Technology Transformation:
Are We There Yet?

In this wide-ranging discussion, RPI's CASE Director Dennis Shelden shares his journey and vision for industry change.

DENNIS SHELDEN

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DesignIntelligence (DI): You've had an interesting career in the technology space. You were one of the early pioneers and leaders at Gehry Technologies, migrating to Georgia Tech to run the Digital Building Lab (DBL) and take over for Chuck Eastman. Now, you have a new opportunity at another leading technological institution, the Center for Architecture Science and Ecology (CASE), and as Assistant Professor in the School of Architecture at Rensselaer Polytechnic Institute (RPI). How did you get into technology?

Dennis Shelden (DS): My personal career trajectory is in some ways a microcosm of the larger evolution of technology in practice and its potential for cross disciplinary integration and value creation. I was very fortunate to have gone to MIT as an undergraduate in the 1980s, when CAD and other digital tools like structural and energy modeling were just beginning to mature to the point of relevance to building practice. Although I went to MIT intending to do something related to computing, I discovered and fell in love with architecture while I was there. Architecture had – and has - this expansive agenda about the world and projections of the possibilities of change through creativity and invention. This possibility is also very apparent the tech world today, but it wasn't so

clear at the time that technology was going to be the profound social driver it has become, and architecture had that appeal.

Computing allowed me to have relevance in numerous aspects of building, not just architecture but also the various associated engineering fields, software and building product firms, and I was able to surf the growing technology wave into experiences across the silos in building space. I worked for a company that was pursuing real time building energy and controls optimization in San Francisco, and then Cyra Systems, who developed the first cloud of points laser scanner that was ultimately acquired by Leica. During grad school I also got a chance to work with Arup in New York on both structural and energy modeling teams. In San Francisco I had acquired a used Sun Unix workstation, which was the hardware platform Arup was using for their proprietary software at the time, so I was the only intern that could access their software on a regular basis. Those early experiences helped me form an expansive view of how

information technology can connect and cut across the distinct disciplines concerned with the development of buildings.

It was during grad school in the mid-1990s that I got introduced to Frank Gehry's practice through an academic collaboration they had with my advisor at MIT – the late William J. Mitchell. The Guggenheim Bilbao was just finishing up at the time. What I saw on visiting the studio was incredibly groundbreaking. At the time they were using the Unix version of the aerospace software CATIA, which had several firsts: the first commercial curved surface modeling, real time rendered navigation of models, and an orientation to design-for-fabrication. They weren't just using CAD to draw and render, they were using the models as a new way of understanding building: lighting, acoustics, and structures, and a way of thinking through how the projects were put together and discussing ideas directly with fabricators and builders. It was clear to me that I was seeing the future of the profession, precisely in this possibility of digital

information connecting design across the myriad of building disciplines. I finished my PhD qualifying exam that semester and left MIT to take a technology leadership position in the firm.

Bilbao created an enormous amount of interest in the Gehry's work and the methods of the firm, and we were able to use that demand for the architecture to drive adoption of the firm's digital tools and methods into collaborating firms on project teams. The tech team that I directed took on a number of services both for the firm and for collaborators, including research and development of new software add-ons as well as specifying, assisting in procurement and training of partners. These services were provided to the teams as part of the firm's architectural services fees and contracts. It eventually became clear that this was both an added complication and risk to the core architectural services, and that ultimately the resources required to support this agenda would exceed what could be "fit" into the firm's design services. And, that there was an emerging opportunity for the

methods and tools we were using beyond Frank's practice. These really were the underlying motivations of the formation of Gehry Technologies: to develop technologies that could connect design, engineering and fabrication together on Gehry's projects and beyond in the broader industry.

It's worth noting that there was, and I think still is, an important back story about the role of technology in the practice. Frank Gehry has always had a passion about re-empowering the architect. Digital technology has been a way of defending the agency, role, and value of the architect in the context of a supply chain where it was increasingly being eroded. Working out the details of the designs virtually – "down to the bolt", and incorporating the knowledge of fabrication and detailing into the design and its documentation, has provided the firm a powerful weapon in de-risking the project, countering the voices of those who have closer control of the project during construction, and defending against "value engineering" the design out of the project.

DI: I don't recall ever hearing about that side of Gehry's motivation. That's not what gets talked about with him. It's always about the art and the form. But I can make the connection because in his early work he used inexpensive common materials — chain link fence, wood studs, corrugated metal siding, and asphalt — as a way to claw out of the diminished architect's role and combat the perception of busting budgets. Likely also to create a brand and a unique materials palette. His later use of technology to adapt standard construction methods is a next generation way of accomplishing that same goal. He reinvented the form, not the familiar means of construction.

DS: Absolutely. That's the story that doesn't hit the Simpsons. First of all, Frank's buildings work. They work because the program is incessantly thought through, and because his designs adhere to budgets remarkably well. I know the lore is everything but that, and the few times there were issues on projects, everybody would shout from the rooftops. But the fact is, there's a point around GMP where

pricing is locked in, and the detailing and system strategies have been so comprehensively worked out and vetted across the team that there is very little of the sort of ambiguity that leads to errors and disagreements .

Another remarkable fact of the work is that despite the geometry, under the hood, the projects use relatively conventional building systems and details, just applied differently. Disney Concert Hall and Experience Music project are great examples. The connection detailing is consistent with conventional curtainwall, it just happens to be expressed across different geometry. Being able to use the digital model to convey to these proposals to the trades is hugely valuable as a means of controlling risk and therefore cost. That has been a big part of the firm's success: using digital technology as a way of adapting relatively traditional ways of building to radically new geometries, then aligning and clarifying intentions, and maintaining consistency, control and understanding. And I think that is again a microcosm of the larger

ambitions of building information modeling as it has expanded into broader practice.

DI: When did you return to academia?

DS: I had been teaching at MIT as a professor of practice while I was CTO of Gehry Technologies. After Trimble acquired the company, I got the unique offer to take over Chuck Eastman's program, the Digital Building Lab at Georgia Tech. Professor Eastman has been one of the pioneers of building data and BIM, and the program had a phenomenal heritage as a leader in developing the open data standards around building information exchange. The possibilities of taking what I had been working on in the context of a commercial tech company, but deliver it through an open, not-for-profit organization seemed like a great way to broaden my potential impact on the profession.

In bringing my experience from the professional and the tech worlds to academia, I'm working on a couple expansions of the BIM agenda now. One is about post-occupancy, but it's beyond the narrow definition of the term. One of the things that the tech revolution in the broader economy has shown is that tech advances don't just transform tools and methods of work, they have the potential to connect to and thereby rewire social structures as well. The digital transformation in our industry – of BIM and related technical advances – has been about reworking delivery process, but it hasn't to date fundamentally impacted what buildings are or how people and organizations interact with them. I think there is a dramatic opening right now to see the building model as a part of life of the building and for it to be a lens for bi-directional information flowing between the building and its occupants, and ultimately back to designers.

**DI: I thought you were going to say the Internet of things.**

DS: Yes. IOT is another one of the names for it. The idea is that the building becomes intelligent and it becomes a partner of the people and organizations it serves, not just in terms of energy and maybe lighting or security but to the functions of the organizations and communities directly. One of the areas this is already playing out is in retail. The "Amazonification" of the retail experience is no longer about making everything virtual, but about re-introducing digitally enabled life back into the building and urban context. The digital model and its assets can contribute to the user experience of the built environment, and maybe to hybrid online and in person experience. I think that has tremendous future opportunities for architects– to reconnect to the end users of buildings in an ongoing way that extends far beyond traditional design.

I've also been interested in the possibility of design agency across scales as well as across disciplines. I experienced the ability for designers to drill down in terms of higher fidelity detailing of buildings, but the same technologies offer the

possibilities to expand design to increasingly larger scales beyond the building – to the campus, city and planet.

Traditionally there has been a major disconnect between architecture and urban planning, with very different tools and modes of control associated with each of these disciplines. The difference between BIM and GIS is one manifestation, and these technologies are converging, but I also think the approach to affecting change at the city scale is coming into the sphere of what design looks like from the lens of architecture. Because of the scale and the decentralization of decision making across urban contexts, city planning has had to rely on relatively low fidelity, arm's length ways of understanding and directing the design of urban context – through prescriptive and reductionist tools like zoning regulations. The coupling of BIM modeling developed through generative means with the sort of scalability provided by the cloud, connected to real world data coming from IoT intelligence in the world, suggests that we can design solutions

Redpath GFA vs Cumulative Sunlight
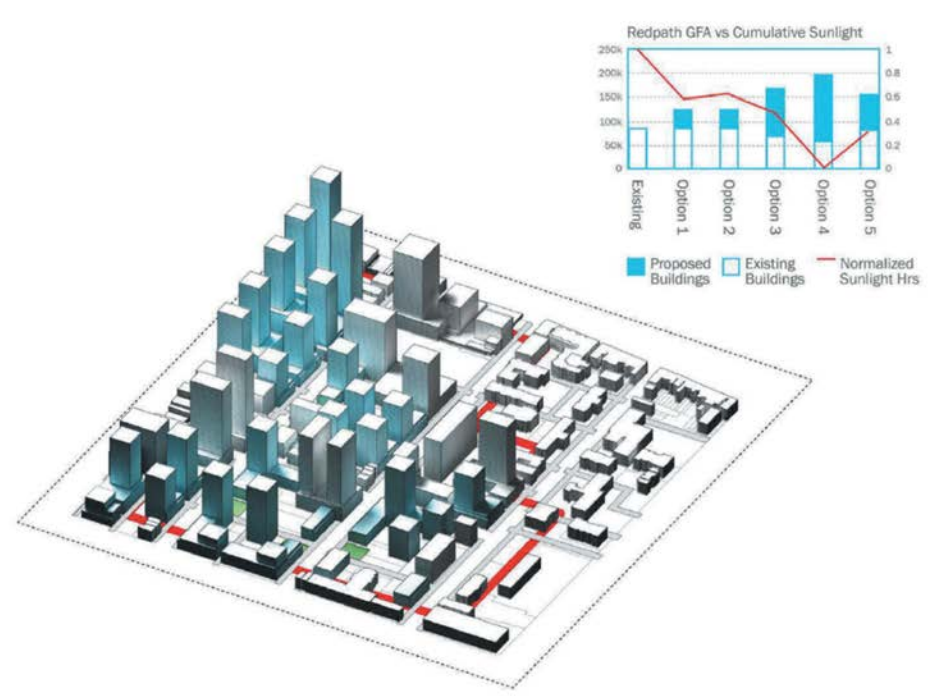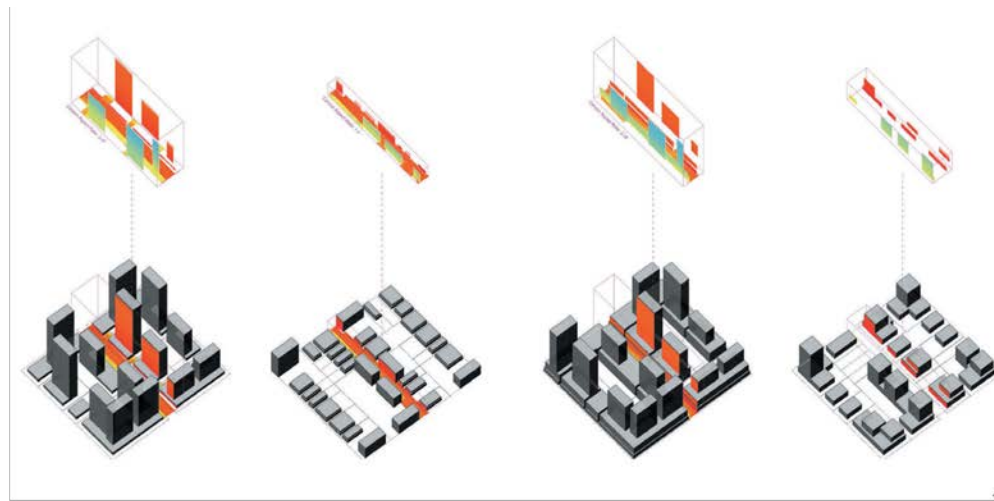
at the scale of cities – with all their richness and complexity, and with the same level of detail and precision that we can now design buildings. We've done work where we can take zoning and building codes, simulate their full extent at city scale and generate and test those building performance codes, which can then be reflected into more precise and informed planning guidelines.

I started working on some of these ideas at Digital Building Lab (DBL), but the program was still very focused on the pragmatics of using better modeling and data to improve the building delivery supply chain. CASE offers a much larger agenda – to rethink the products of building around much larger societal and environmental agendas, in light of changing tools but also maybe to rethink even what a built project is. We have the ability to tackle humanity's macro-level challenges and the impacts of the built environment with precision and efficacy. We can do this at scale, virtually in the classroom or through associations with professional

projects and real cities. That's my motivation now: we have the tools and the capacity as architects to stand with confidence and hopefulness about tackling the massive environmental and social challenges in front of us.

DI: **A much broader agenda and range of tools. It's not a big leap to see the connection between what you just talked about and things like COVID, Black Lives Matter, wildfires, climate change, and floods. Way beyond the notion of BIM, to simulation analysis. Did we miss any other initiatives at RPI?**

DS: The agenda of CASE spans from traditional building systems, research, smarter facades, and smarter ways of managing energy sources, to much larger ambitions about ecology, sustainability and humanity, specifically I think around the possibilities for increased design efficacy at scale through connected data, digital tools, and alternative models of project and innovation delivery.

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…seeing what's happening in other sectors of the world. I am passionate and fascinated by the alternative models of innovation and impact coming from the tech and venture capital worlds. … This other world is offering infinite amounts of capital.

When we started Gehry Technologies, we got a little investment, but we operated under a fairly traditional services business model with existential pressure to make the books balance every quarter. This is true of many of the innovation labs that come out of architecture firms, Architects want to innovate, but their ability to invest in innovation is limited to what they can charge clients under fairly constrained services contracts or out of very limited profits. The cyclicality of projects and the overall building economy makes this investment very difficult to sustain and grow long term.

There is a whole other world of growth driven capital investment that is familiar from the broader tech world vernacular. This wasn't as large a cultural influence and it certainly wasn't available to architecture until recently. Today there are truly unlimited amounts of capital available to pursue transformative innovation that can scale to tackle large and important problems. Revenue is – sometimes - relevant to these business models, but

short-term profitability isn't a significant motivation or constraint. On the flip side, there is innovation happening – by individuals in firms or universities – that has tremendous impact without needing a capital at all. The infrastructure for distribution of innovation over the web is so powerful that individual or small teams can have significant impact.

The second part of this is to see the built environment as the vehicle for the sorts of cultural impact that have to date occurred in the on-line world. I'm convinced the built environment will be one of - it not the - platforms for next generation technology innovation. As part of the work that I started at the DBL and have taken to CASE, I'm interested in thinking about how we can create analogs in architecture for the sort of value creation driven by the internet and world wide web, using the physical environment as the platform.

The technology we developed at Gehry Technologies that really interested Trimble in the acquisition was a cloud-based tool called GTeam, now called Trimble Connect. It's a

BIM and project data management system wrapped with social network constructs, which offered a new take on how cross project collaboration could be supported. At Georgia Tech I was able to learn from some of Chuck Eastman's work around open data standards. In this connected work of building information, IOT and digital twins, there's an opening to create for the building industry what the Internet and Web data have done for technology companies.

DI: It's fascinating to hear you talk about the scale. Maybe it's finally time. After 40 or 50 years of slow gestation, being last in the industry productivity race – flatlined on Paul Teicholz's productivity graph — it's not a surprise. Why is that? Because we didn't have the money to invest. We didn't have the scale. And we didn't have the motivational DNA to be innovators or entrepreneurs. For all those reasons, it's no surprise the architectural community has lagged. Now, maybe these external chaos events are converging. The rest of the world is finally seeing our potential and how we might connect — and vice versa. Maybe we're

finally at the tipping point. Are we there yet?

DS: I think we are, and maybe have been for the past five years. Part of the limits to innovation in building has simply been the inability to leverage advances beyond the individual project. That has created a barrier to the scales of innovation experienced in mass produced manufactured products and software.

But as we all know the cost of digital firepower keeps dropping exponentially, and at some point in the past decade it crossed a tipping point where the cost of technology adoption ceased to limit architecture's potential as a first tier innovation industry. One example of this is the use of drones on construction sites. The price of drones quickly dropped after their introduction. Soon they appeared in two places as

commercially viable technology: in the movie industry and on construction sites. For me that had a powerful message – that the building industry no longer had to wait for the aerospace and automotive manufacturing or entertainment industries to mature technologies before we had access to them as was the case for BIM. Augmented reality is another example. Technologies are coming to the built environment

Sensor 01
Year: 2018
Month: 03
Day: 06
Hour: 17
Minute: 45
Back
Quit

Last updated: 2018-03-06 17:45:51
Temperature: 80.06 fahrenheit
Humidity: 34.90%
Light: 135.95 lux
SoundFrequency: 199.63 Hz
SoundAmplitude: 1371514.00
Motion: 1.00

first, and the entry price of these innovations is low enough that we can afford them in the context of project budgets.

I think the industry transformation is finally happening, but it may happen more through alternative delivery structures and companies that re-organize to create value at multiple points in the supply chain. The risk is that traditional firms may incrementally get pushed out. We're seeing this already. There's competitive pressure through alternative business models and business entities, some coming out of manufacturing, some coming out of integrators. The traditional mentality: "I work in this defined role, and I'm going to keep my head down and shed risk to others because I don't have the fees or scope to assert control," is going to face more threats from other delivery models and companies. This opportunity is bi-directional. Architects can now take on roles they traditionally weren't able to do because they didn't have the credentials, the tools or the capital. Digital modeling and the large sets of easily accessible tools are

creating opportunities to take on some of these broader roles. Architecture firms are reaching out and taking on these broader services opportunities, but other entities are also saying, "Hey, can we just in-house the architect? Do we need an external firm?"

I recently guest edited an issue of AD called "The Disruptors: Technology Driven Architect Entrepreneurs", to take a broad look at the types of new firms emerging and the new agendas being taken on by existing practices. There is huge variability in the ways innovative practices are taking on

THE DISRUPTORS

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TECHNOLOGY–DRIVEN
ARCHITECT–ENTREPRENEURS

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these emerging cross disciplinary opportunities. You see this most in manufactured construction because the traditional, "You draw something and we'll figure out how to build it," doesn't work in manufactured building. The design must intrinsically be part of not just the product, but the system you're building within. To me, it's a call to action because the traditional models will continue to erode. The position of architecture as a contained place — with defenses around it in the building delivery value creation chain — will be continually under pressure, requiring us to rethink the boundaries we impose on the discipline.

DI: That's powerful. Have you read George Johnston's new book, Assembling the Architect yet?

DS: I have not yet, but I think highly of his work, so I look forward to seeing it.

DI: It's a fascinating history of what the profession did to itself, in constantly building walls and defensive posturing. Licensing and

other issues. Whining rather than doing something about it. What you're saying now is reinforcing the need for change. Maybe things have converged. Maybe it's finally happening.

DS: Technology is the wild card in this. The history of the last half of the 20th century was a sense of the technical complexity of buildings getting beyond what an architecture firm and their fees could manage. As buildings got more complex, the process became harder to control with the available instruments of service. That's where risk shedding and building bigger teams came in. But technology has upended that, because now we have the capacity for a broader reach, a more detailed understanding, and ultimately more control without overwhelming our abilities to manage information and our associated contributions to the project.

DI: Let's talk about the human element. How do we change the minds of non-change-ready principals, the people afraid of technology? How does a technology

guy like you learn to become a change agent?

DS: Take Geoffrey Moore's technology adoption curve. There are good reasons to be anywhere on that curve, including being a late adopter. But if you are anti-technology long-term, you're at risk because the history of humanity has been intimately intertwined with technology, not just the digital technology of last 50 years.

DI: **To be against tools is hard to accept.**

DS: I'm starting to work with architectural practices who see this exciting future and are keen to at least explore new opportunities in this expanded world of practice. How do you, as an internal change agent in a firm, move the next generation — the digital natives and future leaders —to take advantage of emerging opportunity in a way that manages risks? Yet every firm has great people who grew to create the central value of their firms using certain pre-2020 methodologies, and the unique differentiation of the firm

is intimately intertwined with that existing process. The question is: how do you evolve that process and yet preserve the unique things that differentiate? The good news is today's software development is obsessed with usability by "normal humans". There are very mature technologies to be brought to bear in developing a firm's approach, and they do tend to interoperate with one another. You can craft an approach that's uniquely yours and supports the unique qualities of the firm without having to create from whole cloth or rely on excessively technocratic workflows. You ought to be able to go to a designer that works in colored pen and show them technologies that can integrate or replace, make their work easier, faster, more compelling, and give them a better, maybe bi-directional connection between design and final product.

DI: **Great point. If you can't relate it to their world and make it be about them and their culture and language you have no hope. Has COVID impacted your work?**

DS: Absolutely, in that I think it points to the urgency and market interest in built environment innovation. When COVID first hit in March and April, there was a lot of interest in people declaring what is the future of architecture held, given what we knew at the beginning of the crisis. Like many, I didn't feel like I had a clear idea of what the future held, but the obvious answers - suggesting an architecture of distancing and sequestration, and a flight from the urban social context - didn't make sense as a long term conclusion. The lesson to me has become about resilience and reconfiguration. I see COVID, and hurricane Sandy, and the incredible impacts of climate change and globalization we're seeing, telling us that architecture can no longer assume the built environment is static. When we build buildings, there's very little sense that the world will be different in five or 10 years. We don't design for future proofing or radical change in program or context. Maybe it's aspirational, but I think the takeaway is that developers, owners, investors and governments are going to need to take a more

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dynamic view of the future of the environment.

We've all seen some amazingly positive responses in the last couple of months. The first is the reconfiguration of cities. Take New York City. Streets are starting to move from everything being about cars and parking, to bicycles and outdoor dining. Things you see in other parts of the world more than in the U.S. I think we're going to need to see the urban context in different ways. We might have to design cities so that they can be partly shut down, but as part of this they should have ways of, re-opening, re-using and reconnecting themselves. It points to a dynamic about the built environment you can read everywhere in the current narrative. It's a view of resiliency — not about putting up walls, but about creating a dynamic reconfigurability and adjusting the urban and building fabric.

It's not just an aspirational, ethical, or philosophical problem. Futureproofing is becoming a business value proposition. And

that's one of the most exciting, positive things happening. These things were happening before the pandemic, but we're seeing reactions now that must happen in months, and this won't be the last one. We have to understand that's part of architecture now.

DI: How is CASE organized to take on this mission?

DS: The exciting thing about CASE is that is a completely integrated design, research and professional collaboration with an integrated agenda and team. It is a unique place to rethink the relationship between design, science, engineering, and research, and between education and the professional world. Because we have a charter that's endemically about the relationship to the city and the professional community, we have the opportunity to rethink the rules of engagement of academia and research with professional practice. The dynamics of the business model of academia are changing. The baby boomer children and undergraduate population was at its highest in a generation in 2009 and has been

declining since. But at the same time, it is becoming clear that learning and innovation training is going to be a lifelong imperative for working professionals. We're starting to work with some architecture firms by offering our classes to staff in these firms. Because everything's online now, they can just dial into our courses. Reciprocally, we see a way of engaging students and firms in an applied research model where students go out into firms not just as interns but as embedded innovators and researchers, and we are working on building programs that support these students and firms in connecting back to CASE.

We are looking at the redevelopment of the educational model into something much more applied. A model in which we're blending professional life, student life, research, professional practice, and education. CASE can be the vehicle to pursue this. Applying this new approach is imperative to solving issues of environment, resilience, and rethinking professional practice through technology. We can take this on through an education and innovation delivery model with intimate bidirectional ties to the professional community and to the environment itself. In some ways this pandemic — by virtualizing everything — has opened doors to

working in more fluid ways than we had just a year ago.

DI: **That is compelling. A case for reinvention. The advantages of starting anew in a self-contained way where you're in control rather than to trying to change centuries of inertia in the traditional institution. Dennis, this has been fantastic.**

DS: Always a pleasure. Good to talk to you.

Dennis Shelden is the director of the Center for Architecture Science and Ecology (CASE) and Assistant Professor in the School of Architecture at Rensselaer Polytechnic Institute. He is a licensed architect, entrepreneur, and author whose experience spans architecture, engineering, and computer science applications to professional practice and the built environment. He holds three degrees from MIT: a Bachelor of Science in Architectural Design, a Master of Science in Civil and Environmental Engineering, and a Doctor of Philosophy in Design and Computation.

His publications have appeared in Architectural Design, Technology and Architectural Design, and the Journal of Construction Automation. He has been interviewed in publications including the Economist, New York Times, Design Intelligence, and Engineering News Record. He is editor for the forthcoming book series Practical Revolutions: Professional Applications of Disruptive Technologies to Building, published by Wiley.

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