(When) Will Robots Replace Us?

By Eytan Solomon P.E., LEED AP

Kurt Vonnegut, whose father and grandfather were architects, imagined a computer program called "Palladio" in his novel *Timequake* (1997). Palladio, the story went, could perform a complete building design according to basic user inputs about the intended use, size, location, architectural style, and even the aesthetic of surrounding buildings. The program output full working drawings – down to "plans for the wiring and plumbing" (presumably structural as well) – in less than half an hour. An architect hears of the program from a friend's teenage daughter, and he goes to his local computer store to see for himself, bringing a wild test for Palladio: to design "a three-story parking garage in the manner of Thomas Jefferson." True enough, Palladio quickly and successfully designs the building and additionally offers "alternative plans in the manner of Michael Graves or I.M. Pei." The architect subsequently commits suicide at the "blow to his self-respect."

Palladio is not possible yet, but there are signs of its approach through increasing computer capabilities and other ways that technology may dramatically change the profession of structural engineering in the next 5, 10, or 30 years.

Site Visit Drones

Camera-mounted drones (or UAVs – unmanned aerial vehicles) are already providing visual access for locations too high, far, deep, or hazardous for humans to view in person, which greatly assists documenting construction progress and existing conditions. Examples include facades, tower spires, inside partially collapsed structures, across debris-strewn fields, and down shafts. Photo and video are already available; sample-taking and resistance-testing (for example, hammer sounding) may be possible soon. Drones controlled from a remote office also save travel time to and from the site and provide views that could be overlaid directly with the design drawings for comparison.

3D Coordination

BIM programs have been steadily progressing toward "seamless coordination" and "clash detection," and we should expect ever more useful, rapid, and clever tools for coordination among design team collaborators. Virtual reality (VR) and augmented reality (AR) will enhance and speed up communication among the design team. Information about architectural finishes and MEP infrastructure will live in the model with embedded structural loading properties. We should expect that structural modeling programs and analysis programs will get better at sharing information, and perhaps move toward one model for all analysis and drawing production.

Automated Tasks

Much as a good design spreadsheet permits unlimited and rapid calculation iterations, engineers will continue to outsource many automatable tasks to computers whose processing speeds will only increase. Ideally, this will free up the engineer for more big-picture or deeply-critical thinking. Many standard and custom programs already iterate and optimize for structural member design and load derivations based on project location and governing code, when enough information has been input by the engineer. Perhaps the computer will soon gather and interpret more of the input automatically; for example, deriving dead and live loads directly from the architect and MEP drawings. Comparing old and new versions of drawings, contracts and reports could also be automated so that only important changes are highlighted for the engineer, like when comparing construction submittals to design drawings.

Machine Learning

The technology industry is developing ever more sophisticated programs for pattern recognition and translation, sometimes called machine learning or deep learning: not just rote, repetitive tasks, but distilling vast amounts of data in recursive learning loops so that the program is advancing its own insights and capabilities. Currently, computers are competing with (or already "superior" to) humans at driving cars, diagnosing cancer from X-rays, identifying faces, and translating foreign languages. Is the day far off when the computer could not just size the beams and reinforcing bars, but lay out the framing plan, choose the structural system, and negotiate the project contract?

Prefabrication

Balfour Beatty, a major construction company in the U.K. and U.S., published a thought-provoking manifesto, *Innovation 2050 – A Digital Future for the Infrastructure Industry* (2017). One of Balfour Beatty's visions for coming revolutions in construction is the expanded use, on a very large scale, of prefabrication and preassembly. They see this as necessary to reconcile humanity's mass urbanization with a shortage of skilled labor and to put tighter control on the often-messy on-site construction process. As the technology and finance industries run away with profits on "scalable" technologies, mass prefabrication could be a similar opportunity for the construction industry. Alternatively, even on the small and custom level, prefabrication can limit time and risk on the construction site and facilitate the increased use of robot "workers" both in the shop and on site.

3D Printing

In short, 3D printing employs technology either in material science (weld deposits, laser-zapped powders, and the like) or computer guidance of conventional materials (for example, the CNC-cut plywood creations of Wikihouse). It also reduces the need for skilled human labor on site – sometimes down to zero. As these types of construction methods gain traction and their associated architectures become more ambitious, structural engineers will need to train themselves (and their computer programs) in these materials and design methods.

Do you see these or other trends? The world is rapidly changing and we, as engineers, will need to adapt to the changes… before the robots replace us.▪

A similar article was published in the December 2017 *Cross Sections (SEAoNY)*. This article is reprinted with permission.

The online version of this article includes a list of suggestions for further reading. Please visit **www.STRUCTUREmag.org**.

Eytan Solomon is a Structural Engineer at Silman in New York. (solomon@silman.com)

Further Reading

Balfour Beatty. "Innovation 2050 – A Digital Future for the Infrastructure Industry", 2017. **www.balfourbeatty.com/2050**

Phil Bernstein. "Disabling (Professional) Expertise." *Architects Newspaper*, July 2017.

Catherine Cardno. "Drone Successfully Used in Airport Construction Imaging." *Civil Engineering Magazine*, July/August 2017.

Jonathan Woetzel, et al. McKinsey. "Reinventing construction through a productivity revolution," 2017. **https://mck.co/2mBiJCG**