

Construction Technology

Adoption is slow, but hope remains

by Barry B. LePatner, Esq.

In 1987, the U.S. Department of Commerce noted that “over the next twenty years it is totally reasonable to expect that we will see widespread application of the following technologies: advanced materials, microelectronics, automation, biotechnology, computing, membrane technology, superconductivity, and lasers.” Almost 20 years have elapsed and none of those technologies are widely used in construction. Construction and engineering companies lag most other sectors in terms of information technology (IT) spending (Figure 1) and as an employer of scientists, engineers, IT professionals, or technicians (Figure 2). In fact, it always has.¹

Ironically, the industry recently *boasted* that 27 percent of contractors now have a functional web site yet most in the industry approach IT with skepticism. Criticism of the industry on this point also comes from abroad. Sir John Egan, former chair of the Strategic Forum of the Confederation of British Industry, recently stated, “The [construction] industry doesn’t use computers enough. The car industry could not deliver its incredible annual improvements without computers. With widespread use of computers, everyone in construction could practice on them, rather than on their customer.”² Surprisingly, even large construction companies have been slow to join the telecommunication and digital revolutions. Only companies with annual revenues greater than \$250 million per year are likely to own an advanced project management software package. Yet, according to Ric Johnson, a Vice President of Constructware, software used as a collaborative tool for large construction projects, the pressures on project executives to achieve greater efficiency and shorter construction schedules demands new responses for reducing costs, improving quality, increasing business responsiveness, and evaluating life cycle costs and emerging sustainable products and technologies.

Why haven’t more individual firms responded? Industry fragmentation is a big part of the answer. There are no dominant firms. Small firms across many different industries have traditionally found it difficult to allocate ▶

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This article is excerpted from Chapter 4 of Barry LePatner’s new book, *Broken Buildings, Busted Budgets, Why We Can No Longer Afford Our Antiquated Construction Industry*, to be published this summer by University of Chicago Press.

The Business Case for Building Green

by C. Bradley Cronk, RA

Until recently, building owners could be forgiven for thinking that green building was limited to installing a vegetated roof and waterless urinals. Within the last year, however, an increasing number of the nation’s major newspapers and business magazines confirms that high performance, sustainable green building practices are gaining marketplace acceptance and resonating with an ever-widening audience of building owners from Fortune 500 CEOs and developers to local school boards.

This momentum does not necessarily stem from widespread agreement with Al Gore’s *An Inconvenient Truth* or other environmentalist arguments (although most now recognize the urgency of combating climate change). Instead, it is being driven by private and public stakeholders alike who have come to the realization that green building is simply a smart business decision. Yes, there are benefits in improved occupant safety and health, community relations and reduced environmental impacts, but it is the economics of green building that has now captured owners’ attention. They are finding that economic and values-based decisions can go hand in hand.

Corporate recognition and commitment to green building in the past few years is impressive: Ford, GM, Toyota, Honda, Gap, Adobe, PNC Bank, CitiGroup, Wachovia, SwissRe, Whole Foods, Starbucks, Nike, Reuters, the Durst Organization, the Albanese Organization, and Bank of America have all completed or embarked on major projects (at or below cost projections) following the ▶

Figure 1.

U.S. IT Spending by Industry, 2001-2003

Source: e-Marketer, 2003

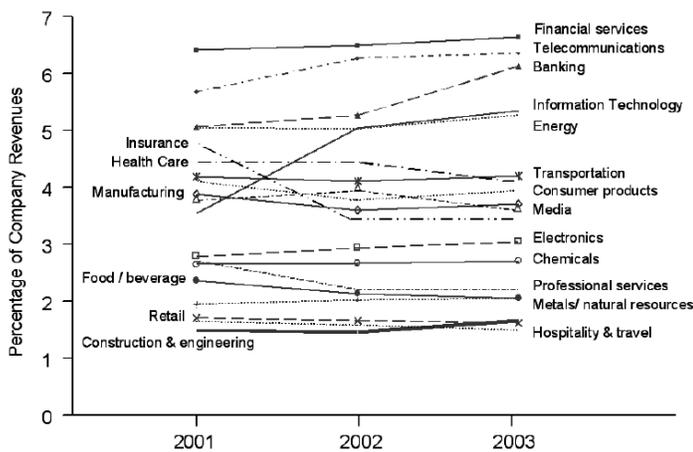
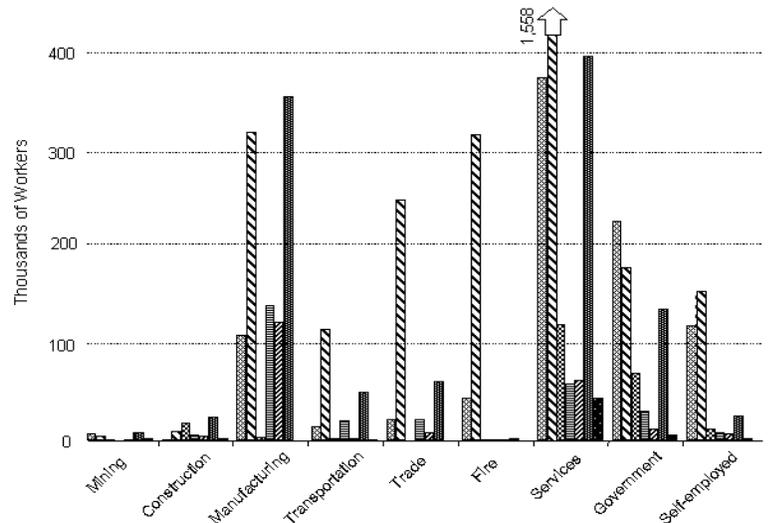


Figure 2.

Employment of Scientists and Engineers by Industry, 2000

Source: U.S. Bureau of Labor Statistics, National Industry-Occupation



resources for development. Most U.S. construction companies concern themselves with short-term survival rather than long run productivity gains. Moreover, companies hesitate to spend resources developing processes that cannot be patented or otherwise protected.³ Technology is the most important contributor to productivity after human labor costs on a project. It is also the most neglected. Excuses abound. And because the industry is devoid of the competitive pressures that transformed the automobile, aircraft, and numerous other industries, the excuses win, the industry stagnates, and the owners lose.

Promising Technology: BIM

Clearly, there are exceptions. Some firms have begun to invest a substantial amount of their own profits in technology and R&D, for their own benefit and that of the industry. Notably, they are not the better capitalized large contractors and construction managers, but design professionals. In projects such as the Guggenheim Bilbao in Spain and the Walt Disney Concert Hall in Los Angeles, Frank O. Gehry, along with a small number of other progressive architects across the country, are leading the industry in their use of advanced design software technology.

Gehry excels because he breaks all the molds, not just the design ones. For example, for over ten years he has used CATIA software, a program originally developed for the aerospace industry by Dassault Systems of France. Frustrated that contractors needed better information than could be provided by standard two dimensional architectural and engineering drawings, Gehry began using CATIA to represent complex designs to the contractors. The firm's extensive use of CATIA inspired it to form a separate company, Gehry Technologies, to create and market a more industry-friendly version of CATIA to its fellow design professionals. Digital Project is Gehry Technologies' advanced architectural and engineering 3-D modeling software based on the CATIA engine. Among other high-profile projects, Gehry used Digital Project on its highly acclaimed Stata Center at M.I.T., a project which led the dean of the school of architecture to state, "they [Gehry] have reconceived the process of construction." By using its specialized software, Gehry conveyed much greater and more

precise amounts of detailed information to the contractors than it could have using traditional drafting software. The payoff? The project remained within its \$300 million budget despite the significant number of highly customized pieces required by Gehry's design. Former Gehry Technologies CEO, Jim Glymph, notes, "We very much believe that the technology has arrived at the stage where it can have an impact in the industry. What Gehry ... does is process change; this is where it starts. Software is simply an enabler."⁴

The utilization of sophisticated software technology is by no means limited to the mega-million dollar projects of Frank Gehry's world. An example of where smart, sophisticated thinking along these lines is being conducted on a smaller scale is the work being done by emerging firms like Sharples Holden Pasquarelli (SHoP). From its inception less than ten years ago, the firm has designed fully digitized projects where every major building component is designed and constructed using 3-D modeling software. The purpose is surprising but simple: to lower project costs. Says partner Gregg Pasquarelli, "We're process driven. We would never build an elaborate framework to support a curve. We'd let the curve be determined by information from our materials suppliers or by the parameters of the fabrication techniques." SHoP inputs those parameters into its digitized model. The software it uses, called Rhino, automatically restricts SHoP from shaping the virtual curve beyond its physical material limitations. In one project, SHoP optimized customized zinc panel shapes to standard zinc panel sizes in order to reduce scrap that raises costs.

Digital Project, Rhino and similar packages offered by Autodesk, IES and other modeling and analytical software makers are collectively known as Building Information Modeling (BIM) software. BIM is a collaborative digital process involving the architect, engineers, and other key consultants, who utilize one or more of these leading software packages, to model and analyze detailed data and information covering a multitude of building characteristics, such as air flow, heat gain, structural analysis, and costs, among others. The architect embeds data and digitized information into a 3D model that can be shared with the owner, contractors, and project engineers.⁵

The design team benefits from several major advantages. BIM increases coordination and can significantly reduce errors and conflicts between the architect, structural engineer and mechanical engineer before the bid drawings are issued rather than discovering them during construction when they instantly materialize into change orders. BIM accelerates the design process, allowing the architect to test and analyze multiple design schemes in real time, while optimizing building performance. Higher quality construction documents has been widely heralded by owners, and is leading to higher fees for design professionals.

BIM yields significant benefits to the construction team as well. The link, via a single software platform, between the design team, contractors and

suppliers transforms the once daunting shop drawing and coordination drawing review task into a series of more manageable and efficient processes that reduce requests for information and costly change orders. BIM also allows more detailed and accurate quantity and cost estimates. The contractor can even create a coordinated 3-D construction sequence schedule model. Access to reliable, detailed project information enables the contractor to feel less at risk.

For the owner, the advantages of utilizing BIM cannot be overstated. It is a critical tool used for clarifying the project's design, schedule, construction costs and future operational costs. As a result, there is better cost and scheduling accuracy, streamlined procurement, and improved team communication and coordination. According to Gehry, "You know where you are going before you start construction, so you minimize the surprise from the owner's standpoint. You get all the bad news up front."⁶ Gehry claims that this technology has reduced dreaded change orders on his projects by at least half.

What does the future hold? According to Phillip Bernstein, Vice President of the Building Solutions Division at Autodesk, a leading design software company, "we're never going back" to the age of the master builder/architect because "the world's just too complicated. The replacement of the master builder is going to have to be somebody who orchestrates the process and all the information that technology creates. And who's going to do that?"⁷

Frank Gehry or SHoP would be a good answer but architects like them are the exception, not the rule. While BIM is here to stay, some say it could be several more years before it is widely adopted and affordable enough for the average architectural firm. If the transition is to happen sooner, other stakeholders need to step forward. Owners are in a position to do that by making BIM a requirement on their large, complex projects. This is happening to some degree from a surprising place: the U.S. government. In order to cut down on rampant cost overruns and delays, The General Services Administration, which is responsible for over \$12 billion in active construction projects across the country, now requires a BIM 3-D model as a deliverable from its architects and engineers.⁸ Public and private owners may also drive mainstream BIM usage as they increasingly adopt sustainable, green building practices. BIM is crucial in developing energy optimization and integration analysis that is the cornerstone of a high performance green building. Owners will also flock to BIM when they realize how it can be used to model their business and financial plans. For example, a BIM traffic flow analysis for a parking garage will reveal the optimal mix of spaces and revenue generated from each. Similarly, assigning a revenue value to each seat in a stadium design will enable real time revenue forecasts for multiple seating variations.

Until more owners step up to the plate, leading design firms like Gehry and SHoP must continue to ignore the cry of the AIA and the professional liability carriers to minimize accountability in the construction process. "If we want the profession to try new methods, we have to be willing to take responsibility for the risk of what we are proposing," Pasquarelli asserts. "We have to break down the conventions of the profession."

¹ *Technology and the Future of the US Construction Industry* (Washington, D.C.: AIA Press, 1986); Nelkin, *Politics of Housing*, 9.

² "Egan slams public sector's progress," *Contract Journal*, January 31, 2007. <http://www.contractjournal.com/Articles/2007/01/31/53468/egan-slams-public-sectors-progress.html>

³ Dietz, "Housing Industry Research," 240-41; Lefkoe, *Crisis in Construction*, 139; Martin Meyerson, "Foreword," in Burnham Kelly, ed., *Design and the Production of Houses* (New York: McGraw Hill, 1959), xii; National Research Council, *Building for Tomorrow*, 15, 55-62, 85-92; Nelkin, *Politics of Housing*, 12.

⁴ "Gehry's New Venture," *Principal's Report* (November 2003): 2; Peter Goddard, "Inside Gehry's Mind," *Toronto Star*, March 17, 2001; Jim Glymph e-mail to Barry LePatner, May 4, 2005; Bien Perez, "Building a New Dimension Software Reduces Errors, Cuts Costs," *South China Morning Post*, November 23, 2004.

⁵ Paul Siodmok, "Computer Aided Design," *Design Council Bulletin* (January 5, 2005).

⁶ Christopher Palmeri, "Frank Gehry's High-Tech Secret," *Business Week Online*, October 6, 2003. http://www.businessweek.com/magazine/content/03_40/b3852132.htm

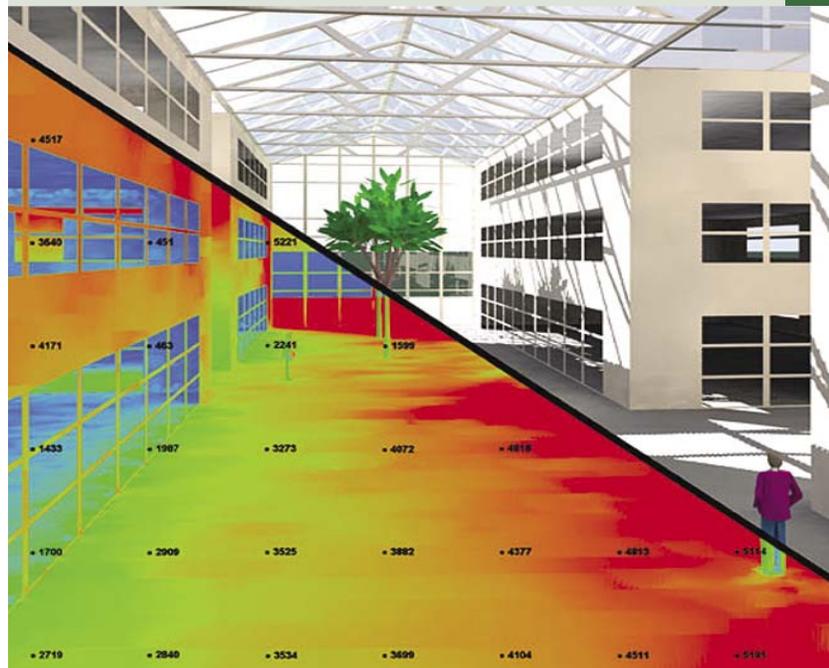
⁷ Gregory Beck, Phillip Bernstein, Jeffrey Inaba, Mikyoung Kim, and Elizabeth Padjen, "Roundtable: Designers Without Borders," *Architecture Boston*, 7 (November - December 2004): 20-29.

⁸ Elaine S. Silver, "GSA to Require Building Information Models by FY 2006," *Engineering News Record*, January 21, 2005.

- ▶ United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Green Building Rating System. Further evidence of the movement's momentum is seen when comparing the 430 projects earning certification in LEED's first six years, 2000-2006, with the more than 600 projects certified now and over 5,000 registered projects in various stages of the LEED certification pipeline.

Insurance companies and investors are also buying in. A critical indicator of acceptance was a Firemen's Fund announcement in October 2006 that it would begin offering a 5% discount for property insurance on LEED certified buildings. In addition, Lloyd's of London offers insurance if the predicted energy savings do not fully materialize as designed. REITs and SRI (socially responsible investment) funds are also paying attention to green building. SRI funds already count nearly \$2.3 trillion in assets under management, and they are actively looking to invest in "responsible" real estate developments. Hines and Thomas Properties Group have each partnered with major pension funds to develop new buildings or renovate old ones to LEED standards. Liberty Property Trust in Philadelphia decided to LEED-certify all its office properties, and some are already fetching more than a 25% premium over market rents. Independent organizations like the Green Building Finance Consortium [www.greenbuildingfc.com] are developing underwriting and appraisal standards for green buildings from a traditional, conservative due diligence and fiduciary duty perspective in order to appropriately recognize investment value and risk in green buildings.

These private sector developments are happening simultaneously with government mandates and incentives across the country. Most recently, the U.S. Council of Mayors adopted the 2030 Challenge for all public sector buildings. This initiative endeavors to reduce building fossil-fuel consumption 60% by 2010 with further 10% reductions every five years thereafter until the goal of a fossil-fuel free, carbon-neutral building is achieved in 2030. In the absence of federal regulations, dozens of city and state agencies have enacted mandatory LEED compliance for municipal building projects. On January 1, 2007, New York City Local Law 86 took effect requiring all City-funded projects to achieve a LEED Silver certification, which will ▶



Screen shot of a daylighting analysis rendering and the corresponding quantifiable color intensity model. Image created with IES Virtual Environment software.

► affect over \$12 billion in construction projects. Some cities, such as Portland and Washington DC now require private development to follow LEED guidelines as well. Boston just amended its zoning code to incorporate LEED requirements for private projects over 50,000 square feet. Other municipalities like Chicago, San Diego and Arlington offer incentives for private sector compliance including F.A.R bonuses, expedited plan and permit approvals, reduction in fees, and energy tax credits. In New York, existing commercial building retrofitting first costs can be subsidized by NYSERDA, which contributes to a faster pay-back period on green investments.

Costs and Benefits

The number one concern still voiced by private owners today is that green building costs too much. However, multiple independent cost studies do not show this to be true. In late 2003, the Kats Study showed that the average construction premium was less than 2% for 33 LEED certified projects it sampled. A year later, a Davis Langdon

equipment, reduce energy consumption, all while improving occupant comfort work environment quality.

First costs are typically material driven, not labor driven. The increased quantity and quality of “green” building products and equipment on the market also contributes to lower first costs than before. Additional consultant costs are stabilizing as increasing numbers of architects and engineers become more efficient in designing sustainable buildings and shepherding them through the LEED certification process. Contractors also can find economic benefits in green construction projects through salvaging and deconstruction management opportunities.

Media coverage of trophy sustainable buildings and climate change has owners and developers of green buildings enjoying huge marketing and public relations opportunities at the moment. While this news cycle may not yet have run its course, as green building becomes standard, those p.r. opportunities will diminish. However, benefits gained from employee pride and corporate reputation will not. Corporate green building owners are seeing significant reductions in absenteeism, illness and turnover,

coupled with anecdotal increases in employee productivity. Benefits extend to other built environments too. Heschong Mahone Group’s studies have shown that introduction

of skylights and other effective daylighting strategies not only increased retail sales up to 36%, but that student test scores increased as much as 20-25%.

The New Class A Building

Gerald Hines and other real estate leaders have been quoted saying that a LEED or EnergyStar certified building will define Class A commercial buildings in the near future. Given that it takes two to three years or more from design to occupancy of a typical commercial project, owners who do not seriously contemplate building sustainably today will likely be at a competitive disadvantage in the market place within five years. Anecdotal evidence today suggests green buildings lease faster and at the top end of the ‘A’ market and experience positive tenant retention. It is logical that a building is worth more if it has lower operating expenses for tenants, superior occupant comfort and air quality, daylighting and other green amenities. A building with these advantages will achieve a higher valuation and will rise to the top in anything but a booming real estate market. A building without these features could find itself at risk in the real estate market, face exposure over employee health issues and increasing operating expenses, e.g. fuel.

The sustainable building movement, while once relegated to small experimental projects, has emerged as one of the fastest growing sectors of the U.S. real estate and construction industries. Prudent owners should ask about additional first costs, but they should also beware of the potential long-term costs for *not* pursuing a high performance sustainable building.

Net savings are derived from a whole-building design approach that captures multiple benefits from single expenditures – doing more with less.

study compared 45 LEED certified buildings against 93 conventional buildings and concluded that the *first-costs* per square foot were similar. Also in 2004, the GSA reported first-cost premiums of *negative* 0.4% up to 8.1% with an average of about 3.5%. An analysis of 30 green schools by the Capital-E Group in 2006 showed an average “green” premium of 1.65%. These studies focused on first-costs only – not the subsequent long-term benefits, one of which is payback in the first five years.

Despite these statistics, some cannot understand how green buildings are only slightly more expensive than standard buildings. After all, FSC-certified wood *is* more expensive than uncertified wood, and triple pane glazing *is* more expensive than double pane glazing. The answer is net savings derived from a whole-building design approach that captures multiple benefits from single expenditures – doing more with less. Design interdependencies and synergies can result in net energy consumption reduction.

For example, effective daylighting strategies for occupied spaces can significantly reduce electric lighting, which would in turn reduce cooling loads, downsize cooling equipment and ultimately reduce peak-electric demand charges. If the building envelope is optimized for winter heating loads, daylighting could permit solar heat gain for those occupants nearest windows, which then might eliminate the need for perimeter heating. Thus, one integrated design effort might address first costs for light fixtures, heating and cooling

Sources can be found in *Building Design+Construction’s* special November 2006 report, “Green Buildings and the Bottom Line” (www.bdcnetwork.com), the USGBC web site (www.usgbc.org), and “The 6th Annual LEED Guide” published by *Environmental Design+Construction* (www.edcmag.com).

Partner **Henry Korn**, a former Assistant U.S. Attorney, Southern District of New York and former Member, Departmental Disciplinary Committee for the First Judicial Department, recently donned his old prosecutor’s cap to write a timely article published January 30, 2007 in the *New York Law Journal*. “The District Attorney Scandal in the Duke University Case” provides in-depth details of the multiple ethical violations committed by Durham County D.A. Michael Nifong and an analysis of the resulting Bar complaint against him. Read a copy of it at www.lepatner.com/nylj-Duke_DA.htm.

Barry LePatner moderated an industry roundtable discussion on the state of the local New York City construction environment and its future. The event was sponsored by **Real Estate New York**, with panelists Richard Anderson, leader of the New York Building Congress, Paul Bello, a partner at AKF Engineers, and Richard Wood, head of Plaza Construction. Read a transcript at www.lepatner.com/reny_roundtable.pdf.

Barry LePatner published “Challenging the Rising Costs of Construction” in the January 2007 issue of **Real Estate New York**. It explains how the construction industry gets away with passing additional costs through to owners, and why owners and their consultants are typically powerless to stop them. The article is distilled from his forthcoming book, **Broken Buildings, Busted Budgets**. The article can be read at www.lepatner.com/BBL-Rising_Construction_Costs.pdf.

QUOTE OF THE QUARTER

The voyage of discovery is not in seeking new landscapes but in having new eyes.
- Marcel Proust

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