Paul: Hello, I'm your host Paul Thies and for this episode of If/When, the topic of discussion is generative design. Joining me to share their insight and expertise are Christopher Gromek, Senior Product Manager Advanced Development in the office of the CTO at PTC [00:00:30] and Kelly Bryant, Deputy Section Manager, Mechanical Design/Drafting & Manufacturing with Jacobs on the JETS contract at NASA's Johnson Space Center.

Well, thank you, Chris and Kelly for joining me today, I'm looking forward to talking with both of you about generative design. I think it's a fascinating new technology and has a lot of potential and a lot of applications. And we're starting to see it deployed in quite a lot of interesting [00:01:00] areas from consumer products to built environments and whatnot.

And so, Chris, I'd like to start with you. For folks who may not be terribly familiar with what generative design is, can you explain a little bit about this technology?

Christopher Gro...: Generative design is a software technology, which combines geometry creation, multi physics simulation and artificial intelligence to produce optimum designs for physically informed problems. [00:01:30] Now I've read off that definition so many times that I almost forget how many buzzword are stuck in there. So, it might be easier for me to just describe what it does. So with generative design, if you tell me what you want something to do, then I will give you the thing that does it best.

Paul: So it goes through the different iterations of how a thing can be achieved and then you're able to pull out the optimum one. Now, let me ask you, Chris, [00:02:00] how does generative design help mitigate potentially negative downstream ramifications in the design process?

Christopher Gro...: Well, in generative, when you're designing generatively, the downstream ramifications that become the upstream inputs. There's an adage that someone told me once, which goes a little like this. If you ask me to do a job, then the first question and I should ask of you is how are you going to grade me? All right.

And it [00:02:30] gets you in the process of thinking from the end result back upstream. Okay, so when you're designing generatively, the first question you ask is, what do I want out of this? Okay. And then what, when you ask in that question is, well, what do other people want out of this? If I'm designing a part, for instance, it might be fine when it looks on the CAD screen, but the moment I pass it over to the machinist, he or she might say, "There's no way that I can reasonably produce this." At least not for less than $50,000.

[00:03:00] So if you build in some of these downstream constraints into the upstream generative model, then you're able to guarantee success from the start.

Paul: Interesting. So Kelly, at Jacobs part of your role is exploring the use of emerging technology. And so I wanted to ask you, what initially excited you about the potential of generative design and what have you discovered along the way that [00:03:30] it's taken that excitement to the next level?

Kelly Bryant: I'm always curious about new design technologies and how they can be integrated into our design process. As mechanical designers, we tend to look at past designs as tried and true examples and if it worked for that previous project, it should work for this one. But a lot of times those might not be the best or the most efficient designs. And another thing is, lot as we tend to make small incremental [00:04:00] changes when maybe a radical design change is what's needed.

And I saw the generative design technology as a tool that really would get us thinking differently about the design process. We wouldn't necessarily have to think in terms of rectangular or cylindrical shapes when we're designing parts. And then also when designers would try to come up with different design concepts, we didn't do a whole lot of them because [00:04:30] it takes time.

And all of our projects have time constraints. So now with the generative design tool, we can set up a design perimeter and constraint. We can hit the go button, we go to lunch and come back and like Chris said, then there's a lot of potential design solutions there. And they may not look anything like the previous designs. And so it just gives us a new way to look at things. As [00:05:00] far as things that surprised me or got me really excited is that we found doing the generative design process on some of our existing parts. We found that some features were unnecessary.

For example, one part, we found that there were a couple of fascinating holes that weren't really necessary. And then on another assembly we found that one of four fasteners weren't really needed [00:05:30] to meet the load constraints. So, Hey, that's an unexpected weight reduction, cost savings and those are good things.

Paul: Yeah, absolutely. Especially in the context of aerospace and when you're trying to send up in the outer space into the moon and whatnot. I can imagine weight and efficiency and all those things become critical. And so you want to reduce where you can. Now Chris, can you share with us some use cases of generative design [00:06:00] riffing off, whether what Kelly was saying-

Christopher Gro...: Sure.

Paul: ... whether the technology's been particularly effective at reducing, cost eliminated waste and improving time and efficiency.

Christopher Gro...: Well, when we're looking to start a company off onto this generative way of designing, we've found that it is most impactful if you use it at either extreme of

a part's life cycle, meaning right up at the very start, when you've still got a clean [00:06:30] shade of paper or way at the very end, when you're looking to replace this part with something else. All right.

So for instance, with the ladder situation, we were working with the Volvo group on their super truck, two program. They were looking to overhaul the power train, take as much weight out of it and especially right over the front axle. Okay, that's where the pound per mass is really, well it has the most compounding effect. All right.

So we searched around [00:07:00] and there was this decade old front engine mount holding up this engine, hadn't been touched in almost 12 years, right now it did the job, but it was far too heavy than it really needed to be. And what was so great about that is because it has been around for a while. It was fully validated. They knew exactly what it needed to do. They had analysis and the parts designed already and we were really just one button away from redesigning that part, because you already knew everything you needed it to do.

[00:07:30] And in the end we were able to take 75% of the weight out of it. So that was a huge savings. You can only imagine what happens if they do that across the entire truck. Now on the other end of the spectrum, we were recently working with a well, an engineering services firm who was bidding on a lunar habitat design project. And before Kelly jumps in, no, they were not competing against Jacobs. All right. So we're still being friendly.

Now in that case, they had very strict requirements, all right. Across multiple physical domains. [00:08:00] And what they were trying to do was just prove feasibility so that they could bid with more confidence. All right. And using generative there on that very front end when still the requirements are negotiable. All right. But they're being asked for something very tough in a very short timeline. All right. They were able to use generative to get to a feasible solution very fast and then they could place that bid with confidence and well, hopefully we'll see him win that contract.

Paul: Very cool. Very cool. So Kelly, can you tell [00:08:30] us a little bit about the work that Jacobs is doing in partnership with PTC?

Kelly Bryant: Obviously, we're talking about generative and so there's some things that we're exploring early on design products with generative, for our customer here at JSC. We're also looking at how we can use this process with some other NASA customers that may not necessarily be at JSC [00:09:00] that have heard that we're looking at this generative product and how can we help them design some of their products. And then there's potential other Jacobs design organizations that don't have anything at all do with aerospace.

If there's some things that we can do with some other parts of Jacobs that may enlighten them on how they could use the generative design tool to do

whatever design that [00:09:30] they're doing, Hey, that would be great too. And we have other products that we use from PTC that aren't just the generative but the whole suite of design tools that we're using.

Paul: Yeah, and I think it's something like this, when you think about construction and engineering, I mean, they typically tend to be risk-adverse industries because obviously a lot of times you're dealing with safety and you don't want to fool around with people safety.

[00:10:00] I had a discussion not too long ago on additive manufacturing. And I see these as complimentary technologies and Kelly we're going to talk just a moment about complimentary technologies, but additive manufacturing where it's like printing on design, 3D printing and stuff, but there's some caution there because it's you want to go with what's tried and true and what's safe, particularly when you're dealing with things that might touch on safety.

But [00:10:30] I see something like generative design as enabling a maybe a greater freedom to innovate because you can use the technology to really explore materials, their strength, how to best deploy them, seek examples from nature and whatnot. Things that are really strong that might not occur to us in our geometric thinking, but it's like, oh, well, if you made it, more like it was a spider web as opposed to a rectangle thing.

You can use [00:11:00] a lot far fewer materials, but it's still as strong as or more strong and so it seems like something like generative design liberates in some respects the engineer, the designer, the creator. So, Kelly at Jacobs, your role as you using a variety of digital tools in concert which iterative design so, can share a little bit about complimentary technologies that you see are particularly well adapted to [00:11:30] work with iterative design.

Kelly Bryant: One of the first ones that comes to my mind is the simulation products. We can take the resulting design out of generative when we're on a structural or a thermal analysis, make sure that that assembly's going to meet the design specs. And then with the simulation live product, we get instant results to help us refine that part.

And it's certainly a lot quicker than to run [00:12:00] a digital analysis than to build a physical prototype and then test it and then especially if you want to run multiple iterations of a design that takes a lot of time and money. Another technology is designed for manufacturability software.

This product we can upload our Creo design model, we can quickly identify and eliminate any features that are either expensive or [00:12:30] impossible to manufacture like Chris had mention before and if we can eliminate these manufacturing issues early in the design process, then we'll improve the profitability, we'll make a more robust design, all that stuff costs a lot more money downstream than it does upstream.

And then also with generative design, it can and help you look at how you want to build that part, whether you want to build it with traditional manufacturing [00:13:00] or additive manufacturing. What materials do you want to try? You could set it up to run a whole bunch of different materials and then get your manufacturability analysis and make your decision from that.

You've already mentioned additive manufacturing is a complimentary technology and it's certainly been a big game changer and I think every year it's just going to become more and more prevalent. You think back at the beginning of rapid prototypes, [00:13:30] they were expensive, they were fragile, they could help you get the look and feel of the part, but you couldn't really do anything with them.

Technology progressed. We started able to build assemblies with them, we used them for testing and now you can use additive manufactured parts for production. NASA's even tested some 3D printed rocket engine parts. So-

Paul: Wow.

Kelly Bryant: ... there's all kind of opportunities that you have there. And then I guess [00:14:00] the thing that ties all of these different technologies together is the PLM system, product lifecycle management. You design your part, you save it to the PLM database. Everyone on your team has access to single source of truth. You don't have to email the files. You don't have to save them to a shared file system. Everyone has early access to those things and even your manufacturing team can look at the design earlier [00:14:30] in the process and say, "Hey, let me give you a little bit feedback on that part and maybe we can improve it."

Paul: Wow. Very cool. Very cool. So, Chris, where do you see generative design technology headed in the next several years? What's on the horizon?

Christopher Gro...: Well and that's a question that I think of a lot. So, I got a lot of ideas actually where we go. First and this is the grand vision is that I see OEMs and [00:15:00] service firms much like Jacobs using generative to democratize their expertise and make custom designs as easily as choosing your t-shirt size off of Amazon.

I see the tools themselves expanding beyond just providing specs for the best new design for the job to determining the best you can possibly do with whatever parts you happen to have on hand. And lastly, this is maybe a personal hope is that I see engineers using generative, not only to [00:15:30] solve problems more if efficiently, but to think more clearly about the problems that they choose to solve.

Paul: Interesting. Interesting. And now Kelly, let's close our discussion today with discussing what this impact of this technology means on the role of the engineer as Chris was alluding to how do you see this technology impacting the engineer

and the design process, and what do you think it will mean for engineers now and in the [00:16:00] future?

Kelly Bryant: I really believe that it'll allow the design engineer to have more freedom, to explore more design concepts and in a quicker fashion. It'll allow to your development time, it'll reduce your expenses. If you have more design options, you're more likely to find the one that best suits your requirements. And then the other thing that I see is that I hope this technology can help young engineers [00:16:30] produce better designs in fewer iterations.

The young engineer doesn't have a lot of design experience to look back on. And so with this technology like what Chris was alluding to, you can let that machine, guide you in that design exploration. And maybe instead of just two or three design options in your given timeframe, maybe you could have 20 to choose from. And you can choose different [00:17:00] materials, different manufacturing methods.

And so you could easily see the cost differential of using aluminum or steel and additive versus traditional manufacturing processes. So, I think there's a lot of opportunities and it's pretty exciting. And for the young design engineers, I think it'll be a big boon for them.

Paul: That's interesting. It's like a, it's having, I [00:17:30] don't want to necessarily say the best teacher, but definitely like a world class teacher guiding you along the way because as it's feeding you optimized solutions, materials, designs, whatnot, you're learning from that as well. So it's changing how you're thinking, how you're approaching problem solving as an engineer and-

Kelly Bryant: Sure.

Paul: ... cause as in, I'm sure older engineers, they look back along their career, unlike what they have learned works along [00:18:00] the way. And this has the chance I think to exponentially change that because now it's, like you just said, you go from looking at two to three options to 20 options. So it really broadens your horizons or at least has that potential so.

Kelly Bryant: Right. And I also see that there's a way that we could tie design rules into this so that, a young engineer that doesn't know all these specific rules, [00:18:30] like these screws can't be too close to the edge of the part and different things like that. You tie those rules in with generative and it does all that stuff for you.

Paul: Well, Chris and Kelly, I want to thank you both so much for joining me today and sharing your insights on generative design. I think it's really fast. I think we're going to see its fingerprints more and more on a lot of aspects of our life. And I'm really excited as well to see [00:19:00] how it's going to impact our lunar Martian missions and the work that we do in the years ahead. So thank you both very much for sharing your time with me today.

Kelly Bryant: Thank you, Paul.

Christopher Gro...: Thank you Paul