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Paul: The beauty of design automation is how it leverages computing power to bring an unbelievable combination of scale and efficiency to projects while also managing repetitive tasks and bringing up professionals to focus on higher value, higher thinking responsibilities. Thanks to design automation technology, you can really shift thinking about your computer as a tool and instead look upon it as a partner.

Hello, I'm your host, Paul Tees. On this episode of If/When, we're discussing design automation with Anthony Hauck co-founder and COO of Hypar, and Jerry Dehn, Vice President, Design Delivery at Jacobs.

Anthony and Jerry shared with me their insights on some of the amazing things that design automation can deliver, how it benefits clients and the professionals who depend upon it, and what organizations should consider when investing in design automation, upskilling opportunities and removing barriers to adoption. Anthony and Jerry, thank you both so much for joining me today. I'm looking forward to talking with both of you about design automation and what the technology is, what it allows us to do and where it's going. Thank you both for joining me.

Anthony, I'm going to start with you, and this will be our kickoff question, but can you briefly explain what design automation is?

Anthony: It's one of those things you could spend an hour explaining and ask four people and get 12 answers out of them, but the way we think about it at Hypar it's essentially capturing the expertise of professionals. It can be applied in multiple contexts. To expand on that, there are ways, for example, that steel structures go together, that spaces lay out, that pipes run through buildings. A lot of this stuff is formulaically derivable out of best practices.

What we do is we work with a lot of companies to find out what those best practices are and help their experts actually scale what they can do during the course of a day, because a lot of the regular road work is taken care of for them. An example that may be close to many young architects heart is, how many commercial bathrooms have you had to draw? They're almost entirely regulated into their configurations.

We look at automation as a way of encapsulating these best practices in the industry so that the humans can actually concentrate on harder problems.

Paul: I love it. It seems like part of the benefit, really, it's time. You're giving time back to the professionals to do more high-value work as opposed to the repeatable processes. You just let the computer do it, it just takes care of that. Then you can just get on with like what you're really trying to do. Now, Jerry, let's peel this back a little bit, what are some of the surprising or amazing things that design automation allows one to do?

Jerry: Well, Paul, design technology has come a long way in my career and started 30 years ago in my career. We had just maybe five, six years ago, transitioned fully away from pen and mylar over to CAD. Then years later, we switched from 2D CAD to 3D design modeling. Now, we are really into this, we're in the coding and

developing scripts to automate much of this design modeling effort. Today piping, electrical conduits, HVAC ducts, they can all be auto-routed.

The infrastructure components can be auto-placed. Reality and digital twins allow us to select design features that best suit operations and provide training for the future of those operating facilities. Master asset databases produce equipment schedules for contractors. They can provide guidance for facility, operation, and maintenance activities. All of these technologies are allowing us to deliver increasingly higher-value solutions to our clients while either maintaining our costs or providing even greater efficiencies in our delivery. That's really what these things are allowing us to do.

Paul: It's not just given time back, but it's also cost containment as well and efficiency. Now, Anthony, I'm going to jump ahead a little bit and I could have saved this question toward the end, but I chose to put it right up front and it's really like, where do you see design automation going as a field in the next three to five years?

Anthony: I want to bridge off something Jerry was also touching on there that we see our customers using what we do is it's not just about time, but it's also about quality. We're talking with one customer who designed certain types of electrical systems, and due to some of the demographic holes of the last few downturns have punched in the industry, there's a lot of inexperienced people who are starting to come into the field. A lot of the most experienced people are starting to retire.

What ends up happening is we have young engineers, in this customer's words, leaving out an entire class of equipment out of a design and they bid on that. Then they just have to eat that additional equipment that they didn't include in their estimate. What a lot of firms are also looking for is for the more inexperienced folks that are coming up through the ranks who have a lot less mentorship than they used to is they're looking for some safety net under them to make sure that at least all the basics are right.

It may not be the most inspired or perhaps effective design, but there are fewer basic mistakes in it. That's one thing that we think is going to happen more and more in the next few years, as companies are trying to adjust to fewer people entering AEC and the entire baby boom generation retiring out of it. That there's going to be this expertise gap, and that as people are retiring, we are getting asked actually like, can you take Jack's brain?

We literally ask, and just download it into a piece of software so that our young project managers will have a baseline of expertise that they're working off of. Then they'll elaborate on top of that to reach the actual solution for that particular project. What we think is going to happen in hopefully within five years is we're going to see a lot of this automation, helping people get projects to the 80%. Keeping in mind that there are actually very few projects in the world that have high design like that are artistically unique that they don't repeat something.

What we're hoping is that what we'll see in automation is more and more distribution of repeatable modules of expertise that people can apply to different projects so that we'll have a situation where we have a more augmented experience for the people making important decisions about buildings.

This is not just engineers and architects, it's real estate people, it's contractors, it's facilities managements folks, so that they get a lot more information, a lot faster, are not spending time on a lot of things that are repetitive, as you were saying, Paul, but also just being able to make better decisions because they get so much more information as they're working through the possibilities of a new building or a change to a building they have.

Overall, what we think is the automation is going toward being a collaborator with our professionals. Nothing's ever going to replace professional judgment. For lack of anything else, someone's going to stamp the drawings. What we see though is that these automated systems become something that enhance both professional practice, construction practice, all the way through so that we get the best of both worlds, like good solid, professional judgment, supported by data, not bogged down by deciding on how this wall is going to be constructed, that we've built 400 times before.

Paul: I've got to imagine too, and Jerry, my next question will lead into this for you, but I've got to imagine, with that demographic skills gap that Anthony's alluding to, the talent is walking out of the industry because it's retiring, that things like artificial intelligence and all these data sets are going to be even more critically important to "capture Jack's brain", and for the systems to be able to train off of that and train each other and discover those best practices, those best designs that are repeatable and that are cost efficient and stuff.

Jerry, can you summarize some of the rapidly growing design automation technologies and how might utilization of those technologies benefit customers in society?

Jerry: Well, let's start by piling on a little bit to what Anthony said here on the quality piece. People walking out the door via retirement, even those that are staying in the door, if we can use tools that produce or provide for consistent quality in our deliverables over and over and over again, our quality is going to go up, even if we don't change the workforce, even with our current people.

Then we have retirement on top of that, so the gap which may have gone down now is going up. The quality is actually going up when we expect it to go down. All of these tools, many tools help provide that, whether it's design quality or whether it's operations quality, but some technologies, like I mentioned before, virtual and augmented reality, they give the owner vision into a facility. What that facility's going to look and feel like, how they're going to maintain that facility before it gets to construction, before the design is completed.

A digital twin provides the same thing, but really around operations of a facility, whether it's the actual building or the process inside the building, whatever that digital twin is. I can train my operators on it. When those new processes come online, that new facility comes online, my operators are ready to operate it. It's quality now in operations, we're talking about.

Then we've got other things, uh, that are emerging, like you mentioned artificial intelligence, but there's also machine learning in that, where the computer can sense past preferences, what was done on past projects and pull those elements forward,

so how to incorporate those technologies into our design tools, so that if I lay out a bathroom in a facility, it knows, "Okay, you've done 27 bathrooms for this client before, they all have these things in common. Here's some common features and functions. Would you like this? Would you like this? Would you like this? You can pull those elements forward."

Now we're providing consistency in a facility, or across facilities from one to another. Then you have things like generative design. This is one that should really excite owners and customers, because, today, when we consider a set of alternatives, we do a manual process where we go through and we identify what are the different alternatives that we could consider for this facility, and we might consider 5, maybe 10 things. We quickly shortlist that to three to four, and then we develop criteria and we run it through a process of ranking each of those alternatives against that set of criteria and comparing them to each other.

If we had a lot of information in the computer, the computer would actually develop literally hundreds, if not thousands of possibilities that it would iterate through. Then it would come back to the designer and say, "Here's what we think are the top 10," or the computer thinks you are the top 10. Then we go back to our owner and say, "We considered, literally, 1,013 available alternatives for your facility, and here are the top 10. What do you think about these? Is there anything you like or anything you think is missing? Or we can tweak that. Then **[inaudible 00:14:26]**."

The owner knows, "We got the best facility designed for us." Collectively, these technologies result in more desirable facilities constructed, more owners for the community, whether it's sustainability, operations efficiency, whatever their metric is for quality, they're getting a better solution. It's not just about the time savings or saving money, it's a better installation for our customer.

Anthony: If I could just bridge on that a little bit, this is exactly the kind of work we've done with a couple of firms of optimizing across multiple factors to arrive, as you say, Jerry, here's the 10 best. I have a theory of hanging over from when I was practicing as an architect, that clients don't get to decisions easily because they hired you to be the expert, and you're showing them things and saying which one is better. They're hoping you'll tell them which one is better.

What I see is, as an outcome of the genetic and optimization workflow you're talking about, is a higher confidence in decision like you're talking about. Like I say, "We looked at thousands of possibilities, here are the evaluation criteria. It's scoring higher on this, lower on this. In each of these instances, what's more important to you?" That's the right conversation to have with a client. What's important? Not like, "Should this wall be here?" That's the wrong conversation.

What's important to you? Is it daylighting? Is it cost? Is it collaboration spaces? What's your value system? Let's find the thing that serves it.

Paul: I love generative design. They're using it now in things like automobiles and consumer products and stuff, and it's cool because then you really can tweak variables, like what's going to be more energy efficient? Or what's going to have a reduced carbon footprint? Or what will take the least amount of materials or be structurally the strongest? Any number of things, and the computer can just crank

through hundreds or thousands, like Jerry said, and then kick you back, "Okay. Here's five, what do you think of these?"

You can adjust whatever variables float your boat to come up with the best solution. It's just really super fascinating.

Anthony: That's why humans are never going to be out of the loop on this stuff, because we can't instantiate a universal value system into software. Someone has to say, in context, "This is good." That's what we're hoping to do, to show people, here are different ways that good can be achieved. What is best in your opinion?

Paul: Yes, absolutely. Now, Anthony, let's talk about organizations standing up the design automation functions. Can you talk a little bit about the investment that's necessary and what resources, talent, financial computing power, that sort of thing. Typically, they are necessary to effectively leverage this technology.

Anthony: Yes. We see a story in, especially design firms, over and over again, where efforts like this are under-resourced and continually are stood up and gradually pier out again until another initiative starts. It's a shame, what generally happens is, some technologically astute professional starts developing things, people see some possibilities, and then that person eventually leaves, often they're underappreciated, their stuff isn't maintained very well thereafter, and then you're starting from scratch.

It's one of the reasons we started our company. I really think, just watching this happen over and over again, dealing with outsourcing organizations ourselves, that you need three full-time people to be working on this, and they can't be dragged back into projects when the deadline siren calls. It's really a matter of setting aside a real budget for people more than tools, because most of the tools are actually free, and deciding what they should spend time on and giving them the infrastructure support.

I talked years ago with an executive and a nationally known architecture firm when my company was still in its infancy. I showed him some examples, and he was like, "Well, we're doing much more sophisticated stuff than this Anthony." I said, "Of course you are, you have a whole R&D group. How's the roll out on that stuff going?" Because I knew. He just hung his head down, because there was no infrastructure in place in the firm to take an outcome of R&D and roll it into production. That's where everything died over and over again. My contrast, we have a customer of large construction company, also a developer in some markets. I asked them, like, "So this thing we made for you, what's the rollout plan?" He just told me, he was like, "Well, we have all these people identified in each region who evaluate our software and give us feedback. Then we give feedback to the developer and they adjust it, and when they're all satisfied, then each of them has a task to roll it out in their region and support it."

I was like, "Well, I have nothing to say to you now." [laughs] You have just outlined the exact way, but that's the thing. It's easy to quickly invest in technology, stand up some things, but what you need is the social infrastructure to make all that actually turn into production value. I think it's underappreciated in a lot of firms.

It's appreciated in other sectors. You see a lot of appreciation for that thing, especially in manufacturing, because they're used to that. They're going to trot in a \$100,000 brand new machine. Everybody's going to be trained. Everybody's going to know what to do. Their whole production is going to be redesigned around that because they just invested in a production change that they expect to get a return on.

What happens on the factory floor is what's going to happen in offices. People have to, without perhaps going overboard into ISO land, people have to consider, we are going to change the way people work. What does that mean? How do we manage that change? How do we make sure it's successful on its rollout however small that first rollout might be, so that it gets good word of mouth and keep going?

That's where we see firms fall short, thinking all the way to the point of we will have new technology, not the implementation piece. That's what I would really urge people to think about.

Paul: Yes. I've seen this in financial institutions and some of business data, that it's a similar thing like data science. People get really excited about it. The C-suite recognizes that it's important for an organization, but then competing interests, other things need to be resourced and stuff and so maybe things don't get. They see it's a value but they may not understand entirely that it's a value.

It doesn't get the investment that it needs, or it doesn't have the institutional fortitude required to beyond just this R&D effort but actually to scale it into operations like you said earlier.

I think that's industry agnostic. I think that happens in corporations across America, probably with a lot of these new sciences and new technologies. Jerry, this question dovetails on that, and Anthony was saying. What are some of the significant barriers to adoption for an organization to deploy design automation at scale? What are they and how are they typically overcome?

Jerry: This can be really hard. I would say I can think of three big ones. There's obviously more, but learning education, right for sure. Company culture and just people's reluctance to change in general. Speaking on the first one, just talk about education, design automation technologies are advancing very rapidly. What today is tenfold, what was available 10, 15 years ago? I can think back to operations I ran 15 years ago. At the time we were doing 3D design modeling, I felt like we had pretty solid command of our design tools. Our people understood what to do. They understood how to apply the new functionality when it rolled out.

We had pretty good commands. Now, the tools that are coming from our big design automation tool vendors, either functionality is just accelerating more and more every year and we just can't absorb it. **[inaudible 00:24:28]** can't absorb it without a skill-building program being in place. I think there has to be some skill-building program that goes along with this, so we can stay on the leading edge. That's one of the things we're looking to build internally is a program that advances the skills and the proficiency so we can be more productive on our projects using these enhanced tools. That's one.

I would say company culture as an example, we are a very entrepreneurial cultured in Jacobs. Our vice presidents of operations are entrepreneurial. They connect with clients. They collaborate locally. They're told, "You don't have a lot of handcuffs put on you. Go be entrepreneurial, give our clients the best solution you can." A lot of times that means figuring out solutions on their own. A lot of times that might mean that they're really not super interested in a solution offered somewhere else in the business. How do we bring those people along? That's a big barrier.

The last one I mentioned was just people's reluctance to change. Think about successful people that are very experienced, they've delivered this type of project or this type of product to the market time and time again with success. I've had my learnings, I've taken my lumps, I know how to do this. What would motivate somebody like that to deliver something that might have greater success, but maybe brings an element of risk?

We've got to give them reasons to change, some sort of incentive or, "Hey, look, side by side, we've proven it to you. This A is better than B. You've been doing B, it's great. You can keep doing it, but it's a B, but if you do A, look at how much better the results will be, look how much more you can do." You've got to educate our people on the reasons why to change.

Anthony: Back when dinosaurs roamed the earth and I was IT director at EYP and we were looking at moving to Revit from AutoCAD., we encountered the same phenomenon. It's going up to people whose whole job is to reduce risk and asking them to increase risk.

We had a happy conjunction of events where we were, as part of the management of the firm, we were all going to the project managers and saying, "Get your multipliers up. What are you guys doing? You're below a three, what's happening?" At the same time, we handed Revit to a young architect who started banging out developer projects at five-O multipliers. All of a sudden, everybody wanted Revit.

Now that wasn't the reason he was banging out five-O multipliers exclusively, but there was a clear example that somebody could be highly profitable using a new tool at a time where we were really putting pressure on the project managers to get more profitable. There's a little bit of- Jerry, you talk about entrepreneurial moments. That's one of them. If there's some conjunction of a real business goal that clearly the technology can enhance, coupled preferably with someone's personal goals for the year, then you've got a real flywheel.

Paul: Yes. I don't want to overplay this, but I think going back to Anthony, what you were saying about demographics a little earlier and about that gap, I remember again, being in the financial and risk and tax and accounting industries at another company, the challenge there was, for instance, on the tax and accounting side, they would come up with new automated accounting software and you would run up against clients.

You'd run up against accountants who had built a career 20, 30 years using Excel. Suddenly it's like, out the gate, we're okay. Now we're moving away from Excel spreadsheets and we've got this new thing and it's like, I'm on the back end of my career.

I'm not sure I really want to throw the baby out with the bath water to learn this new software thing. I've got pressures, I've got time pressures, I have to deliver stuff. You're asking me to slow down suddenly to learn something new. I can see some of those dynamics at play potentially. Again, I admit it's like, I don't want to be overplaying that because everybody's different. Everybody has a different comfort level with new technology adoption and education and their work situation's different. I could see, in broad strokes, those might be some of those dynamics where it's like--

Jerry: No doubt.

Paul: Adoption is slowed, so--

Jerry: Think about this, Paul. We put our most seasoned, most successful project managers on our most challenging projects. Let's say we have a project manager, she's delivering, been delivering projects successfully for 25 years. Very well respected. Why did we put her on the most challenging jobs? Because she has a system. Now, we're trying to change her system. How hard is that? That's hard for her because she's got success. She knows how to deliver success.

Now we're saying no, "That's great, but how about we go for outstanding? Can we do this instead?" There's some risk involved with that.

Paul: Yes, and I think the organization has to have, going back to what Anthony was saying about not pulling people off of a dedicated stream like pulling back project emergencies, you've got to have that fortitude to say, "Okay, we're serious about investing in this. We're going to let Jane have the time and head space she needs to acclimate to this new technology, and we're just going to be patient about that. We'll find an alternative way to do whatever we need to do so that we're making that investment and we're serious about it. We're not just, 'Oh, we bought some software, go figure it out.'"

Jerry: Right.

Paul: Let's talk a little bit about folks starting out at the-- Flip the script a little and talk about folks starting out at the beginning of their, let's say, their professional careers where they would touch design automation. Anthony, I'll start with you. For those in our audience, like I said, are starting out in their professional careers. Can you speak to some of the career opportunities that design automation enables?

Anthony: One of the things that we spend a lot of time on is with subject matter experts figuring out what they know and so you have to know something, and having some professional experience just around getting buildings out the door and getting them built and walking around on sites and everything makes the conversation around automation so much richer. You can really tell when somebody has just been making software their whole lives instead of actually being part of what they're trying to support.

I would say, especially to young professionals, even if you wanted to go into a more technologically heavy route in your career, there is no wasted time. Understanding a domain is actually far more important than understanding whatever the current flavor

of technology is. We're a software company and almost every one of our employees is a building professional who went over to make software full time.

We have, I think, 2 computer science majors in a team of about 12 people. We find, even when we're hiring for sales and marketing, we're looking for that AEC experience. I would say, the technology, you can pick up if you have an inclination to do so. Get some building experience, try to solve real problems. If you want to start trying to solve things with technology, don't do abstract, I can make a computer buttercup, like actually take a problem from work and try to fix it using automation of some kind or some other technology.

Because abstract solutions just work. Is anybody else tired of seeing pavilions? I know I am. Go try to solve a problem like this roof leaks, why did we do that? What automation might have told us that that roof was going to leak? Pick something and try to solve that problem. If it's valuable to your firm, you might actually get to see it adopted. That's the advice. Try to bring that real-world experience back into the world of technology and marry them up in a productively, useful way and make a tool that you wish you'd had when you ran into that problem.

Paul: Excellent. Then Jerry, the same question for you. For those in our audience new in their professional careers, can you speak to what you see or some of the career opportunities for design automation?

Jerry: Yes, for sure. I'll speak really from a design consultant's perspective. Of course, most of our new hires, young professionals already know this. Technology is not the enemy. Automation is not the enemy. Yes, we are removing hours, but we're moving the mundane hours. As Anthony mentioned earlier, we will need more people who have command of these technologies to steer it and drive it.

It's creating more opportunity, it's not taking opportunity away. I think, Anthony, I don't want to just repeat what he said, but emphasized maybe a couple of roles, software development, and that becomes part of the digital design modeling, digital delivery. We call it, at Jacobs, experience. It's part of the role description. I'm not just drawing. It went from literally drawing to modeling.

Now it's how can I codify something. I developed a script to automate a process to get more consistent results to convey my point. You mentioned like, can we bring remote sensing into the design process and bring intelligence from the sensors into our process? How do I think outside the box? I would say, software developers, computational bin designers, a mindset of trying to partner with your computer instead of just using the computer like you would a pencil and a pad of paper.

I'm trying to partner with my machine. What can it do? What can I get a bot to do? Free me up so I can do something more challenging and think more strategically about the problem we're trying to solve. I really think as technology continues this toward pace and we all agree that this is not going to slow down, more change in the future, not less. Those who can embrace this change, I think, will find themselves in high demand regardless of what the job looks like.

They will be the ones in the highest demand in the engineering design marketplace. That's what I would say to professionals coming into the industry today.

Paul: I love it. I love that idea of thinking about your computer as a partner and as a tool. I'm guilty of that too. It's a thing that I use, but it's really shifting your thinking of like, "This is a partner, it's not going to replace me. If I use it right, it will augment what I can do."

Well, Anthony and Jerry, I really appreciate you both for a fascinating discussion. It's really cool where this technology design automation and generative design and all these kinds of things, the possibilities and where they can go. I really appreciate you both taking the time today and unpacking this with me. Thank you.

Jerry: Great. Glad to do it.

Anthony: Thank you.

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