet occasionally to ensure that their solutions don't clash, but for the most part their aim is to stay out of each other's way.

In an *integrated* process, on the other hand, the team works as a collective to understand and develop all aspects of the design. The design can then emerge organically, with the full benefit of each expert's input—a structural engineer can contribute to the elegance and efficiency of the structure, a mechanical engineer can inform choices that enhance energy efficiency and comfort, a landscape architect and civil engineer can optimize the siting and orientation, an interior designer can improve the indoor spaces, a contractor can enhance the constructability of the resulting design, and a cost estimator can manage the budget. Depending on the size and complexity of the project, the owner, prospective occupants, facility managers, and a wide range of specialty consultants may be involved as well. While each expert plays an essential role, in effective integrated design exercises the best ideas often emerge when participants cross the usual boundaries, because their views are not as limited by familiarity with the way things are usually done.

Architect and consultant Bill Reed lectures and consults extensively on integrated design (although he prefers the term “integrative design” as more evocative of an evolving process and less of a fixed practice). Reed describes an integrated design team as the modern equivalent of the master builder in pre-industrial societies—a designer-builder who embodied the knowledge of place, of indigenous construction practices, and of the available resources for building construction and operation. With the complexity of modern buildings and the tremendous breadth of knowledge needed to design and build them, Reed argues that today we need a “composite master builder” in the form of a highly collaborative and multidisciplinary team.

Origins of Modern-Day Integrated Design

Integrated design has become a buzzword in the green building world. Everyone claims to do it, although not everyone understands it in the same way, and not everyone is successful at it. Unlike their American counterparts, European architects have a long tradition of designing in close collaboration with engineers and openly sharing credit for the design with them. Yale University Professor Don Watson, FAIA, traces his first encounters with integrated design to the 1960s. “Louis Kahn would often refer to his ‘colleague commandant,’ the engineer, as an equal partner,” he notes.

Others point out that integrated design didn't begin with sustainable design. Vivian Manasc of Manasc Isaac Architects in Edmonton, Alberta notes that her firm was

leading design workshops with client groups to address social and cultural issues before they focused on green building. “Our original approach was always workshop based. It was a natural fit for us to move from that into a fully integrated design process,” she says. Manasc credits Nils Larsson and the C-2000 program from Natural Resources Canada with turning her firm onto integrated design as the way to create green buildings without adding cost. But for the origins of their workshop-based design approach, she (and many others) points to Caudill, Rowlett, and Scott (CRS).

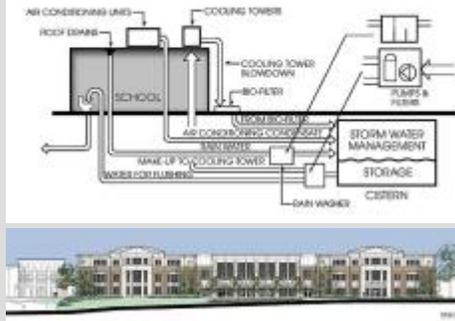
CRS was a Texas architecture firm that revolutionized the work of many architects in the 1950s and 1960s by promoting participatory design workshops with client groups. CRS famously used “squatters sessions,” in which the architects camped out at their clients’ facilities or at project sites for intensive charrettes that lasted as long as a week. These workshops resulted in design solutions with implicit client approval, thereby avoiding the need to spend time creating multiple design options and revisions in response to client objections. That same efficiency explains how some leading green designers today are able to invest in extensive charrettes without adding to their overall design budgets.

Design Features that Benefit from Integration

Whole-building design demands an integrated approach if it is to be done well, as every aspect of a building affects—and is affected by—other aspects. Certain features common to green buildings are especially strong candidates for integrated design because of their inherently interdisciplinary nature. In addition to the areas of expertise specific to each feature, nonstandard elements in any of them benefit from suggestions on constructability from a building contractor, and input from a cost estimator early in the process can help keep the systems affordable.

Daylighting – Effective daylighting depends on basic decisions, such as siting and orientation, and architectural elements, including the size, location, spacing of apertures, and, potentially, exterior shading systems. It also requires attention to interior design characteristics, such as interior shading systems, the layout of indoor spaces, the height of partitions, and the geometry, color, and texture of interior surfaces. If daylighting is to reduce energy loads rather than increase them, it must be accounted for in the zoning of the electric lights (so that areas with more daylight can be controlled separately from those with less) and with light-sensitive controls on the electric lighting, which are typically the domain of an electrical engineer and lighting designer. Finally, the mechanical system will be sized properly only if the mechanical engineer understands and accounts for the lighting controls.

Green roofs – Vegetated roofs are relatively expensive roofing systems, but they may be cost-effective if they help manage stormwater. Designing a cost-effective green roof system requires input from a roofing consultant or roof-system manufacturer, a structural engineer to account for increased loading on the roof, a landscape architect or biologist to assist with selecting plantings, and a civil engineer to exploit the stormwater benefits. In addition, a mechanical engineer should account for the thermal insulation value and evaporative cooling potential of the roof.



Schematic courtesy of Moseley Architects



Schematic courtesy of Moseley Architects

For the T. C. Williams High School in northern Virginia, Moseley Architects designed a half-million-gallon (1.9 million liter) cistern to go under the parking lot to collect rainwater and manage stormwater. The cistern will supply toilets, irrigation (including for the garden roof), and cooling tower make-up water. Close collaboration between the architect and the plumbing, mechanical, and civil engineers was required.

Exposed thermal mass – Exposed concrete or other massive, conductive materials in ceilings and walls can reduce peak cooling loads, especially if they are coupled with night-flushing of the building to cool the mass. Implementing such a strategy effectively requires collaboration among the architect, structural engineer, mechanical engineer, and interior designer. In addition, an acoustic engineer may help analyze acoustic issues caused by hard surfaces, and a lighting designer is likely to help with unique lighting considerations.

What Gets in the Way of Integrated Design?

The architect wants total control. The engineer won't think outside the box. The owner is unconvinced. The fees won't cover it. The very strength of integrated design is also its greatest weakness—it depends on collaboration from all the key players. Any persistent skeptic or foot-dragger can undermine the process and detract from the results. "The impediment to integrated design can be summed up in one word: inertia," says John Boecker of L. Robert Kimball & Associates in Harrisburg, Pennsylvania. "This is a very different process than most of us were trained in, not only through our education but also in our first decade of practice. None of this is difficult at all, but it is asking people to change what they do," he adds.

The lead designer must be skilled in nurturing and giving form to the collective vision, rather than expressing his or her own vision. Not all architects are comfortable with this role, which is more akin to that of a midwife than to that of an individual artist. "I believe we have the intention to become cooperative but lack the skills," notes consultant Terry Brennan of Camroden Associates. "The major obstacle I have seen preventing team behavior is fear. Examine your own [obstacles], but mine mostly come down to fear of not being good enough, fear of rejection, and fear of poverty," he adds.

In general, contractual relationships can get in the way if consultants' fees are

coming from someone (either the owner or the architect) who is not totally committed to the integrated process. “On my own projects, I have the consultants working directly for me. I don’t want them to feel like they’re under pressure from the architect,” says Vancouver developer Joe Van Belleghem.

Another common barrier is the belief, common especially to design-build or architecture and engineering (A/E) firms, that what they do *already is* integrated design: “A/E firms that we’ve worked with seem to be less nimble than the straight architects or straight engineers,” says consultant Tom Paladino of Paladino & Company, Inc. in Seattle. While A/E firms do often have a close working relationship between their architects and engineers, they are still more sequential than collaborative in their approach. “They think that they are integrated but often are more optimized,” notes Paladino.

Design fees are an obstacle as well, not necessarily because integrated design takes more time overall but because the time is spent differently than what is assumed in a typical fee structure. Fees that are tied to the cost of systems, common for mechanical engineers, provide a strong disincentive to integration and downsizing. But alternative fee arrangements are feasible. “The most difficult thing is not cost but schedule—scheduling that many people on the same day at the same time,” says Boecker.

Even a green agenda can become a barrier to integrated design if it is pursued too narrowly. “I try to stop people from using LEED as a design tool. I am a big fan of LEED, but I don’t like to see the [LEED] checklist on the table until the third or fourth integrated session,” says Van Belleghem. He suggests that it is more useful to engage the team around the underlying goals, such as saving water and energy and promoting indoor air quality. “If you bring the checklist out too early, you get into this point-chasing mentality,” he says, adding: “Then it gets expensive because people miss how the points work together.” Van Belleghem acknowledges, however, that if they are pursuing LEED Gold or Platinum certification, some point-chasing later in the process is inevitable.

Strategies for Succeeding with Integrated Design

Successful integrated design depends on two key factors: thinking outside the box and working as a team from the beginning. Creating an effective collaborative process requires clear intention and skill, especially for large, complicated projects with numerous consultants and participating stakeholders. And every participant must be open-minded about potential design solutions and willing to take some risks.

Thinking outside the box

The Rocky Mountain Institute (RMI), a long-time advocate and facilitator of integrated design in buildings, breaks down its approach to green development into four parts: whole-systems thinking; front-loaded design; end-use, least-cost planning; and teamwork. Two of these four, whole-systems thinking and end-use,

least-cost planning, are specific ways of expanding the box in which conventional design processes tend to be trapped.

Whole-systems thinking typically refers to the need to consider the entire building as a system—connecting thermal efficiency measures in the building skin with downsized mechanicals, for example. Beyond building technologies, the implications of whole-systems thinking are limitless because the “systems” in question can be expanded indefinitely to include ecological systems, social systems, timeframes beyond the usual payback horizon, and others.

End-use, least-cost planning entails thinking about a problem from the perspective of the end-user’s needs, before considering how to provide for those needs. As RMI’s Amory Lovins has pointed out in relation to energy supply issues, people want hot showers and cold beer, not sticky, toxic, black goo. Conservation often proves to be much cheaper than increasing energy supplies, even before environmental costs are factored into the equation. This principle can be applied to other demands and technology decisions as well.

Any number of other conceptual models and ideas can help to expand the framework in which design decisions are made. Some designers and consultants are using The Natural Step™ or permaculture to provide a broader context. “We are increasingly incorporating biomimicry principles, biophilia, triple bottom line, and ecofootprint into our thinking and presentations on this subject,” reports Huston Eubank, a principal with RMI’s Green Development Services.

Working as a team from the beginning

Integrated design is about bringing together all key members of the project team to work collectively across disciplines. “The collective knowledge is far greater than the individual knowledge,” says Boecker. Representatives of the owner or client and all the consultants who would typically contribute to the project must be a part of this team, but others are often included as well. In particular, bringing construction managers and cost-estimators, whose expertise is typically applied only after design is completed, into the team as collaborators from the beginning can be very helpful. “It is not just integrated design but integrated design *and construction* that really makes a project come together,” says Jules Paulk, manager of green building services at Southface Energy Institute in Atlanta. Extending this thinking even further, some teams bring facility managers on board early to share their experiences and aspirations from a building-operations perspective, and to increase the chances that the building will be operated in a manner that is consistent with the design goals.

With such a diverse group, there is the risk of an ineffective design-by-committee process or an authoritarian approach masquerading as collaboration. What distinguishes the sort of teamwork that raises a project to a higher level? Behavioral scientist Judith Heerwagen of J. H. Heerwagen & Associates in Seattle suggests several key features of an effective team:

- Joint decision-making and problem-solving (not just individual assignments that are later integrated into a whole);

- Mutual respect and trust;
- Effective communication and interaction throughout the entire project, including long-distance communication when the team cannot be together;
- Respect for dissident views; and
- The ability to deal with conflict.

These characteristics are enhanced, according to Heerwagen, by clear expectations, and “strong client support, particularly at the beginning of a project when teams struggle to define issues.” Engineer Chris Schaffner of Arup adds knowledge of other team members’ strengths and weaknesses to this list: “The projects that I’ve worked on where integrated design has worked the best are those on which people have worked together before and trust each other; they understand what other people are capable of and not capable of.”

A team’s effectiveness will be determined in part by the skills and commitment of each team member. “Integration, no matter who’s on the team, is only possible at a deep level if everyone has really made that commitment individually,” notes Bob Berkebile, principal at BNIM Architects in Kansas City, Missouri. But a team’s success also rests on how the group comes together. Those experienced in integrated design have tried many different methods to make a group of designers, client representatives, and other stakeholders into an effective team within the timeframe of a project’s initiation. Ideally, these methods serve both to enhance trust and communication and to expand each person’s view of what is possible.

Tours are one popular approach. “We have found great teamwork results from team tours of facilities with functioning technologies similar to those being proposed for their project. In addition to increasing the owner’s comfort level, these tours have served to get the design team fired up and to inspire integrated thinking,” says Alan Scott of Portland General Electric’s Green Building Services in Portland, Oregon. Heerwagen notes that teamwork is enhanced by “relaxed time together in informal settings that combine socializing with information and knowledge sharing.”

Bill Reed has evolved an approach that seeks to simultaneously bring the team together and expand everyone’s vision of the task at hand: “The best technique we’ve seen employed, and employed ourselves, is developing artful questions that get at the ‘core purposes’ of building a project during the programming phase. These help to elicit the fundamental aspirations behind the urge to build,” Reed suggests. “Typically these aspirations yield an understanding that the purpose of a building is not ‘the building’ but the creation of a quality of life, or protection, or health, etc. This process typically yields a different worldview, which then allows the creative process and optional solutions to be seen in a new perspective and from more fundamental values.”

“Integrated design works best when all team members are communicating before pencil is even put to paper about the design solutions,” says Boecker. Subsequently, it is very much an iterative process. “Everyone has to be in the same room, at least at key milestones,” he adds.

Getting Paid for Integrated Design

Some experienced practitioners argue that a front-loaded design process is not necessarily more time-intensive than a conventional process; the time is just distributed differently. “The more-experienced architects and integrated designers spend significant time up front,” and therefore less time is required to prepare construction documents, says Van Belleghem. “I’m not paying them any more fees than you would pay under the normal architectural rate structure. But I probably pay more than the average developer,” he acknowledges, adding: “There is an investment that teams have to be ready to make in their first two or three projects to learn the system.” Energy consultant Marcus Sheffer of 7group puts it more bluntly: “The ones who want extra fees have either not figured out how to do it and want someone else to pay their tuition, or they view this as an added layer on top of their preconceived notion of the process.”

The design for the Water Center in Calgary, Alberta “was probably the most expensive integrated design process that I have ever seen. How can you afford to have ten meetings with all these people?” asks Van Belleghem, before adding, “The results were quite amazing.” Vivian Manasc, who led charrettes for the Water Center, says that on large projects they often hold between six and ten one-day charrettes, with anywhere from 20 to 200 participants. Yet, she insists, “We only get to charge the same fee as everyone else.” The extra time for the charrettes is offset, according to Manasc, by reduced back-and-forth with the client later in the process. “What we’ve found on projects where we’ve done a really integrated process is that the client is with us all the way through, and we don’t get the miles of foolish review questions,” she says. “It’s a bit of a risk-management strategy for the design team. The more sophisticated the client, the more effective this integrated process is.”

The design of Water Center, which is going out to bid soon, benefited from participation by a construction manager and a cost estimator, both of whom were hired separately by the city. In addition, the project manager for the city, Russ Golightly, was engaged and supportive, and city staff participated in the charrettes. Not including the cost of specific additional services, such as energy modeling, design-phase commissioning, and cost-estimating, there are numerous examples of green buildings produced within a standard budget for no additional design fees. There is little doubt, however, that if one is committed to significant innovations and pushing the green envelope, more design time will be needed. “We worked hard at integrated design strategies on the School of Nursing building at the University of Texas Health Science Center in Houston,” says Berkebile of a building that has been occupied just a couple of months and has already received four design awards. “We invested a fortune in that job over and above our fee,” he notes. “How to consistently deliver exemplary performance and make money in the process—make it sustainable—is a question for us,” says Berkebile, adding: “There is a tendency, even among our associates and partners, to avoid that financial quicksand by jettisoning aspects of integrated design. It is a cost that we can control.”



Photo: DesignInc.

Thanks to an intense integrated design process, Melbourne, Australia's Council House 2 achieves a remarkable melding of form and function, providing comfort largely with passive features integrated into the building's skin.

Occasionally an enlightened owner is convinced that a better design is worth paying for and willingly foots the bill. According to Eubank, a new building for the Melbourne, Australia city council, dubbed "Council House 2," was designed for that kind of owner. Eubank reports that the project manager contracted with a design team based on standard fees and then, in addition, paid the team on an hourly basis to work together intensively for as long as it took to produce a workable schematic design. The team worked for two and a half weeks in an extended charrette process and generated a design with a level of integration that Eubank suspects could not have been achieved in a more conventional process. This approach also saved time—having a fully developed schematic design to which the entire team was committed significantly shortened the time needed for design development and construction documents.

Owners willing to pay such additional fees are relatively rare, however. More owners might be willing to share a portion of actual energy savings with the designers, leading to performance-based design fees (see *EBN Vol. 4, No. 2*). RMI's Lovins has long advocated such fees, based on the principle that one should "set minimum performance benchmarks, and reward better." In principle, performance-based fees are simple. Just agree on an energy performance threshold and tie the design and construction fees—with incentives and penalties—to actual performance that exceeds or falls short of that threshold. In practice, measuring energy performance against benchmarks isn't so simple, given the need to adjust results for variables such as the weather and the number of occupants: "You have to stand on your head and agree to a lot of protocols," quips Watson, who wrote a report on some tests of this concept in the 1990s. "It is not yet a science and cannot be held up to a legal test," he adds. If it is hard to manage performance-based fees for energy costs, which are readily measurable, using such fees for less concrete (if larger) benefits

such as productivity is unlikely.

Since a fundamental premise of integrated design is that it helps reduce construction costs, design-build projects would seem to be ideal candidates for taking advantage of the necessary up-front investment. While many design-build firms already include construction managers in the design process to ensure ease of construction, not as many are applying this approach to innovative green design.

Incentive programs

A number of programs from local governments and utilities offer financial incentives for the creation of energy-efficient or green buildings—but most of these payments go to the building owner and thus contribute to the economic case for creating a green building but don't necessarily pay for better design. A few programs have targeted the design process specifically, however. The Canadian Commercial Buildings Incentive Program pays incentives for design integration, as do several programs in the United States.

The Savings by Design program promoting energy-efficient commercial buildings was started by San Diego Gas & Electric (SDG&E) in the mid-1990s and was soon expanded with the participation of all of California's major utility companies (see *EBN Vol. 8, No. 10*). The program offers technical assistance to design teams and pays incentives for the adoption of specific energy-saving measures or for predicted whole-building energy savings (up to \$150,000 per building). When the program went statewide, a separate incentive directly to the design team of up to \$50,000 was added, on top of the payment to the owner. The logic of adding this component was simple, according to Charles Angyal, program manager at SDG&E: "When we get people to integrate the systems, we get higher energy savings per square foot." Perhaps more compelling in terms of long-term savings, however, is the fact that design teams are more likely to repeat the integrated design approach on future projects. "If you can give the practitioners a piece of the action, they're going to embed it into their practice," Angyal says. Until now, Savings by Design has been focused exclusively on energy savings. But SDG&E is currently pilot-testing a sustainable communities program, which Angyal describes as "Savings by Design on steroids." Projects participating in this program must achieve energy performance at least 30% better than code, and a LEED rating of Silver or better.

NYSERDA, the New York State Energy Research and Development Authority, has structured their New Construction Program for commercial buildings much like Savings by Design. The program will contribute to the cost of specific efficiency measures or provide an incentive for whole-building performance based on predicted energy savings, power demand reductions, and LEED certification. Incentive payments of up to \$440,000 per project are available to the owner, and up to \$15,000 more is earmarked for the design team. The design-team incentive was added about two years ago, according to program manager Craig Kneeland. "We recognize that there is extra effort on the part of the design team, and we are trying to help defray some of those costs," he explains, adding, "We see this as a variation on the performance-based fees approach."

Final Thoughts

Integrated design is key to creating cost-effective green buildings, but it is more than that. It encourages us to expand our thinking beyond the immediate design problem, as it is presented, and think about what we are doing and why. As such, it is reinforcing the connections between green building and social issues. “Group process and creative collaboration is the heart of the social sustainability movement, and here it is being practiced in the building industry. Who would have suspected?” asks Paulk.

For designers who are inclined towards personal engagement and interpersonal relationships, it is an exciting opportunity to develop those relationships within their work and pursue design innovations that require interdisciplinary collaboration. “It’s about making a commitment to engaging people’s imaginations,” says Manasc. When they are encouraged to challenge assumptions and think more broadly, “they remember why they went to engineering school,” she adds, concluding, “The process is more satisfying, and the results are more satisfying.”

– *Nadav Malin*

