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The Brothers Bentley on Infrastructure and BIM



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Infrastructure, BIM, and The BROTHERS BENTLEY



The iconic Marina Bay Sands hotel, expo, and conference center (left and above) in Singapore was the venue for the Bentley Year in Infrastructure 2017 conference and Be Inspired awards ceremony. This internationally lauded example of engineering, art, and design was a Be Inspired award-winner in 2010.

Meeting the needs of the global infrastructure boom, a prominent design software firm has forged technology partnerships; moved to erase the workflow barriers among surveying, engineering, and construction; and may soon change the way design models are shared and synchronized. By Gavin Schrock, PLS

Infrastructure—the human footprint on the planet, the processes, systems, instrumentalities and built environment we inhabit—makes our lives possible. It provides the foundation for the lives we hope to live in the near and distant future. Modern infrastructure is the global tendrils of humanity, reaching all corners of the globe and binding us together in our local communities and glob-

ally. Providing infrastructure for a growing world populace and meeting the needs of new generations that demand smarter and more sustainable infrastructure are continuing challenges.

Presently, the sheer scale of infrastructure development is mind-boggling. While it may not be as pronounced in our local communities as in other locales, take a look online in Google Street View at different places around

the globe to see many examples of staggering growth in infrastructure. The term “developing countries” now has a new definition, incorporating both tremendous growth in population and urbanization that’s spurred by the growth of individual wealth.

Yes, there is a global infrastructure boom currently underway, and Bentley Systems, an engineering design software company, has become inexorably joined at the hip with the rise

THE BROTHERS BENTLEY

WHEN ASKED ABOUT THE EARLY DAYS

of Bentley Systems, founder and CTO Keith Bentley likes to tell the following anecdote. "I remember 35 years ago hearing a guy named Bill Gates from a little company called Microsoft talking about how the personal computer was going to revolutionize individual productivity.



Keith

"And I remember sitting there thinking, 'You know what? That guy is right.' And I thought to myself, 'Hey, this is a once-

in-a-lifetime opportunity, and I'm all in.'" Keith Bentley was working as an engineer at DuPont in the early 1980s, using the large mainframe-based CAD system from Intergraph. Such systems represented the state of the art in computer-aided design and drafting, but per-seat costs were high.

Keith came upon the idea to write software to run on a small CRT terminal (and later a PC) to perform many of the same CAD functions. Engineers liked this option to be able to do certain work and edits from a lower-cost device, but there was an issue.

"The problem is that the terminal was weighing down the CPU the same as the [large] workstation," Keith says. "So, I wrote software that could run standalone for early PCs, like the [PC/AT]." He dubbed this early solution, "PsuedoStation."

While driving to California to work with his brother Barry in an unrelated tech company, Keith stopped at Intergraph in Huntsville to show them his solution. They were

not interested in PsuedoStation at the time.

Yet, information about PsuedoStation had been released, and interest had grown for this new alternative to traditional CAD workstations. Keith and Barry formed Bentley Systems, Incorporated in 1983, and they sold the first commercial copies of PsuedoStation in 1984.

By 1985, they had a new version called MicroStation that could run on an Intel 286 and could do many of the things that a large mainframe system could do. It is



Barry

important to note that many of the customers for the large systems were in transportation, large engineering firms, and utilities—in other words, infrastructure. And these roots and focus in infrastructure have only grown deeper as the company has grown.

Relocating back to southeastern Pennsylvania (the current headquarters is now in Exton, Pennsylvania), brothers Scott and Ray Bentley also joined the rapidly expanding company. There were periods of joint ownership with Intergraph, licensing of MicroStation products, and expansion beyond drafting software to include design packages.



Ray

The relationship with Intergraph continued to be complex, but Bentley Systems had grown substantially in its own right. By 1995, there were more than 100,000 users and a development team of more than 100.

In 1991, a fifth Bentley brother had joined the company, Greg Bentley, who had successfully grown an unrelated software company. He joined to help with the business side. Keith, Barry, and Ray worked in development; Scott worked in operations (he would later go on to become the CEO of VideoRay, maker of underwater remotely operated vehicles); and Greg became CEO.



Greg

Development of both MicroStation and engineering design applications was rapid and has accelerated to this day. Through acquisitions and mergers, but also with substantial in-house development, Bentley fleshed out its product lines for all facets of infrastructure, building, plant, roads, rail, utilities, and more (space considerations limit how many of the developments we can include in this article). This history is punctuated with many familiar names, such as GEOPAK, Jacobus, Workplace Systems, BRICS, MOSS Systems, MX, and Haestad.

Development of Bentley products took early turns towards full 3D and design modeling, often ahead of other software and more towards what we take for granted today. Development has continued unabated, growing families of discipline-focused design software packages and the new focus areas of reality capture (e.g. ContextCapture) and collaborative design models (e.g. iModel).

History may be repeating. "I hear about new things, like the cloud and machine learning, from companies like Microsoft, and how this is a once-in-a-lifetime opportunity," Keith adds. "And I think, 'Hey, I'm all in, and how many times do you get two once-in-a-lifetime opportunities?'"

of modern infrastructure design and development. This symbiosis was rooted in the earliest days of the company's inception, more than 34 years ago (see above).

Many readers may know of (or are already using) the newer generations of Bentley products. Rather than go through all of Bentley's product offerings, which can be viewed on

the Bentley website, we're concentrating on the three current elements of Bentley Systems' ongoing story that we feel are significant:

- growing technology partnerships;
- erasing legacy gaps among engineering, surveying, and construction; and
- innovation in the distribution and synchronization of engineering design models.

NOT GOING IT ALONE

It seemed that the trend over the past two decades for geospatial-giant firms was to grow through acquisitions and seek to resolve infrastructure-lifecycle issues by producing all of the hardware and software. Approaches to managing lifecycles and solution integration have changed, with key hard-

ware elements becoming more commoditized.

What we see now (and several of our feature stories have examined prime examples of this) are more and more technology partnerships and joint development initiatives.

At Bentley's Year in Infrastructure conference 2017, held in Singapore (the city-state is often described as the global "center

of gravity” for infrastructure development and innovation), several key technology partnerships were highlighted, including:

Siemens is a global leader in providing sensors and system for many industries. Siemens and Bentley announced a strategic alliance in 2016 and have since announced further collaboration with the Siemens energy management division to jointly develop solutions to accelerate “going digital” for energy providers.

Microsoft: The two companies have collaborated in cloud-enabling Bentley solutions. For example, Bentley announced ProjectWise 365 Services, leveraging Microsoft Azure (cloud services) with a project dashboard in the Office 365 environment.

Bureau Veritas is a global leader in testing, inspection, and certification (TIC). New solutions will be developed for transportation and industrial infrastructure owners with Bentley’s expertise in data modeling and Bureau Veritas’ expertise in TIC for asset management.

Topcon Positioning Systems: Announced in 2016, Bentley and Topcon have launched a joint initiative under the term, “Constructioneering” (read *xyHt’s* March 2017 constructioneering feature at goo.gl/7t34YL).

CONSTRUCTIONEERING

The initial thrust of the strategic alliance with Topcon Positioning Systems is to remove the barriers to smooth data flow among engineering, surveying, design, construction, and machine-controlled equipment.

The term “constructioneering,” in this context, was reputedly coined by CEO Greg Bentley in discussions with Topcon Positioning Systems president and CEO Ray O’Connor. They spoke about this alliance in a joint keynote at the YII2017 conference, where they also announced the development “Constructioneering Academies,” coming in early 2018.



“How do we solve this massive problem of automating the construction industry?” asks O’Connor. “I started as a young Irish immigrant boy in 1983 working on construction jobs and could not understand why we were not automated. At Topcon, we started working on that, and the first place we started was automating big equipment. Those machines work much in the same ways as milling machines, like in machine shops, and as I see them operate, we are simply machining the face of the earth.”

O’Connor asks, as he has before, “Why can’t the same level of automation that exists in factories and machine shops be achieved in construction?”

O’Connor speaks to the challenges that constructioneering seeks to address: “As we grew that business, and as the business evolved, the question became, ‘How can we connect the engineers with the operations that are going on at the construction site?’ How do you make the software integrate seamlessly with the type of 3D models needed to drive the machine control systems and take that data and feed it back into the [engineering] systems?”

“We are on a mission to au-

At the 2017 Year in Infrastructure conference, Topcon Positioning Systems CEO Ray O’Connor (left), and Bentley CEO Greg Bentley (right) announced the joint initiative of Constructioneering Academies, to begin in early 2018.

tomate the largest manufacturing industry in the world,” O’Connor continued, discussing the construction industry and noting that it is a US\$10-trillion-a-year industry. “It is very difficult and has been a challenge to get to where we are today with big equipment automation. It took years, but automation will drive the industry in the future.”

But, says O’Connor, “When somebody buys two new machines that are automated, then what about the other 100 machines? What about connecting all of them via Sitelink 3D for the communications to bring the data back and make them into IoT machines? We are on a mission to get that done, to continue to solve those problems so that you have a greater return on investments.”

O’Connor says that it takes more than just updating the hardware. “If you do not solve the workflow issue, you do not have a solution. You have to think about the manufacturing industry; it is very fine-tuned, but those technol-

ogies, methods, and processes can be transitioned into our industry.”

Greg Bentley describes how the new, jointly developed constructioneering process works and how it will move the industry closer to the automation goal first by describing the legacy scenario of compartmentalization. “Engineering, survey, and construction is a continuous process, and it is rare that [data] is not simply handed from one group to another.”

Bentley discusses how constructioneering is now possible as, for instance, Topcon aerial vehicles and software can capture images of the construction site, and the data is then brought into Bentley ContextCapture, an engineering-ready reality environment, through Topcon MAGNET Enterprise cloud service.

“The design can [go] back through MAGNET Enterprise from our connected design environment, federated with theirs, to the machine-control equipment using Topcon devices for accomplishment of heavy civil construction,” Bentley explains. “And then back again from positioning devices, capturing a record of what was actually built, into the engineering and management environment.”

Much of the hardware side of the equation is already in place, explains O’Connor. “There is not one major [construction equipment] manufacturer not already integrating [machine control] systems into their machines—exponential growth in that area.”

The cost of adding [automation components] to machines used to be up to \$100,000, according to O’Connor, but the development of sensors, systems, and actuators for autonomous vehicles is dropping costs for a lot of components.

Automation hardware is becoming standard on construction equipment; the pieces are in place, but, O’Connor warns, “If the engineering and construction sides do not calibrate, the workflow will not be solved.”

Advances in machine learning will only improve productivity. “Machine learning for construction won’t just mean controlling the depth of a grader blade or positioning a bucket; it means the machine will provide feedback in real time, and learn from it, shortening [task] cycles,” O’Connor says.

The two companies have begun exploring the possibilities of implementing machine learning.

CONSTRUCTIONER ACADEMIES

At the YII2017, the two CEOs jointly announced the launch of Constructioner Academies. What will these look like? Presently, the key points of collaboration are in the software and data-sharing mechanisms, so there will be classroom time and online-learning resources.

To provide full context, some of the Academy locations will be co-located at or near existing heavy civil construction training or actual construction sites, with real heavy equipment and earth to move. Topcon has often held their technology Road Shows at such venues. The first Constructioner Academy locations and agendas for 2018 will be announced soon (check for notices at constructioner.com).

SYNCHRONIZING DESIGN MODELS

The next development could turn out to be quite significant. Synchronizing design models in the manner that Bentley has recently implemented challenges conventional wisdom on how to handle version-control and how project collaboration can be enhanced by the cloud, and it presents a new model (no pun intended) for how engineering and construction can accelerate “going digital” for infrastructure projects.

What is a Bentley iModel? Think of a portable design model: it is a database of everything you need to convey to stakeholders, implementers of BIM technology at construction sites, collaborat-



Founder Keith Bentley is working on solutions leveraging what he considers the next “once-in-a-lifetime” opportunity: the cloud and machine learning.

ing engineers, and others within the workflow. Some liken iModels to portable document formats (e.g. PDFs), but, unlike some of those formats, it does not “pound the data flat” to genericize them.

iModels, first introduced in 2009, store graphics from simple 2D planimetry to complex 3D solids, standard data tables used in BIM software, and much more. Viewers and collaborators do not necessarily need the specific applications that created the data stored in the iModel to access it.

But each legacy iModel was a snapshot, and if any of the collaborators made changes, new copies had to be distributed. How many different versions of a design file do you have on your hard drive? Version control has bedeviled computer-aided design and drafting from day one.

Keith Bentley, executive vice president at Bentley Systems, wanted to remedy this challenge and provide additional capabilities to iModels where the cloud would feature prominently

There are some misconceptions about how “the cloud” can solve version-control issues. One misconception is the idea that there could be one giant master design loaded up into the cloud and that everyone involved can simply connect as thin clients and work collaboratively on the master. This idea would be a recipe for disaster and pose single points of potential failure.

For scalability and portability, having many individual copies of models is optimal—provided there is a way to keep them all synchronized, according to Keith.

“We have to embrace change—literally—and that change, the transactions and the timeline of changes, is what is most practical and valuable to enable in the cloud,” Keith says. iModels is the Bentley product that enables that, and the next evolution of the application is iModel 2.0, which is both a cloud platform (with the iModel Hub service) and a relational database.

“Think about your bank account. You do not get your whole account sent to you, only the monthly transactions,” Keith explains. “For the iModel, we need a ledger, a timeline that multiple users synchronize to, even if they have been working on their copy on a tablet in the field offline and then sync changes when connected, adding their updates and receiving updates from others.”

I ask Keith if this type of collaboration model is being used in other industries, and he mentions GitHub, a popular (and rapidly becoming the standard) for software developers, for commercial and especially open-source code

development. GitHub has an online version-control repository hosting service that makes it possible for dozens of developers from all over the world to collaborate on programming code, to work on their own sections of code, and to sync with the rest.

“People ask, ‘Where is the master [copy]?’” says Keith. “There is no master; the ledger [of changes] and the timeline is the master, and this is on the cloud service.”

This is a similar model to what Keith and his team have developed for iModel 2.0. Changes are noted graphically and in tabular data in a familiar color schema: red for deletions, green for new additions, and blue for altered. Users can sync up to the iModel Hub and update all, or just the relevant parts, of their own iModel.

YOUR ROLE

With the blurring of traditional roles in geospatial professions and industries and the forging of new roles, business opportunities, and career paths—many that did not exist only a few short years ago—the interconnected world of modern infrastructure is the nexus.

This treatise on Bentley is an example of what’s going on in the world of infrastructure and where it’s headed. There’s a lot of exciting innovation and development to support infrastructure development by many other firms, and we will publish about those, as well. This example is particularly pronounced, and the subject firm and their global community of users is focused in their self-association with infrastructure.

Whether you are a direct user, an indirect user, or working with unrelated solutions, you are part of the ongoing process of accelerating the “going digital” of infrastructure development. If you have an opportunity, try to attend a Year in Infrastructure conference or a similar event; you will most definitely be impressed and, we hope, inspired. ■