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INSIGHTS

The Rise of Artificial Intelligence in Construction

A RESEARCH BRIEF BY: BUILTWORLDS + Microsoft

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The future of the construction never looked so bright (or smart)

When people hear the term “Artificial Intelligence” (AI), talking robots and movies such as The Terminator, The Matrix and Ex Machina often come to mind. But AI is so much more than clever robots and talking machines. Artificial intelligence is a set of intelligent systems that are making people’s lives easier – from software that can recognize objects to digital assistants that anticipate their owner’s needs to completely driverless cars. AI is the future that tech giants including Microsoft, Google and Amazon are heavily investing in today.

Several definitions of AI can be found online, but here are a couple good ones:

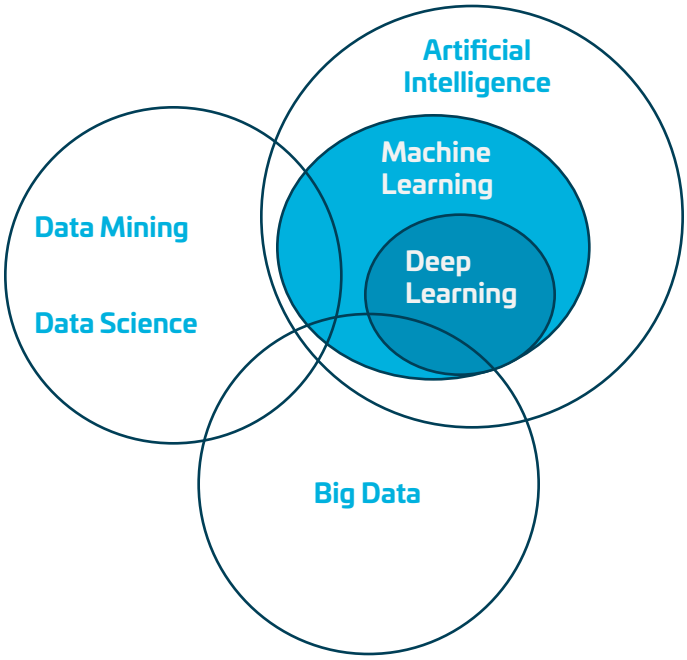
- The capability of a machine to imitate intelligent human behavior.
- A computer system able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Often times, the terms “Machine Learning” and “Deep Learning” are used interchangeably with AI, but it’s important to understand the distinction. Picture deep learning, machine learning and artificial intelligence as a set of Russian dolls nested within each other, beginning with the smallest and working out. Deep learning is a subset of machine learning, and machine learning is a subset of AI, which is an umbrella term for any computer program that does something smart. In other words, all machine learning is AI, but not all AI is machine learning, and so forth.

Machine Learning and Deep Learning defined:

- Machine learning uses algorithms to parse data, learn from that data, and make informed decisions based on what it has learned
- Deep learning structures algorithms in layers to create an artificial “neural network” that can learn and make intelligent decisions on its own – it’s usually what’s behind the most human-like AI

There's a difference:
Making sense of AI language



Graph: https://whatsthebigdata.com/2016/10/17/visually-linking-ai-machine-learning-deep-learning-big-data-and-data-science/

The easiest takeaway for understanding the difference between machine learning and deep learning is to know that **deep learning *is* machine learning**. More specifically, deep learning is the next evolution of machine learning.

Considering AI is an umbrella term for any computer program that does something ‘smart,’ the term covers a broad spectrum of capabilities. Unlocking your iPhone with your face and cool new smart speakers are good examples of AI on one end of the spectrum while driverless vehicles that use deep learning to recognize a stop sign or distinguish a pedestrian from a lamppost is a good example of how far we’ve come – and are still going – with AI on the other end of the spectrum.

AI within the built environment

Just as technology companies' heavy investments in AI are already changing our personal lives and gadgets, they are beginning to lay the groundwork for a more AI-dependent future in construction as well. And when it comes to AI within the built environment, there's also a huge range – as well as an increasing awareness – of AI programs being used on the job site today. From more simple applications such as drones and visual recognition software to much more complex applications such as generative design software, AI runs the gamut within the construction world. What we do know is we're only scratching the surface of what's possible.

"I like to call Artificial Intelligence Augmented Intelligence instead as it's really assisting humans in making decisions."

– Travis Connors, Partner - Borealis Ventures

According to Jen Suerth, VP – Technical Services, Pepper Construction, "In reality, although Building Information Modeling (BIM) has been around a while, we're still pretty early in the game. We are now taking all of the data gathered from these models and analyzing it in order to make better decisions around labor, safety, scheduling, materials, etc. going forward. Capitalizing on all of this data through our AI efforts will help us be much more productive and smarter since much of what we do can be iterative. The key is to continually analyze, learn from and then react to the data."

"There's a real labor shortage within the construction industry, and we believe AI is going to help with that as well," added Suerth. "Some workers may fear they will lose their jobs, but studies show that the more you automate, the more 'different' types of jobs you create because there's always the need for humans to oversee the machines. To this end, AI should ultimately create a whole new set of possibilities for workers within the industry."

Only in the first inning

"With so much pressure on the built environment today, we need to scale the way we design, build and construct. Machine learning is critical to gathering data in order to ultimately optimize workflows, but construction companies are only in the first inning when it comes to AI, and they need to get up to speed fast," according to **Travis Connors, Partner – Borealis Ventures.** "We look at AI as a continuum. Over time, machines will be able to do more and more. Software gets better and underlying processes get more capable and they can take on more tasks. This will enable new sets of capabilities to allow humans to do more, which ultimately allows for optimized workflows. Construction is a massive industry with extremely complex projects – yet it's facing skilled labor shortages along with little productivity growth. This is an exciting time for emerging technology companies within the AI space. There's so much opportunity and huge potential to make a real difference."

Building smarter – from pre-construction to close out

Although AI may be fairly new to the construction industry scene, several emerging technology companies are not only making their mark, they are setting the stage for a major revolution in the built environment. From pre-construction to close out, AI is helping every step of the way throughout the construction process. It's improving safety, productivity and the overall quality of the built world.

Pre-construction / design – Using Computational / Generative Design software in the pre-construction phase is a great example of advanced artificial intelligence. With this type of smart software, instead of coming up with one or two design solutions, you can come up with hundreds of solutions. According to **Brett Young, CEO – BuildingSP**, "Design is always on the project's critical path and has a huge influence on cost. Our work is focused on improving AEC design using the same approaches that Pixar uses for animation or the Internet

industry uses for Big Data. BuildingSP believes that fixing the industry's tech woes starts with fixing design. Better, faster and more flexible design processes enables all kinds of downstream innovations, like supply chain control and robotics. The potential for AI and Machine Learning in AEC is enormous."

"The bigger question we have for the industry is what is AI not going to be able to do."

– Dan Bulley, Senior VP – Mechanical Contractors Association (MCA)

Scheduling and productivity – Imagine being able to generate and explore millions of buildable construction schedules at the push of a button. Now you can with Parametric Scheduling, yet another example of the type of AI that is revolutionizing the built world. According to **Rene Morkos, CEO - ALICE Technologies**, a pioneering leader in the space, "We created a machine (software) that understands construction. It's BIM based, generative, recipe based and parametric. All you do is put in the proper parameters and recipes for building columns, etc and the software tells you how long it will take, how many people you need and what materials you need along the way. Since it understands cranes, crews and equipment, it's really easy to tweak. All you have to do is put in the new parameters and it comes up with alternate schedules within minutes. Having this ability to accurately forecast and schedule the entire project results in huge productivity gains – on average, 16% shorter durations and 11% lower labor costs with little to no down time or wasted days."

Smarter project management – Drones have become an important tool on most job sites. Being able to take pictures and survey sites 24/7 has led to increased efficiencies, safer conditions and more accuracy all around. But drones also provide a great example of how AI is getting smarter and more sophisticated over time. According to **Chris Anderson, CEO – 3DR**, "Sure, drones have proven invaluable for automating the surveying process on a job site, but we are taking the process even further by capitalizing on the data we are gathering. Leveraging AI, we are now taking all of the data we collect and analyzing it, which is able to reveal all sorts of opportunities, problems, clashes, lack of progress, timing and more. Having this capability and intelligence has led to much smarter project management and increased productivity all around."

Microsoft | Achieving More with AI

Microsoft wants to empower you and every organization on the planet to achieve more. That's their mission. And the company believes it will achieve this mission, in part, by infusing AI technologies into its products and services. From Microsoft's personal digital assistant Cortana to its intelligent search engine Bing, Microsoft has already achieved so much on the AI front and is now putting construction in its direct line of sight – starting with safety.

Safety is an ongoing top priority within the workplace and on the job site. According to The Bureau of Labor Statistics, there are roughly 150,000 construction site related accidents with 1,000 construction workers dying each year, on average. To combat this alarming statistic, Microsoft recently launched an AI solution using its Azure technology to make the job site a safer place. It does this by identifying tools, people and even potential issues, like major spills, in real time. The software can even identify people who are trained to use a specific tool. For instance, if a saw is left unattended on a job site, the system can notify the nearest trained employee and instruct them to store it in a safe place. It can also identify non-employees and even policy violations like an unauthorized individual using a particular piece of equipment. The best part? The sophisticated software works instantly and can be managed from something as simple as an iPhone.

Microsoft is also achieving more with AI in the area of architecture and design. Until recently, the only way builders and architects could see their plans in action was on paper or computer simulations. Now, thanks to Microsoft's HoloLens, they can get a holographic, interactive view of their layouts like never before and all they have to do is put on a pair of futuristic goggles that overlays their vision on top of the real world virtually. The smart technology is proving to be a real game changer for the construction industry because now it's easier than ever to see your designs come to life – and you can make quick edits or even major overhauls to your designs in a matter of minutes instead of days or weeks.

Products like HoloLens are so important because they allow changes to be made on the fly to everything from room design and layout to structure. Merging virtual reality with actual reality provides builders with the freedom to augment their decisions and plans easily without having to undergo costly and time-consuming redesigns.

Although AI is still in its infancy and there's still so much to learn, Microsoft is more committed than ever to investing in the smart technology for the long term. And when it comes to the construction industry – an industry faced with ongoing labor shortages – AI and machine learning are the clear answers to achieving more productivity, more efficiencies and more overall growth.

"We're not trying to get people replaced by machines, but rather augmenting safety managers by extending their reach with automation. And when it comes to safety where there are never enough 'eyes' to go around, having this type of smart technology available has led to dramatically improved safety, productivity and quality on job sites all around the country."

– Josh Kanner, CEO – Smartvid.io

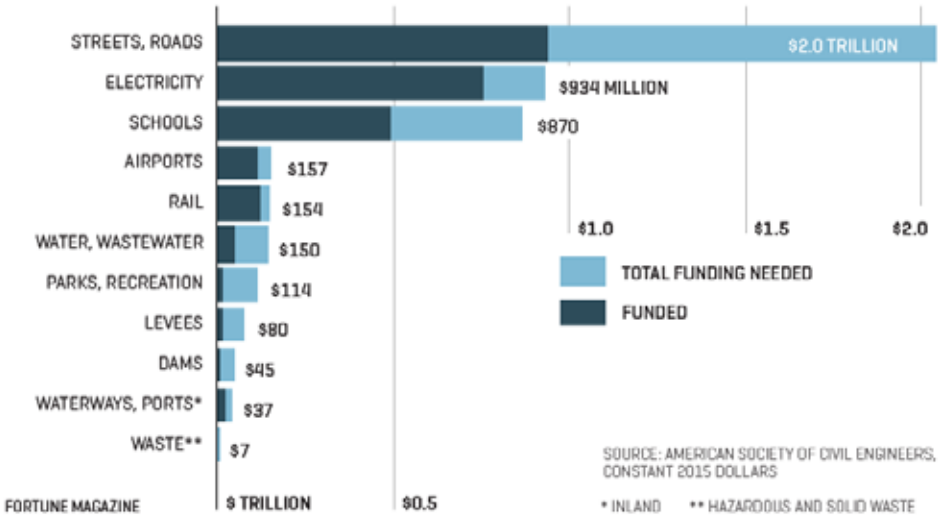
Safer job sites – Safety on the job site is a top priority and concern for every construction company and general contractor. Safety managers can't be everywhere at once, so it's hard to ensure 100% compliance. However, the advent of AI is quickly changing this. According to **Josh Kanner, CEO – Smartvid.io**, "Since safety is such a huge issue in construction and safety managers can't be everywhere, we built our own machine learning capabilities that are tuned in specifically to the safety needs of the built environment. This machine, which we've aptly named VINNIE after one of the superintendents who was an inspiration for the product, acts as a safety inspector that never sleeps. The technology monitors and reviews job site imagery 24/7, observing field personnel and providing an overall safety score that relates back to compliance issues such as not wearing work gloves or jobsite conditions like poor housekeeping. It's important to note that we're not trying to get people replaced by machines, but rather augmenting safety managers by extending their reach with automation. And when it comes to safety where there are never enough 'eyes' to go around, having this type of smart technology available has led to dramatically improved safety, productivity and quality on job sites all around the country."

Microsoft also understands how incredibly important safety is in the workplace, which is why the company is doubling down on AI in this area within the built environment. During its Build 2017 Conference, Microsoft demonstrated how its smart technology can identify tools, people and even potential issues, like major spills, on a job site in real time – making the workplace a much safer place. (see Microsoft sidebar for more)

Getting on board with AI now and in the long term

With a 27% increase in construction spending forecasted for the coming years according to Statista.com, the whole industry is going to need to get on board with AI in the near future. An increased reliance on AI could also help supplement the trillions that will be needed to fix the US infrastructure over the next ten years. Because, at the end of the day, leveraging AI and Machine Learning gets construction projects done more efficiently, seamlessly and faster. And the more we use the technology, the smarter – and faster – it's going to get. It's really a continuum.

U.S. Infrastructure Needs Over the Next 10 Years



Graph: http://fortune.com/2017/03/30/infrastructure-spending-funding/

When it comes to AI, anything's possible

Artificial intelligence has limitless potential with its usefulness positively impacting our daily lives. From performing repetitive and dangerous labor-intensive tasks to detecting safety hazards on a job site, it's transforming the construction industry as we know it – and it's not slowing down anytime soon. New products and capabilities are being rolled out every day – all with the promise of constructing buildings smarter, faster and more efficiently.

According to **Dan Bulley, Senior VP – Mechanical Contractors Association (MCA)**, "Although we're in the beginning stages of the AI process within construction, it's going fast. The bigger question we have for the industry is what is AI not going to be able to do. What areas will we need to supplement? Jobs won't go away completely, but we will need to figure out how our mechanical contractors, welders, etc. fit into this new world. There's clearly going to be a big shift and we want to make sure everyone is as prepared for it as possible."

As of today, the reality is there are still many things that machines can't do, such as understanding the nuances of language, common-sense reasoning, and learning a new skill from just one or two examples. AI software will need to master tasks like these first in order to match wits with the creative intelligence of humans.

In this smart new world, however, anything's possible.