BIM and Laser Scanning for As-built and Adaptive Reuse Projects:

The Opportunity for Surveyors

In his inaugural speech the new President made many references to using our natural resources more wisely, to reducing our carbon and water footprints, and investing in smart electric grids and other similar new energy-efficient technologies. Energy conservation and sustainability are top priorities and efforts are underway in many states to reinforce that–many offering fast tracked permitting to those projects that are "green". While many in the surveying community may view this as a nice gesture and work for others to do, make no mistake, while nothing is recession proof this opens up many doors of opportunity for surveyors, ones that are profitable and very much in demand.

Figure 1 Visualization of a BIM project *(Image courtesy of Autodesk)*

>> Terry D. Bennett, LS, LPF, LEED AP

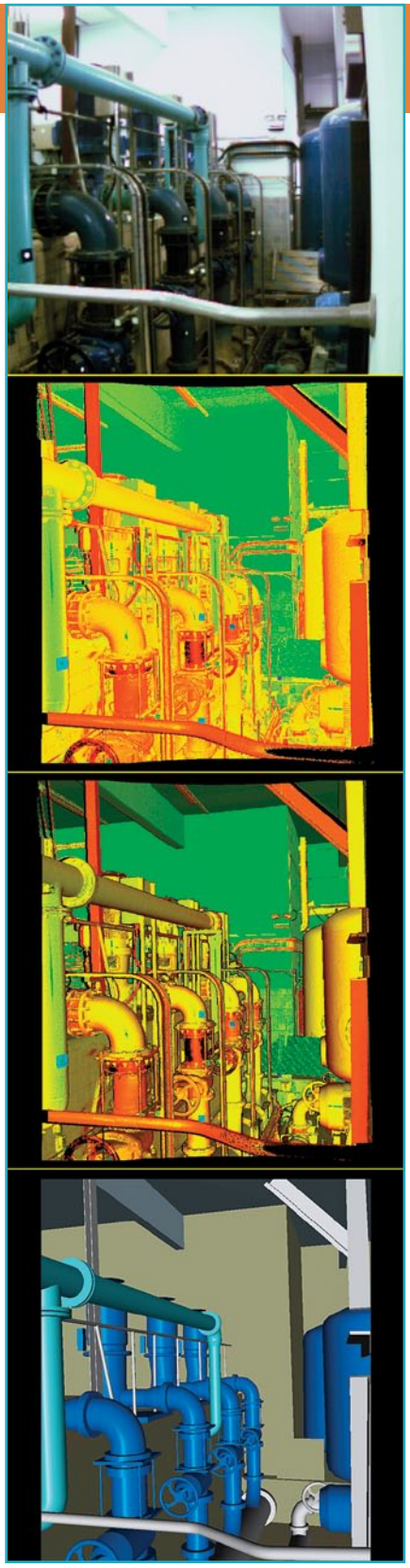


Figure 2 Shalford Project—Laser Scans and Resulting BIM of a Water Treatment Plant Pump Replacement
(Image courtesy of Plowman Craven)

Given the economic challenges facing the AEC community worldwide today, many are looking at both new areas of growth while at the same time looking to streamline how they approach projects, and the associated workflow to be more efficient and more flexible. Terrestrial laser scanning technology in the context of building information modeling (BIM) processes bode well in addressing both areas. As new building development slows down, utilization of existing buildings and sites will grow in importance. Coupled with this trend is the need to improve resource efficiency, especially of buildings, which is a cornerstone of sustainability efforts today. The U.S. Green Building Council (USGBC) and many other researchers have indicated that buildings account for more than 40% of all energy consumption, annual greenhouse emissions, and up to 30% of the water use in the U.S., even more when you add in irrigation. This puts buildings at the center of the sweeping energy reform movement. Deliberate and cost-effective renovations to buildings can generate substantial environmental, financial, and societal benefits–from reducing energy consumption to creating new jobs. Having accurate as-built data will be a vital component of the entire planning and design process in this space.

The process of adapting old structures for new purposes or "adaptive reuse" as it is called, represents quite a paradigm shift in the construction industry. Given the focus on adaptive reuse of buildings, especially in light of the current economic climate and sustainability efforts, the spotlight on this trend will become increasingly hot. We're witnessing a change in consumer perception. People want to live in an urban community where old buildings are kept and reused, some of historical value (like the textile mill buildings in the northeast), rather than bulldozed. This in turn has caused a challenge to the AEC industry, where the core focus in recent years has been on new construction. New skills and new approaches are now being rapidly adopted to meet this emerging challenge to modernize older structures–and laser scanning and BIM are the powerful tools for success that you need to understand and leverage.

While the roots of BIM are in architecture, the basic principle of working from and on accurate 3D digital models applies to nearly all infrastructure projects, including site work, subdivisions, bridges, highways and all the other things that surveyors routinely stake out. BIM is more than just a 3D model (see **Figure 1**); it allows you to have a better visualization of the entire project from many perspectives, and uses analysis on data within the model to more easily predict the outcome of projects before they are built.

This coordination allows for many things. Designs can change faster in response to new ideas and conditions. Designs are easier to optimize with analysis and simulation. Project documentation is of higher quality and is easier to generate. And, it's easier to visualize the way the project will work after construction. But it all starts with existing condition information in 3D, and that is starting point we surveyors provide the design professionals. But in using new technology we must examine our work processes and how they may change, and how *those* changes propagate downstream to the AEC ecosystem that relies on our spatial expertise. At first glance, the changes seem to threaten surveyors. But in fact, just as with BIM and laser scanning, there are opportunities for surveyors to take on new and expanded roles on today's big construction projects. Let's look at the compelling business drivers that will make adaptive reuse projects and retrofits take hold:

The Energy Policy Act of 2005 (EPACT 2005) It mandates the use of sustainable principles for siting, design, and construction of public buildings.

The Energy Independence and Security Act of 2007 (EISA 2007) requires a steep reduction in fossil fuel energy usage and encourages the use of cost-effective solar hot water heaters.

Figure 3 Stoke Rochford Project—Historic Manor damaged by fire, not safe for traditional survey, scanned to assess damage and recovery options *(Image courtesy of Plowman Craven)*

Executive Order 13423–Strengthening Federal Environmental, Energy, and Transportation Management, requires agencies to:

- Reduce energy consumption by 3% per year for a total of 30% by 2015
- Reduce water consumption by 2% per year for a total of 18% by 2015
- Reduce green house gas emissions
- Increase renewable energy usage

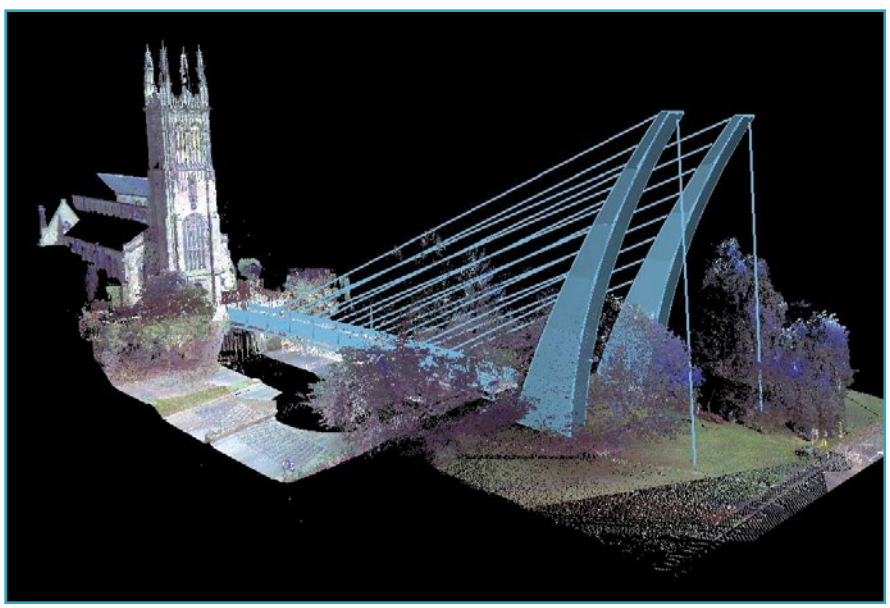
As-builts have always been a key part of construction process and surveying workflow–it's all about verifying that the on-site infrastructure is, in fact, in the right place. This leads us to the next step in the process, as-builts and the rise of adaptive reuse. Adaptive reuse is a significant trend in the development industry. Do a Google search on the key words "as-builts" and you'll find nearly 700,000 hits. And the term is even listed in Wikipedia. In today's sustainable mindset, the old method of just raising an existing building for new developments is no longer always acceptable, no different than simply clearing land and turning it into subdivisions and planned communities. Instead, developers are paying more and more attention to the sustainability issue and looking for ways to adapt and reuse existing valuable old structures–this not only saves the resources that go into new construction, it prevents the waste and toxin release that results from demolition.

These could be old buildings, sites, or bridges, or even redoing the associated water and sewer systems, or access roads to these sites. Anywhere infrastructure is going to be repurposed or reused for something else via adaptive reuse, architects and civil engineers are going to want existing as-built data to start the process. I see this trend increasing dramatically given the economic conditions today and the need to do more with what we have already. This is tightly coupled with the need for energy retrofits on many existing buildings, and redoing miles of sewer and water lines (see **Figure 2**) or bridges given the influx of people from suburban to urban areas.

Ensuring our infrastructure can handle this dramatic change is key, and without a lot of existing records, surveyors are going to be called upon to build that asset database. The AEC industry is meeting this new challenge in a variety of ways and one key is the provision for rapid, accurate as-built data of large, complicated, and often derelict buildings and their supporting infrastructure (water pipes, sewers, drainage, etc.). Often these elements in older buildings, such as department stores into residences, factories into offices, brown fields into technology parks, the list goes on, are ripe for transformation. Since much of this infrastructure is quite large and complex–bridges, water and sewer plants, factories, old department stores, warehouses, etc.–surveyors will have to step into the breach and provide accurate data and 3D models to a BIM-centric process.

Why is 3D information so critical to this adaptive reuse process, and why should surveyors care? As Simon Barnes, RICS, CEO of Plowman Craven in the UK notes: "A lot of this wouldn't happen at all without scanning and 3D models. True, it's exactly what surveyors have been doing for a long time, gathering 3D coordinates, *but what we have now is a system and method that can collect all these*

Bass Malting's—an old Brewery and Listed Building located in Sleaford, Lincolnshire, UK being converted to luxury condominiums *(Image courtesy of Plowman Craven)*



Darby Bridge project—1.5 km stretch of road and surrounding buildings. 3D model used to present local governments proposed bridges to get a feeling which design best fit the environment *(Image courtesy of Plowman Craven)*

3D data points incredibly quickly. We're solving the same problems–defining shapes and surfaces–but we're doing it a heck of a lot quicker, and in a way that is perceived as exciting."

Simon also noted, "Surveyors must understand that we want to make that distinction, and explain to project stakeholders that there is now a lot more we (surveyors) can do for a project. We shouldn't just be delivering data and walking away. Clients may not realize that surveyors have the skills and desire to help them far more than we have previously and that you are keen to do that."

Accurate as-built data is a critical component of any planning and design process especially where sustainability and reuse of existing infrastructure comes into play in areas like energy refits. Many buildings that are more than 30 years old, that is before the mainstreaming of CAD, simply have no available design

or as-built data let alone in an electronic form or in 3D. When they do exist, they are most often hard copy blueprints that may have limited value for preservation, rehabilitation, restoration, or reconstruction efforts tied to today's efforts.

Even newer buildings, which may have good plan sets, have never been surveyed to determine the differences between design and construction and those that have are often still in 2D. So there is a whole world of critical data that needs to be gathered to support sustainable building and infrastructure trends, and surveyors are the ones who will do that work. With accurate as-built data, designers can assess the reuse potential of buildings, understand the original construction, estimate the need for structural upgrade or seismic retrofitting, or simply create an accurate model for design and visualization. This is a job that surveyors *could* do previously, but slowly and with minimal detail, often crossing the threshold of cost effectiveness for a project. Now, accurate and dynamic 3D models employed as part of a BIM process can be used even on extremely complex structures.

The architect and engineers armed with this comprehensive model created from the surveyor can now make better informed intervention at the early design phase, and thus have a real impact on design decisions for the future of the building or other infrastructure. As-built data is being used increasingly to initiate a facilities program for the long-term management of an asset.

More and more owners are starting to understand and search out providers to assist (see **Figure 3**). There is no doubt that, presently, laser scanning combined with a BIM-centric process require a rethinking of traditional processes as indicated in the examples above from Plowman-Craven. But there are plenty of success stories, and it is increasingly understood that the speed, accuracy and efficiency of modern survey techniques are so necessary to modern construction that the return on investment is significant. Now is the time for surveyors to promote the power of thinking in 3D and their role as key partners in the effort to fix, refurbish and optimize our infrastructure for a more sustainable future.

Terry Bennett is the Senior Industry Manager for Civil Engineering and Construction at Autodesk, responsible worldwide for the company's industry strategy and relations in the areas of land/environmental planning, land surveying, civil engineering and construction. He holds multi-state registration in both Land Surveying and Natural Resource Forest Management, and is a LEED® Accredited Professional. Bennett has also been a practicing professional consultant for the last 26 years.