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The Future of Technology in Construction Management

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Technology is one of the topics discussed in CMAA's Professional Construction Management (PCM) Course, of which I am an instructor. In previous years, the course focused primarily on Building Information Modeling (BIM), but now focuses on the overall transition to technology in the construction management industry, the role of construction managers (CMs), and the use of technology in each project phase.

PCM classes typically include construction managers with varied experience. The most engaging part of the class usually takes place when I ask students to discuss where they see the technology and the construction management industry in 40 years.

Given all the recent hype and discussion about how artificial intelligence, machine learning, and ChatGPT will impact other areas of our lives, this article attempts to shed some light on how new technology will impact the construction management industry.

Following the advice of the philosopher George Santayana who stated, "To know your future, you must know your past," let's look at technology from the early 1980s when I started my career and when CMAA was formed, examine the advances in technology over the past 40 years, and use this information to determine what construction management technology might look like in another 40 years.

The construction management industry in the early eighties was "old school." Even though the first PCs became commercially available in the mid to late 1970s, they did not become powerful enough or have any helpful business applications until the mid-1980s. At the time, larger public projects utilized CAD programs like McDonell Douglas McAuto on large mainframe computers. Typical projects at that time were still designed by engineers using calculators and drafted by hand with ink on mylar in rooms full of drafters. Secretaries typed reports on electric typewriters, then reviewed, marked with red pencil, and retyped. All documents were stored in hard-copy file cabinets. Each project team included a document control specialist responsible for tracking, updating logs, and keeping all correspondence organized and distributed by hand or mail. Daily reports were handwritten and filed. There was no digital documentation, email, internet, cell phones, or virtual meetings. The high-tech communication tools at the time were pagers and two-way radios.

By the late 1980s, things had changed quite a bit and the digital age had finally reached the construction management industry. Personal computers became powerful enough to support essential business applications like DOS-based WordPerfect and Lotus 123, which started to replace electronic typewriters and paper logs. Autodesk released the first version of AutoCAD in December 1982, Primavera released the first version of P3 in 1983, Microsoft released the first version of Windows in 1985, and Primavera released the first version of Expedition in 1987. Pen plotters became commonplace, and drafters were trained as CAD operators. This technology made ink on mylar obsolete. AutoCAD's LISP routines allowed for integrating survey data collected by total stations to be processed and automatically plot base maps saving countless CAD operator hours.

By the early 1990s, PCs had more speed, memory, and storage capacity, allowing MS Windows to replace DOS. The increased computing power and obvious productivity benefits incentivized businesses to invest in PCs as an everyday tool for every employee. This increase in business use created the need to develop additional business applications. However, the biggest technological advancement of the 1990s and early 2000s which benefited the construction management industry, was in the communication industry. The introduction and eventual adoption of the Internet for business use, the ability to add multimedia attachments to emails, the mass production and portability of cell phones, and the development of handheld GPS receivers changed how we communicate forever.

By the end of the 1990s into the early 2000s, the combination of increased computing power, better business applications, and advancements in communications resulted in the actual digitization of the construction management industry. During this period, most projects were designed in CAD. Contract documents were digitally produced and distributed, hard copy documents were converted to digital form by high-speed scanning, and Project Management Information Systems (PMIS) like Primavera Expedition were commonplace.

Large public agencies were procuring and configuring their own enterprise PMIS platforms for all agency projects. When Autodesk purchased REVIT in 2002, BIM became famous again for use not only on larger projects like the Freedom Tower in New York City, but it was economical for use on mid-size and smaller projects as well. At this time, REVIT also introduced the first BIM with time as the fourth dimension.

In 2002, Caterpillar and Trimble used GPS technology to develop machine control products for improved productivity and lower cost on earthwork projects. In the field, communications were primarily via cell phone, submittals and RFI's were submitted via email, and all data was tracked in a PMIS. Inspectors used laptops to complete daily reports and cell phones or digital cameras with date stamps to document fieldwork.

By 2010, further advancements in computing power, communication network coverage and speeds, more extensive use of smartphones, handheld GPS equipment, and later versions of REVIT gave design and field teams the ability to collaborate and work on shared central files simultaneously. This technology allowed the construction management industry to move away from traditional, design-bid- build delivery and towards integrated project delivery. This shift towards integrated project delivery created the need for cloud computing and the development of collaborative applications for use on iPads, smartphones, and other personal devices making design and field personnel much more productive. The last decade also saw the introduction of virtual reality, virtual meetings, virtual site walks, cashless procurement and payments, and the further development and broader use of BIM. In 2002 we added time to BIM, which created the fourth dimension. Today, we have 10 dimensions: cost and quantity management, sustainability and energy management, operations and facility management, construction site safety management, lean construction management, and quality management.

Today, drones flying above our sites to monitor progress and collect data are commonplace. Lidar surveys and scanning are regularly used to create real-time as-builts. The construction industry has learned from the automotive industry and now uses robotics and 3D printers to prefabricate more construction elements in the shop for quicker, more efficient, cost-effective, and safer installation in the field. The construction industry has also adapted technology from the home automation and security industry. The Internet of Things (IoT), which allows us to monitor cameras, locks, appliances, and other devices from our smartphones, is now being widely used to monitor safety, equipment, resources, and operating systems.

The real-time data collected by various sensors combined with sophisticated BIM modeling has allowed the construction industry to incorporate digital twin technology. A digital twin is a virtual model that accurately reflects a physical object. Using real-time data collected by sensors attached to an existing object or system, the virtual model can be used to run simulations and study performance issues that can then be used to tune or improve the current system. The latest advancement in this combination of technologies is artificial intelligence. AI allows computers and sensors to collect and analyze real time data to learn and recognize patterns, identify issues, generate solutions, and make recommendations.

So, how do we use this information to determine where technology will take the construction management industry in the next 40 years?

By studying the past, we can easily see that the key driving factors behind technology's continued innovation and development over the past 40 years have been increased computing power and network connectivity. Assuming that in 40 years computing power and network connectivity are no longer limiting factors, imagine a project site where 99% of projects use an integrative delivery method. In these cases, design-build teams input the basis of design, performance criteria, and site characteristics into BIM software that uses AI to generate detailed designs and construction alternatives. Each generated design alternative is a multi-dimensioned BIM model that can be toured by the stakeholders who can review quantities, resources, costs, schedules, construction sequences, and more virtually.

During the tours, comments can be added and implemented on the spot, with dimensional data updated automatically helping to expedite the decision-making process dramatically.

The future is one of increased collaboration, cohesion, and automation.

Technology will enable general contractors, architects, structural, civil, and MEP engineers; subcontractors, material suppliers, and manufacturers to work simultaneously on the same virtual model, sharing data with supplier and manufacturer networks to constantly update and verify that dimensional data meets project goals and requirements. Envision advances to ground penetrating radar (GPR) systems that allow design-build teams to document and model underground conditions accurately then being automatically incorporated into the shared BIM models. Imagine AI and ChatGPT programs automatically developing 95% of contract specifications with technical staff reviewing and making final revisions. During the construction phase of the project, imagine cameras using facial recognition software, equipment tracking sensors, and machine controlling software in combination with lidar scanning technology to document and track daily labor and equipment, production rates, quality and quantity of work performed, identify potentially unsafe conditions or employees not wearing proper PPE.

Concrete can be poured with embedded microsensors that report the real time, compressive strength of the concrete, and sensors being installed with all piping and conduit that monitors flow, conduit conditions, and location.

Robots in the field will perform repetitive tasks more quickly and accurately like laying bricks. Envision utilizing autonomous-operated earthwork equipment like scrapers to perform mass earthwork operations or backhoes, and excavators using the same software to excavate around existing utilities more accurately and safely. Imagine equipment with sensors that automatically alert mechanics when maintenance is needed, or when a catastrophic engine failure is about to occur. Drones, robots, and machine-controlling sensors will document and track conditions at the end of each day, creating real- time as-builts and updating BIM models.

CMs and inspectors in the field can imagine an environment where they can view a holographic image of the planned model on a wearable device and directly compare it to what they see in the field or have the field cameras compare the as-constructed portion to the model while highlighting deviations that are outside the project tolerances. CMs can imagine having the computers review material or product submittals by automatically comparing information with specification requirements and returning comments. Once approved, submittals and RFIs will automatically be attached to the BIM model for later use in the digital twin. Imagine seeing and tracking procurement, fabrication, shipping, and delivery of long lead items in real time.

Increased use of AI can lead to generating and distributing meeting minutes, helping review RFIs, assisting with determining the merits of a change order, and performing time impact analysis based on data collected daily by computers or alerting inspectors where items are out of compliance. A budget control system will be synchronized with the BIM model in real time and automatically generate progress payments based on the data collected during the period and verified by the inspectors.

The future of construction management is bright. The impact of technology in construction management is only limited to the imagination and those who embrace it.

About the Author

Paul Buckley is a senior technical expert with over 42 years of experience overseeing complex programs and projects for public and private clients in the U.S. He has a degree in civil engineering from the New Jersey Institute of Technology. He has worked as a designer, contractor, and public agency project manager. Paul has combined his extensive expertise with his passion for facilitation to teach hundreds of construction industry professionals. Before joining Anser, he owned a project and construction management consulting firm for 25 years.

About the Article

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