**ViZZ Technologies - Know It All**

Episode 7 – Collaboration & New Ways of Working in the Construction Industry from Stanford University’s PBL Lab (with Justin Schwaiger and Dr. Renate Fruchter)

As the construction industry prioritizes productivity and process growth and innovation, it’s critical to engage the next great minds of the industry – students – to share their thoughts on what the future looks like. The Project Based Learning (PBL) Lab at the Center for Integrated Facility Engineering (CIFE) at Stanford University is doing just that by giving students the opportunity to experience, practice and innovate construction methodologies, practices and processes through real-world experiences. This program, started by Dr. Renate Fruchter, enables student teams with mentors from the construction space to push the envelope via a project-based learning course that allows them to use their skill set in a practical manner, arming them for their future.

In this episode, Collaboration & New Ways of Working in the Construction Industry from Stanford University’s PBL Lab, Justin Schwaiger, Director of Customer Success at Manufacton, and [Dr. Fruchter](https://profiles.stanford.edu/renate-fruchter), founding director of the PBL Lab, lecturer in the Dept. of Civil and Environmental Engineering, and Sr. Research Engineer thrust leader of “Collaboration Technologies” at CIFE at Stanford, discuss this program, its benefits, and what the industry at large can learn from it.

To learn more about the course, please visit [PBL Lab’s website](https://pbl.stanford.edu/). To explore some of the projects discussed in the episode, please visit [PBL Lab’s Project Page](https://pbl.stanford.edu/AEC%20projects/projpage.htm). The video detailing the Atlantic2020 Project Evolution Story is on [YouTube here](https://www.youtube.com/watch?v=yw3akBi3i3Y).

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**Justin** **Schwaiger:** Welcome to Know It All, the podcast about the future of construction. I'm your host, Justin Schwaiger. I'm joined today by a very special guest. Dr. Renate Fruchter, the founding director of the Project Based Learning Laboratory, or PBL Lab, at CIFE at Stanford University. So great to have you here, Renate!

**Dr. Renate Fruchter:** Thank you for inviting me, Justin. It's a great pleasure to join you on your quest to “Know It All.”

**Justin:** I was very excited to talk to you today about the work you're doing with the PBL Lab, as well as some key takeaways that we can learn from the Lab about collaboration, leveraging technologies, new platforms and new ways of teamwork for the industry at large.

But, before we dive into this, why don't you take a couple of minutes and introduce yourself, some of your accomplishments and the work you do at the PBL Lab?

**Renate:** With pleasure! So, I joined Stanford and the Civil and Environmental Engineering department in 1990. And I come with a background in design, structural engineering and construction management, as well as computer science focused on emerging technologies, such as artificial intelligence.

It has been an amazing journey that allows me to continue to work with fantastic partners, including faculty, students and industry partners, all from very diverse backgrounds, including design, engineering, construction, and technology. So, since the nineties, I've been studying, experiencing, practicing and teaching global teamwork and focusing on collaboration technologies that can transform the way we learn and work and stay socially connected to be creative and innovative.

**Justin:** Great. Yeah, the work you've done for the last 30 years now with these project teams is so interesting, pushing the envelope on design and new methods of collaboration. Really interesting, especially in the last few years with Zoom and fully virtual, internationally dispersed project teams that you're working with.

Tell us a little bit more about those student teams and the kind of projects that they focus on.

**Renate:** As you mentioned, the Lab I launched in ‘93 had the very clear mission to prepare the next generation of workforce innovators, change agents and leaders in our industry by bringing together students, faculty, and industry experts from five disciplines: architecture, structural engineering, mechanical engineering, construction management and life cycle financial management, the financial and operation maintenance aspects as well. And they come from university partners and industry partners distributed all over the world, and we've been looking at how technology can actually enable us to leverage the best expertise with people that want to give forward and have an impact on the learning experience of the students.

The students that come from the five disciplines from departments and programs and universities that actually educate the students towards these professional careers rather than role modeling are invited to engage in multidisciplinary, globally distributed project-based learning. So, we've created a close to the real world project teamwork learning experience, and these teams work on university building projects that are located in challenging contexts on real university campuses, addressing hazards, such as earthquakes, hurricanes, flooding, labor conditions, code conditions, accessibility to the site, resources, etc. And they work for five months; every year, we bring a new generation of students into the program, and they learn how to virtually collaborate and design and build these university buildings.

And in addition to that, we invite them to address three challenges related to sustainability, integrated project delivery and leveraging emerging technology. These three challenges are defined jointly with industry partners and sponsors to weave in the emerging pain points that our industry partners identify together with me and create an opportunity for all of us to learn from each other. So, it's not just industry mentors and faculty sharing data and knowledge and real context constraints with the students. It's also an opportunity for us to observe how the students integrate new technologies into their daily work, practice, and process and innovation, and that inspires us.

**Justin:** I want to get into more of that industry-academic partnership that you are working on, and that Stanford University does a really incredible job of. But first, let's touch a little on the students. You mentioned a little about the students and the disciplines they come from. What do they look to get out of a program like this?

**Renate:** Well, first, being exposed to students from other disciplines replicating the real-world experience. We still are in a context of very well structured, siloed education systems that prepare the students to do what I call the know what and how depths knowledge, analytic knowledge in their discipline. And what this experience offers them is to break down the silos, to learn how to construct a dialogue and the process of working with other disciplines, like the real world.

They have a chance to appreciate and understand the goals and constraints and objectives of the other disciplines to understand how they can contribute to and complement each other's ideas to create an integrated product. That is typically the first challenge of a real project, to work with partners from all the different trades.

Second, they learn how to embed new technologies in new ways into their daily work practice, as I mentioned before. By doing that, they can develop a whole new workflow and process as they communicate, collaborate, and coordinate their tasks and understand how to manage their task interdependencies across time and space, which are the third and fourth challenges of a global or distributed team.

The fifth challenge is to learn to work in a multicultural setting. And when we look at culture, it's first and foremost, of course, the discipline culture. We have the goals, constraints, and objectives of each discipline and they are learning that every decision in one discipline will have an impact on one or more or all the other discipline solutions and learn how to create a satisfying outcome for the client. In addition, as the students come from different universities, they will have to navigate differences on an organizational level. In the real world, we have different trades and stakeholders coming from different companies, with each company having its own culture and rules, norms, and work practices. How do you work in that context?

Thirdly, they’re navigating national culture, so really working in a multicultural setting where they learn how to interact with people that come with different behaviors. How do you give feedback to people from different cultures? How do you construct a dialogue? How do you build common ground? How do you set common goals and then work together towards them?

So, in summary, they are exposed to these five global teamwork challenges to cross the chasm between disciplines, embed technologies, definitely emerging and cutting edge technologies in the daily work practice, and process, managing task interdependencies across time and space because they are truly geographically distributed.

Every team is distributed across multiple time zones. So, they’re learning how to work around the clock, as we like to say. And finally, they are learning how to work in a multicultural team. These are the key challenges.

The other kind of meta-level aspect is that I like to call the AEC Global Teamwork journey a ‘why’ learning experience. Remember I mentioned all the students come with discipline backgrounds, from design analysis, modeling, to visualization skills, as well as their tool set for their discipline – that is the what and the how. Coming to the AEC Global Teamwork learning experience, we provide them with a why: why are you learning all these discipline skills, not just the what and the how. We integrate their discipline skills in a multidisciplinary project-based learning activity over five months, allowing them to grow and evolve because this doesn't happen overnight, as you probably recall from your experience.

**Justin:** Right. That was a fantastic overview of the program. I just have to emphasize here that this program that Renate has built and the student projects that these students do are not just normal graduate-level student projects. This is the most incredible student project course that you can imagine. You have to check out these projects ([link to the PBL Lab student projects](https://pbl.stanford.edu/AEC%20projects/projpage.htm)) and what these students, these absolutely incredible, multidisciplinary cross-cultural, overseas, internationally located students are doing. It’s really incredible. What Renate puts together here, leveraging technology and all these depths that each student comes with and then allowing them to build these cross-functional breadths to expand disciplines is amazing.

In my experience as a student, Renate, this course was one of the highlights of my graduate studies. Why I chose to do it as a student and why I think all the students that I've interacted with have chosen to do this is they want to stretch themselves in an interdisciplinary way. So, they come with that depth, as you mentioned, and have a deep skill set. My deep skill set was in structural engineering. Or, they come with construction management backgrounds, financial modeling backgrounds, mechanical engineering backgrounds, architecture backgrounds, etc.

But they want to know, how do we apply all that we’ve learned? And like you mentioned, what's the why to be able to put this all together into a project, into something really compelling.

It's also a really great opportunity for students to learn their public speaking skills. Not only are you leveraging your technical expertise to help build this team project, but you are also then presenting it at least five times through various iterations, getting critical feedback from mentors and industry panelists. And then, finally, culminating with a very large, very interesting final project presentation. Again, I can't say this enough, you guys have to go check out this website ([link to the PBL Lab student projects](https://pbl.stanford.edu/AEC%20projects/projpage.htm)) and see some of the student projects that get pulled together.

**Renate:** Justin, thank you for your comments and your reflections on your experience.

Every year, every generation stands on the creative and intensive learning experience and lessons that we take forward from past generations. Indeed, the PBL learning experience is also grounded in this social interaction. Design is a social activity and what each discipline member in a team learns is to build, first, an awareness of the other disciplines, goals, constraints, and objectives, as well as evolve from appreciation to participation in this collaborative effort that hopefully leads to a deeper understanding of what each discipline can contribute to a project, to the product, and for a client. And build that collaborative coordination and communication between the team members that are geographically distributed and leverage their discipline experience that they acquire through their programs in the context of a close to real world project.

**Justin:** Yeah. Wonderful. It’s so interesting to have viewed this lens as a student, myself, and then for many years, as a consulting engineer mentor for structural engineering students while I was at Thornton Tomasetti, and then how that lens has changed for me, personally, as I moved on to a business operations role at Katerra, looking at changing the world by vertically integrating construction and mass-producing housing using offsite methods. And now, at Manufacton, where we’re helping people manage their supply chains and run their offsite factories.

My role has changed, but some of these skill sets that you were training me on 12 years ago to think cross-functionally, think interdisciplinarily, and think globally, are coming to fruition now in my own career. It’s just been an interesting lens for me to view your project course over time.

Let's move on to a little bit of the academic model that Stanford has taken and especially, you know, CIFE and the PBL Lab, and how you're leveraging these partnerships between industry and academia to be synergistic. Can you tell us a little more about that?

**Renate:** Absolutely. Thank you for this question, which kind of brings back our conversation to working models – one which I like to emphasize is Stanford broadly accepting and implementing a model that focuses on the synergistic collaboration between academia and industry.

You mentioned a couple of times CIFE, the Center for Integrated Facilities, that was established almost 35 years ago. And I have been a member for the last three decades with CIFE almost from its inception. And I would love to also acknowledge the visionary support of our first director of CIFE, Professor Paul Teicholz, that offered us a chance to take the question of whether we can teach, whether students can learn and whether such a project-based learning experience can have a long-term impact on the student’s professional careers and their role in academia and industry.

So, the synergy between industry and academia has been front and center to CIFE, as we interact with industry partners from design, engineering and construction firms, as well as technology firms; as you mentioned, Justin, Manufacton has been one of our latest collaborators. And that creates this two-way street, as I mentioned, learning opportunity for both the students and industry, creating inspiration, as well as bringing real industry challenges and needs to the students, including data and case studies that allow our research students to have a reality check, if you want, for their big idea or vision for their research projects. So, these case studies, data, and access to real projects provide tremendous value to pushing the innovation envelope. On the other hand, we enjoy working with our industry partners to expose them to cutting edge concepts that they then take into their pilot projects and through our collaborative efforts, they move the pilot into an integrated new way of working and new business processes and work practices. So, this is a very, very valuable synergistic model that tightly integrates our academic research and education efforts with our industry partners.

The second big contribution to our education and industry community is the PBL Model. And for our big vision, I defined PBL from day one as P5BL, as a working model, which stands for Problem Based, Project Based, Process Based, Product Based and People Based Learning. These are five Ps that are critical for high-performance products and processes.

Consequently, we have modeled the PBL environment as a collaborative effort, bringing five disciplines together, bringing students, faculty and industry partners together, as well as visionary technology partners. So, we integrate both the knowledge and the technology and explore new ways of working and learning.

In this context, we have created a vibrant AEC Global Learning network. And we have created a collaborative ecosystem that can evolve as new technologies, methods and processes become available through research as well as through new technologies developed by industry partners like Manufacton.

And in the last couple of years, we have been very excited because of the emergence of quite a number of technologies that are starting to mature that allow us to start to look at new processes, what we call end-to-end processes, and expose our students to new ways of working that address intelligent interoperability, end-to-end, from design, to manufacturing, to sourcing, to delivery, to construction, and to operation maintenance. Manufacton has been very generous, and Justin, you have been a key participant and contributor to this learning experience where the students are exposed not only to virtually designing and building university buildings, but understanding how to take a conceptual design solution, architectural engineering solution into intelligent operations in terms of managing and optimizing the manufacturing aspects and the delivery aspects towards an intelligent supply chain. So, thank you again.

**Justin:** Yeah, it's been an honor to be involved, frankly. Really enjoy working with you and your students on all of this.

And, you know, I think it's such a critical thing to be developing these students with the skill sets they're going to need for the future. I mean, the world of construction is changing. Technology is impacting everything at this point. Supply chains are changing. Procurement methods are changing. Methods of construction from the design, detailing, scheduling aspects of construction and design, all the way through, like you mentioned, offsite manufacturing, different procurement methods, thinking through what an operations and maintenance phase of a project is and how the design and construction impacts all that.

These are the skill sets that students need going forward. It's such a critical thing to provide these students. I can tell you, as an industry partner, your student skill sets coming out of your course are incredibly interesting and are setting them up to be successful in their careers as the world continues to change.

**Renate:** And, these are really exciting times for our students because we, as designers and builders and operators of facilities, constantly think and build in 3D. And these are opportunities that allow us to expose the students to emerging technologies that integrate these new technologies, such as AI and optimization and virtual reality and robotics into a whole new work process and that is critical. So, it's not about just optimizing your design or just applying new machine learning algorithms to big data that you would collect in different project phases or managing your supply chain or your manufacturing production line, but really connecting the dots towards what we are now starting to see a whole new focus on digital life, smart buildings, and smart cities emerge, and taking the students to the next level of understanding how you engage with the client towards designing intelligent experiences in our buildings, our neighborhoods, and our cities for wellbeing, as well as for a better world in terms of sustainable solutions.

**Justin:** Right. Couldn't agree more. And you're training these students to be broad-minded thinkers, holistically thinking about problems from a multidisciplinary perspective, which is absolutely critical to solving some of these really, really challenging problems that require a multidisciplinary approach – like what does it take to develop a new building material or a new ecosystem for building materials built around industrialized construction.

These are the kinds of questions that your students are prepared to face as they go out into the world and interact with all sorts of those traditional construction phases, like design, construction, detailing, scheduling, estimating – all those normal construction processes – in addition to manufacturing, robotics, AI, and new procurement methods, all these ways that are kind of opening up to make construction finally move forward in terms of its adoption of technology and, ultimately, productivity. In my mind, that leads us to lower cost of housing and more efficient buildings – I mean there are so many advantages and positives that we are all striving to achieve.

Like, I really feel that the world is at a point where we're close to being able to achieve those goals. So, thanks for sharing so much about the companies, the academic model, the PBL Lab, and we'd love to focus right before we close on just a little about scaling innovation. Pull it all together for us. You've got these incredible students with their depths, their interest in holistic thinking, these projects team, you’ve got a ton of leading-edge industry partners and the firepower of Stanford University behind you. Tell us about scaling that innovation with the PBL Lab year-over-year with all that in mind.

**Renate:** Well, that's really a big picture question and I want to share reflection I formalized and now share with all my colleagues, in academia, as well as industry partners, which is that an iterative cycle that starts with experiments – industry calls that pilots – and that's what we did in the first three years. We started this vision and the question was, is it teachable? Is it learnable? Does it have any impact, not just within this class or learning experience, but beyond it, on the professional careers and the contribution of our graduate students to the industry? But experiments are interesting; they are always exciting.

The next step is how do you take that experiment and sustain it, and that applies both to academia and industry. Sustaining means growth for us. It means funded efforts to continue our journey. And we demonstrated that thanks to the support of our first industry sponsors and partners.

And from an academic as well as corporate perspective, how do you move from a sustained effort to an institutionalized effort? For us it meant that this AEC Global Teamwork class became part of the standard curriculum. It was not a skunkworks project and forgotten.

Many think that's good; this is our final accomplishment. And I always like to remind everyone both in academia and industry, this is just the launch bed for the next reinvention cycle. And so, experiment, sustain, institutionalize and reinvent has been part of our education model of the AEC Global Teamwork towards scaling innovation. The second model that I constantly implement is the experiment is always the seed towards potential scaling for innovation. And so, we always start with experimenting a new approach, a new technology, a new method with one of the many teams that I have every year in the class testing and validating the concept.

With respect to Manufacton, in 2020, thanks to a longstanding working relationship and collaboration with founder Raghi Iyengar, whom I knew and interacted with in the nineties when Raghi was the industry liaison at CIFE. We brought that relation back to the AEC Global Teamwork class looking at a whole new experience that is even more holistic than just integrating the five disciplines, but really looking at intelligent supply chain and looking at optimized manufacturing technologies and thanks to his support and the team at Manufacton, we brought this aspect to the learning experience.

It was a very successful experiment. I encourage everyone to go visit the [Atlantic2020 project evolution story on YouTube](https://www.youtube.com/watch?v=yw3akBi3i3Y) to find out what the kick starter was for the next cycle of innovation, so starting the experiment with one team, then formalizing that and sustaining it and institutionalizing that and then exposing all the teams and all the students to this new way of working. So, every two to three years, we have these cycles of experiments sustain, institutionalize, and then reinvent. Now after three years, all the teams are implementing this end-to-end process in their projects where they integrate optimized manufacturing, generative scheduling, AI, virtual reality, and visualization towards this very broad thought process shift in mindset toward what collaboration and system thinking bring to the product and the process of a team.

**Justin:** Thanks for that, Renata. It's been wonderful to be a part of the course and really does emphasize the fact that Manufacton, we're part of an ecosystem of software and technology that's helping these project teams push the envelope in concert with all these other really incredible technologies. You mentioned AI scheduling, so there are these workflows that leverage Alice for AI Scheduling and Fuser for other things and Manufacton for other things and that's all just part of this holistic thinking about these projects. So, it's been an honor to be involved.

**Renate:** Atlantic2020 was the first project where I brought in this end-to-end approach. And then I formalized that and since 2020, all the teams are now integrating Manufacton. Prior to that, we had Alice and VR. So, it was an AI and VR integration that I started in 2018. And then, in 2020, we integrated the manufacturing aspect, which really created a well-rounded end to end experience for the students.

**Justin:** Renate, great summary of the course. I can’t emphasize enough how this integrated and cross-functional thinking with all sorts of industry partners is part of this really holistic solution that your student teams are building, leveraging all sorts of technologies, leveraging all of their disciplines. It’s been an honor to be involved with Manufacton for the last three years.

Renate, thank you so much for your time. Love what you're doing. Keep up the good work. And I look forward to participating next year for the thirtieth year of the PBL Lab. Can’t wait to see what you have for us, for the students and for the world as you train this next generation of students.

**Renate:** Thank you so much, Justin. A pleasure.