Technological Advances Emphasize Speed, Accuracy and Safety

From seismically sound 3D printed homes to BIM- and drone-enabled safety solutions, technologists and visionaries from around the world are changing the way we visualize and construct building systems.

This summer, the United Arab Emirates (UAE) inaugurated its first 3D-printed and fully functional office building in Dubai as part of the Dubai 3D Printing Strategy initiative, a global program launched by His Highness Shaikh Mohammad Bin Rashid Al Maktoum, vice president and prime minister of the UAE and ruler of Dubai. The organization reportedly printed the building in 17 days. Similarly, China recently announced that it has 3D printed a villa that can withstand a major earthquake.

Further building on autonomous construction techniques, Australian robotics firm Fastbrick Robotics Limited introduced its new Hadrian X automated bricklaying robot. The truck-mounted robot cuts, grinds, mills and routes bricks prior to laying and can reportedly build a house in two days.

While these systems certainly hold promise for the future, many believe that it's drones and mixed-reality solutions that will make the most advancements.

Aerial Options

In a presentation to the BIMForum earlier this year, David Stone, director of Virtual Construction at HITT Contracting, and a colleague spoke on the topic of drones in construction for project control and virtual design and construction to improve efficiency and accuracy.

The firm already relies on drones to track project progress and quantify soil removal moved over the course of a few months—tasks that would ordinarily be done with survey tools.

Now, the company's virtual reality team is looking beyond soil management to other applications. Stone says, "The more we use it, the more ways we find to apply it. In one recent case, we had to blast bedrock on the project and used the drone to monitor the site to make sure nobody was on the site as well as to document the blast. Down the road, I believe we'll use drones inside construction projects as well. For instance, we could use it to laser scan as-built conditions of a renovation or new construction instead of having someone walking through a building and setting up scanners."

PHOTO: ADG DRONES REALISATIONS

A low-altitude flying drone captured thousands of millimeter-resolution images of the Aqueduc de Roquefavour Roman aqueduct in Ventabren, France.

Researchers at Stanford University are already working on just such a system. The team, led by doctoral student Iro Armeni, uses existing 3D sensing technologies and light sensors to scan and measure architectural details within a building interior.

Similarly, ADG Drones Realisations (ADG) used drones to capture high-resolution photos of unreachable areas in the Aqueduc de Roquefavour, a Roman aqueduct in Ventabren, France. The UAVs, flown at low altitude, captured thousands of photos to millimeter-scale resolution. The team then used Bentley System's ContextCapture tool to generate a precise 3D reality mesh and navigable model with the precise geometric accuracy to assess the structural integrity of the historic site.

BIM and Workspace Safety

Building information modeling (BIM) is taking on a greater role in the industry, moving beyond clash detection and coordination to a valued resource in the field for real-time jobsite safety monitoring.

In the research by Zhang et al.[1] an approach is taken to proactively improve construction safety through a combination of lean practices, BIM-enabled automated workspace visualization, remote sensing and workspace modeling technologies. In the case study tested on a real construction project, high-precision

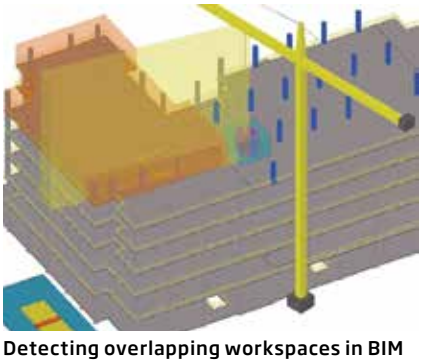


IMAGE: JOCHEN TEIZER

Detecting overlapping workspaces in BIM

GPS data loggers were attached to the personal protective equipment (PPE) of a work crew constructing cast-in-place concrete columns. The team developed algorithms to extract activity-specific workspace parameters from the recorded workforce location tracking data. Using an unmanned aerial vehicle (UAV) to create as-built information of the site's working conditions and visualized within BIM, construction managers, foremen and site supervisors are able to evaluate potential workspace conflicts among the other competing work crews or lifting equipment.

More recently, Golovina et al.[2] developed a method for recording, identifying and analyzing interactive hazardous near-miss situations between workers-on-foot and heavy construction equipment. Using spatiotemporal GPS real-time location tracking system data to automatically measure a hazard index on a heat map, a project team is able automatically generate personalized safety performance reports. The data will help define and validate safety parameters—such as entry of workers-on-foot in equipment blind spots—to determine the root causes that lead to equipment- and visibility-related fatalities on construction sites, thereby transforming field of practice in safety training and preventing accidents in the first place.

Dr. Jochen Teizer with the RAPIDS Construction Safety and Technology Laboratory in Ettlingen, Germany, says, "Our goal is to proactively eliminate hazards and accidents through real-time automation and predictive leading indicators. The technology is available; it's our job to pull it together in a clear, ethical and affordable framework for the construction industry to apply." ■

[1]Workforce location tracking to model, visualize and analyze workspace requirements in BIM for construction safety planning, Automation in Construction, 2015, Vol. 60, p. 74-86.

[2]Preventing struck-by and near miss interactions between workers-on-foot and construction equipment, Automation in Construction, 2016, Vol. 61, in press.

Reality Modeling Comes Of Age

By **Dustin Parkman**, Vice President, Civil and Reality Modeling Product Development, Bentley

The explosion of reality modeling techniques and the expansion of engineering design applications are transforming how we think about engineering, construction and operations. The ability to combine BIM methodologies and as-built data with new operational technology provides users with critical engineering analysis for the design and management of infrastructure.

With the latest advancements in reality modeling, engineers and designers are able to connect real-time data for existing conditions and performance monitoring at each phase of an asset's life, vastly improving business decision making for the best possible business outcome.

The combination of reality data and virtual data with predictive analytics provides insight into how well an asset will perform much earlier in the design phase of a project. Continuous survey techniques can be applied along with traditional stakeout methods, allowing owners and contractors to easily compare as-constructed conditions to schedule and cost intent with detailed accuracy. New sensors and devices are making it far easier and affordable for owners to monitor, maintain and extend the life of constructed assets.

Future success will be measured by the connectedness of all data within a system that supports workflows from concept through construction and operations. ■

Increase Wrench Time with Equipment Maintenance App

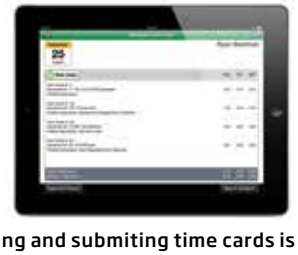
Heavy highway contractor Earle Asphalt Co. knows that lost hours for maintenance equates to lost dollars.

To improve wrench time and limit miscommunication, the company implemented the Maintenance Request App, a new feature in HCSS's Equipment360 equipment maintenance software program. Through it, project managers are able to report equipment issues from the jobsite or the shop on a smartphone or tablet.

The app saved Brian Cooper, project manager for Earle Asphalt, direct dollars and time almost immediately. During the first week using it, one of Earle Asphalt's night-shift foremen found an issue with a milling machine. What would normally take two to three days was resolved in less than 24 hours.

Previously, Earle Asphalt reported equipment issues via phone or email and then manually prepared work orders. Now, it uses Maintenance Request to turn requests into work orders with two clicks, communicating information such as who requested the repair, what equipment needs repair and what parts are needed, with clarifying photos.

Earle Asphalt's mechanics increased their wrench time by decreasing miscommunication. Want to do the same for your mechanics? To learn more about Maintenance Request, visit www.hcss.com/e360. ■



Entering and submiting time cards is easy with HCSS Mobile Mechanic.

IMAGE: COURTESY OF HCSS