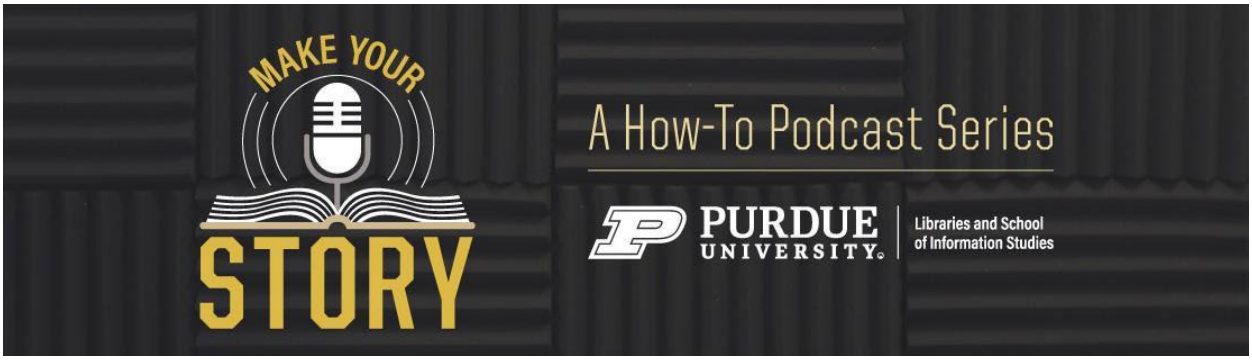

Make Your Story
Purdue Libraries and School of Information Studies

Season 2, Episode 1: From a Marvel vs. DC Chess Set to a Resilient ExtraTerrestrial Habitat, 3D Printing in the Libraries

SH: Sarah Huber
AA: Ari Atlas
PT: Professor Marissa Tremblay
TI: Takaharu Igarashi
JZ: Jake Zuckerman
BW: Ben Wogan

SH: Hello and welcome to your *MakeYourStory* podcast. All across campus Purdue students are making tangible works that are creative and innovative during the ideation process. There is a need for research. Research allows us to understand something in depth and can lead to thinking about it in new ways. This year's programming is devoted to the exciting interactions between Purdue Library and information resources and the making of Purdue student and faculty ideas and projects. My name is Sarah and I'm an associate professor of Library Science and the Purdue Libraries and I am your host for this year's first episode devoted to Purdue students and faculty using the library's 3D printing services. Our first guest is Ari Atlas. Ari is a senior in biomedical engineering, and Ari is going to talk with us about 3D printing a Marvel versus DC chess set, and when he got to talk with Michael Uslan about the Batman portion of the chess set. Thanks for being with us here today.

AA: Of course.

SH: Can you tell us about your project?

AA: Yeah. So I decided that I really wanted to make a superhero chess set. I love playing chess. I've been playing chess since, uh, middle school or elementary school even. And I've always been a huge superhero fan and people are always getting to arguments with me about Marvel versus DC which is better. And I have a hard time with that question. And so I thought making Marvel versus DC chess set would be really, uh, would be really fun.

SH: So this is a way to battle it out to see who really is the better.

AA: Um, I, uh, do all of my own CAD-ing. I do it all, um, do all my own designing. And then I come here and I 3D print mostly. And I started off trying to make these pieces, you know, look like superheroes and I was having a lot of trouble. I'm really good with more like shapes and forms. I'm not so good with human bodies with CAD-ing, it's very frustrating. But my sister is a

very gifted artist and so I teamed up with her and she was sketching a lot of things for me and we were working together and she would help me model the bodies a little bit and then from there I could make them look like superheroes.

SH: Interesting. So what did software did she use?

AA: She didn't, uh, she just drew, hand drew, like with a pencil and a paper and would say lets break the body down into shapes and this is what the arms should look like, the arms should look like, the chest, the face, the neck, how have those all fit together? I would start modeling and we just kind of go back and forth, you know, that that looks a little too bulky or that looks a little too skinny and just kind of move on until we kind of perfected a single body, uh, of a person. And then from there I replicated that body and changed each of them to look like different superheros.

SH: Interesting. And is that an AutoCAD when you say CAD Software?

AA: Yeah, it was a Fusion 360.

SH: And what about Thingiverse? Is there already some models made there or do you even check?

AA: I didn't even check. Yeah, I don't like to, when I'm making things, I like to just kind of make them myself. It's more of a, I, I like to be challenged. So for all of this, all of the logos, all of the designs, nothing came from the internet. No, no stencils, no images. It was all just from my own brain basically. And making all of these, even the, the logos on the actual chess board,

SH: Purdue is was very much about innovation and marketing your ideas. Do you think you will market it someday?

AA: Uh, my family keeps telling me too, <laugh>, uh, I definitely, I, I love this kind of stuff and if people who know about it reach out to me and, and, and want it, you know, I, I'd be willing to to, to talk to 'em about it cuz it's just, it is, it's, it's not just, uh, material, let's say it's also, it's all the time and effort that was put into, I mean, this was months and months of, of CAD-ing, just CAD-ing. And then on top of that, the 3D printing and then the sanding and the gluing and everything. It's just, it's a lot.

SH: Well, we will make your contact information available <laugh>. Looking at it. That was the first thing I thought was you did this all just with the libraries pre 3D printing services, <laugh>.

AA: Yeah, I, uh, I love, I love CAD-ing but I, I don't have my own 3D printer yet. I'm looking to buy, but I haven't had my own. So I found out about this place. Uh, so I reached out to WALC (Wilmeth Active Learning Center) and they said, Yeah, there's, there's 3D printing here with the, you have a monthly allowance or you can bring your own filament. So I started buying my own spools, bring that in and they, they print my, my stuff.

SH: For free. Yeah. Yeah. That's awesome. That's pretty cool. I was gonna ask if you way surpassed the free amount.

AA: Well, yeah. So it's, it's, you know, there's, it's a monthly allowance, right? They give you a hundred grams per month or, uh, and within that it's 50 gram max per print. Um, they don't like to run too much of their own stuff at a time, but if you bring in your own, so if you go out and you spend a little bit of money and you bring in your own kilogram, they will sit there and they will print the whole kilogram if you, if you need it, um, in a single print. If it works, I enjoy it cuz I, it's just kinda like a wanted done. I, I email it off and then a few, a few days later, I've, I've got all this stuff that I can plan with. So.

SH: Is there a resource in particular you would recommend to people developing 3D print ideas and projects? You mentioned the software. Is there any other resource through the Libraries or online that have really helped you hone the skill?

AA: With, with CAD-ing, like specifically with Fusion, there's a lot of resources online that can help you out, but, but most of it is pretty much kind of trial and error yourself figuring it out. Um, I started CAD-ing freshman year. I'd never done it before. I joined EPICS as a freshman and said I really wanted to 3D model and I had no idea how to do it. So they said, figure it out. So I found software that was compatible with my laptop through Purdue, with the educational license and all that, and downloaded it and started CAD-ing. I spent the entire winter break trying to figure it out to get better and better and I just kind of been increasing since then. There's, uh, I started doing CAD training with a ASME, was instructing other students cuz a lot of it is self-taught, but having someone, having a resource like that can also be really helpful.

SH: Can you tell us what EPICS is and ASME? Yeah.

AA: So EPICS is a learning community specifically mostly for, for freshmen, but you can maintain EPICS as a all the way up to a senior. But EPICS, uh, is engineering projects and community service and, uh, it's a learning community where freshman engineering students can, uh, get together and work on real life problems and solve them with engineering solutions, uh, to help the community.

SH: And ASME is?

AA: Yeah, ASME is the American Society of Mechanical Engineers. Even though I'm a biomedical engineer. I got involved with the group as a sophomore with their prosthetics club. And then from there they reached out to me about joining, uh, and helping teach, uh, CAD training for, uh, for new students and old students. Um, we get, we've got a couple seniors in there now among freshmen, sophomore engineers, everyone who just wants to, to, to learn. It's a really, it's a really good skill to have.

SH: So can you talk about your process? Can you tell us what your process is for developing your ideas and, and how this idea in particular is unique?

AA: Yeah, so I, uh, like I said, I'm really into superheroes, uh, all nerdy things, really. And I see something in a movie or in a TV show, and I think, wow, that would be just, that would be the coolest thing to just have, right? So I, I just kind of start there. I start thinking, man, it would be really cool if I had this and I pull out my, my iPad or my piece of paper and I start sketching out how I think it would work or how I think this, uh, might look or connect with it. And I start sketching in from there. I move on to, to CAD-ing. Um, I've made light sabers, Rubik's cube, spaceships for this one particularly. I, uh, sat down and I said, I, I think a Marvel versus DC Chessboard would be really co ol. But the first question obviously is, you know, what are the pieces?

Um, there's, uh, 16 pieces for each team total with, uh, eight pawns and then two rooks, two bishops, two nights, a king and a queen. And that's for each team. So deciding what those five or six or seven characters were gonna be was my first challenge. I started with DC I knew I wanted Batman in there. I've always been a big Batman fan, and I figured, you know, he's the Dark Knight and there's a knight on the chessboard. I thought that was just perfect. And because of that, that's why I chose DC to be the, the black pieces on my chessboard so that he could really truly be the Dark Knight. From there, I decided the rest of the, the rest of the team, I made the king Superman, uh, with the queen being Wonder Woman, like I said, Batman was the knight, the Bishop, uh, I made the Flash.

Um, and my thought process for the the Flash specifically was, you know, he kind of runs in a zigzag kind of thing and bishops on the chessboard only moved diagonally. So I thought that

that was kind of, I kind of like that idea. And then for the rooks, I had, uh, Green Lanterns. I love Green Lantern is one of my favorite DC characters. And the rook is, besides the queen, the rookie, in my opinion, is one of the most powerful pieces on the board. And I think that Green Lantern is also one of the most powerful characters. And then that just leaves the, the pawns. Uh, for DC I made, I decided to make Robin. Um, I really love, you know, the whole Batman and Robin dynamic in the idea that, you know, in this Justice League team, Robin kind of is like a pawn for them in the sense that he's this kid superhero that will do a lot of the stuff, uh, that they might not want to do.

So Robin, uh, is smaller than all the other pieces cuz he's a pawn. He makes up eight of the, the black pieces. Uh, so that's, that was the Justice League, uh, black side. For white, I wanted to go a little bit less, I'd say mainstream, You know, there's a lot of big Marvel, uh, characters, uh, that I love and I kind of wanted to highlight some of those. So starting with the king and queen, I made the king Vision and I made the queen the Scarlet Witch or Wanda. And I really liked that because that's just a really interesting dynamic, especially because in Marvel, I sincerely believe, at least in the MCU, you know, Wanda is one of the most powerful characters, uh, out there. And the Queen is the most powerful character on the board. So I wanted to have a character that was reflected.

And then I moved on to my knights. I made Captain America. People might assume, you know, make him a king, let's say, but I, I really like the idea of having, he's more of that night that that person that's gonna come in and, uh, do a lot of the work. Like, yeah, sure, he's a leader, but also he's, he's a soldier. Um, and I kind of like that. For the bishop I made Ironman. Um, and again, kind of similar with the Flashed, you know, Ironman flies around and I kind of like the idea of the bishop can move diagonally really far across this board, uh, very easily. And I kind of liked the idea that Ironman was doing the same. And for the rook I made the Hulk. I really enjoy The Hulk a lot and I think he's one of the strongest Avengers. I had some arguments with my sister at the time whether or I was gonna be the Hulk or Thor, and I ended up leaving Thor out of it. But the cool thing about the chessboard is I can always go back and I can make a whole new set of chess pieces where maybe Black Panther is king and maybe Captain America's the rookie, or maybe Thor is a knight and I can do anything I really want. Add more variety of characters, make an entire anything really. There's a lot of, uh, leeway there. And then lastly for the pawns, my all time favorite superhero and Marvel and maybe in general is Spider-Man. And I could not dis-include him. And the idea of putting eight of him on my chessboard made me very happy. So I made all of my paws Spider-Man. And similar to Robin, you know, he's more of a kid and he's kind of running around all the time. So I thought having all of these Robins and Spider-Man as pawns was, was a good match. Uh, as smaller characters,

SH: I can't help but think that people when they reach out to you, cuz I believe they will, that maybe you could cater it to what they think would be the best characters on this chess set. Yeah, they might, like with your sister, you, there might be an argument about who best <laugh>.

AA: I've always, you know, I've always been, you know, maybe I do make a, a couple 4s to swap out with the Hulks, you know, see how that works.

SH: That's true. You can, you can have some, um, backup characters that can change the dynamic of it.

AA: And the biggest thing is, you know, liking chess and liking superheroes are two very separate things. I mean, I'm not saying a lot of people, but I'm sure there's not nearly as many people that like both as there are other people like them separately. So if you are a chess player and you don't know, typically chess pieces have very similar shapes, you know, across all boards. But now all of a sudden I'm introducing these characters instead of pieces. So to kind of give you a, a roadmap, every single piece on the base has a carving of what it's actual chess piece is meant to be. So the Batman all have these, uh, knight, uh, the, the horse shape carved

into the base, uh, as well as the Captain America pieces. So that way if you're playing the game and your opponent approaches you with, with a piece from the front and from the back, you can tell which piece is, uh, approaching yours. So that way, you know, um, you don't have to just love, uh, superheroes, you don't have to just love chess to to, to familiarize yourself with the board.

SH: I think this is brilliant. I, and you know what, my, my dad and brothers play chess. I don't play chess, but I just love the way you've combined these. But like you said, you give a roadmap, like for someone like my dad who would know to look underneath for what it is.

SH: Can you tell us about this meeting you had with Michael Uslan?

AA: Yeah. So, um,

SH: And who he is?

AA: Yeah, so, my sister, uh, is four years older than me and she, when she was in college, she had a professor her senior year, um, who taught one of her, uh, uh, cinematography classes. Um, and his name was, uh, Michael Uslan and he was the, the executive producer on every single Batman movie since, uh, the first Michael Keaton one. My sister lives in LA now, and she's, uh, working in film production and is still in regular contact with him. And I went out over spring break to visit her and she, uh, very generously set up a meeting where, uh, we got lunch, the three of us. And, uh, I got to, to talk to the executive producer. It was, it was a very, uh, cool experience for me. Um, and kind of to say, to show my appreciation, I took the, uh, Batman piece that I had made for the chessboard and I supersized it to a, to a much larger, uh, scale.

And I printed that out and I hand delivered that to him in person in LA and that was a really cool thing for me. Handing the Batman to the guy that creates the Batman, you know, it's pretty cool. He's, he's had a really interesting, uh, I'll say, uh, relationship with the Batman. He owned thousands and thousands of Batman comics and bought the rights cinematically for the Batman years and years ago and used that to create the, to be the executive producer of the very first Michael Keaton Batman movie. And since then he's been out making all these Batman movies, including the new, the Batman movie starring Robert Patson. Uh, so it was just really cool to, to talk to him about

SH: All that. I'm curious, did he say anything particular about the chess set? Did he give any suggestions?

AA: He was, uh, he was, he, he, he did suggest making an entire Batman only type. You know, Batman has a lot of characters in his whole story arc, right? I could make an entire Batman versus Batman villains chess set. I think he was curious about that. It would just, it it would be a lot of work. Um, but I, I think it would be a cool idea cuz he also, you know, he was a big comic guy back in the day, so he read a lot of Marvel too. And, uh, uh, he thought, yeah, he was definitely pretty interested in the chess board. So.

SH: Well, thank you Ari. Lots of good resources, very inspiring. We really appreciate you being with us today.

AA: Thanks. Yeah, thank you.

<Break. Part 2 of episode 1.>

SH: Hello and welcome to the second part of episode one. My name is Sarah and I'm an associate professor of library science in the Purdue Libraries. And I'm your host for this year's first podcast devoted to Purdue students and faculty using the library's 3D printing services. Our second guest is Purdue assistant professor Marissa Tremblay. Professor Tremblay is with the

Department of Earth Atmospheric and Planetary Sciences, also known as EAPS. And she is going to talk with us about 3D printing, a shield for a diode laser to heat geologic samples. Thank you for being with us today.

PT: Thanks Sarah.

SH: Okay, so our first question is, can you just tell us what your 3D print is and its function?

PT: Sure. So in my lab we heat small pieces of geologic samples, so usually rocks or mineral grains when they're under vacuum, uh, with a laser. Um, and we heat them up because we wanna extract gases that are trapped in, in those rocks or minerals. So we do this heating using a diode laser, but diode lasers are, uh, are dangerous. Um, the particular laser that we have in my lab is a, what's considered a class four laser. Um, and so when we use it or when we operate it, we need to have the environment that the laser is exposed to completely enclosed so that no laser radiation escapes because it can damage people's eyes and skin. The chamber that we put our, our samples into under vacuum is kind of a weird shape. It's circular and has this circular view port that the laser is able to transmit through.

Um, and so we needed to design a shield or housing to, um, keep that laser radiation, um, contained while still being able to heat the samples. The object that I 3D printed, it's actually two objects that I've sort of stitched together. There are essentially two halves of a cylinder and I also, uh, put holes in the cylinder in specific places where I was going to add a hinge. And so it's, it's basically two halves of a cylinder. And on the bottom side of it, there is an extended portion that kind of sits around that view port that I mentioned, uh, in the lab. So I 3D printed that and I put a hinge on. So I was able to basically put screws through where, where I had left holes in the, um, in either side of the cylinder. And then the, the 3D print is obviously plastic, but for laser safety I needed to actually cover that with a laser safety fabric that's rated to, for example, not catch fire if we misalign the laser and, and accidentally, um, point it in the wrong direction. So it's got some, uh, laser safety fabric glued onto the inside and the hinge added. And then there's a little velcro strap that you can use to sort of open and close it, um, after you've placed it around that view port that I mentioned.

SH: That's so interesting. Okay, so one thing that comes to mind is how come the machine didn't come with this and because it didn't, where did you get your idea to build this?

PT: A lot of things in my lab, uh, over in Hampton Hall are sort of custom made or custom designed because we're doing things that other people aren't doing. So what I didn't mention is that after reheat those samples with the laser, that gas that we get out of the samples gets processed on this whole other custom piece of equipment. And so we sort of have to MacGyver things to suit our, our purposes. So the laser, the diode laser that I have is often used for like metal soldering and that's not what we're using it for. And so we kind of had to develop something different for our purposes because we're basically aiming that laser as something different than um, what it's typically used for. So that's why it wasn't just given to us with the laser, although that would've been nice. Um, and then the design was really, it's very simple.

Like I said, it's two halves of a cylinder. Um, and in former labs that I've worked in, we've kind of made these two halves of a cylinder using other things like PVC piping or before I 3D printed this, I even tried ordering some, um, like cake tins that had the bottom dropout. They ended up not being quite the right size and actually quite difficult to modify to get this like hinge effect. And so, uh, I knew that it was very simple shape, it would be very easy to design because I hadn't done any 3D printing before and it was, yeah, it was surprisingly easy and straightforward to do.

SH: It makes sense. I, I'm thinking not that you could use this type of 3D printing to cook in, but it does, you do think you could make a bundt cake where you just, velcro right off the cylinder and it would be perfectly sized.

PT: It does, it looks like. Yeah, yeah, exactly.

SH: That's interesting too about that material. Did you say it's a fire retardant material?

PT: It's, yeah, it's called laser safety fabric. Okay. So it's, it's a pretty stiff fabric and if you look at it closely, you can see that there's actually kind of what looks a little bit like metal, like embedded in it. Um, and so it's basically just rated, it won't withstand forever if you shoot the laser directly at it, but the idea is that it's not something that will catch fire or otherwise, um, behave badly if for a brief period of time we, um, were to have the laser fire at it. So.

SH: So is that something you already knew about going into this or is that something you also had to research? Was this type of material going inside the 3D print?

PT: I sort of knew about it beforehand when I was thinking about using other non 3D printed materials to sort of provide the structure. Um, I had found this laser safety fabric. Not everybody uses it, I would say like depending on where you are, you know, Purdue, uh, our radiation safety, uh, team is very good and they have follow sort of what the standards are. I've been to other places where you wouldn't necessarily have coated it with the laser safety fabric because it was a little bit more lax.

SH: This is just a little question like sometimes people wanna know where, like resources where, like where you got that. Is there a particular company you ordered through?

PT: Yeah, so this, uh, fabric in particular I ordered through Thor Labs. And Thor Labs actually does also provide other types of laser components. That's not actually where I purchased my diode laser. My diode laser is from a, a German company called Dr. Mergenthaler. Uh, but I've purchased other things through Thor lab. So for example, um, the laser is actually part of this design is that the, this can move a little bit and not, um, I impinge on, on the laser and that's because the laser itself is mounted on some stages that can mechanically move it back and forth. And those are also from Thor Labs. So I've, you know, acquired a bunch of my laser related stuff from them.

SH: The ability for it to move is interesting. And how did you hear about the Libraries as a place to print?

PT: I think I first heard about it from one of my colleagues in EAPS. Her name is Robin Tanamachi. I don't know if you've seen over on Wang Hall, there's a big radar dome. It's this like big white spherical object on the roof. Um, and that's Robin's radar. And so she, and this was a while ago, she has a 3D printed model of her radar, but in miniature form. So it's like maybe a foot by a foot in size instead of the real radar, which is like, I don't even know how big it is. Maybe 15 feet by 15 feet. So.

SH: I'm pretty sure you did because she's kind of famous over here.

PT: Okay. <Laugh.>

SH: We all know about this radar. As it was being printed, our um, two 3D printing gurus, Robin and Victoria were like, Come here, take a look at this. You know, and, and yes, we provide a certain amount monthly free. And then if you go past that, then, then you provide your own, but the service is still free.

PT: Right? Yeah. And I mean, like for this type of lab equipment, if I were to get somebody to like custom make a shield or a shroud, it would be a lot more expensive than the cost of the filament. So, you know, things that are these sort of relatively simple shapes or geometries that I can figure out how to make quickly are, I'm always gonna choose to 3D print those as long as it's like the appropriate, you know, material for what I'm, for what I'm doing. So yeah.

SH: Do you have any kind of background in 3D printing? Like how, how do you make that leave? Well, I could do that. I could 3D print that.

PT: This is the very first time that I've done it. And so I will say though, I had plans to start doing 3D printing, um, actually as an outreach comp-- onent as some of my research. And so it was something that I was on my mind and I have a bunch of fulfillment in my office. And then when I was thinking about how to solve this problem, I, I thought maybe this is a good, good way to do that. So it's yeah.

SH: A good intro. What kind of research went into developing your idea? Was there an article handbook, any kind of spec specifications, documents that helped you develop this?

PT: So I actually read a lot of the like informational material on the Library website about like what different softwares are available to do to make the design, what things to think about in terms of what filaments to buy and what's what, what works for a rigid object like this versus like a flexible object. And so I would say that was probably my primary resource.

SH: Is there a resource in particular you would recommend to people developing 3D print ideas and projects?

PT: I use Tinkercad to design the 3D print. I mean, I would start with Tinkercad cuz it was very easy. It's, you didn't have to know very much to make basic shapes. Um, and they have good help information too. That was really useful. And then yeah, the library website had lots of resources for me to be able to use and think about what filament I need, what density to print to that, that sort of thing.

SH: So do you have any 3D print ideas or projects on the horizon?

PT: I do. So I have, um, an NSF funded project where, um, we're studying volcanism in the Deccan Traps which is in India. It's about 66 million years old. The eruption of these can rocks coincided with when the dinosaurs went extinct. And so I've got a project, a scientific project looking at the volcanism in that area. But part of that proposal that we got funded, um, involved doing an outreach component where we were going to make what we considered a more sustainable version of this thing called a dig box. Um, so a dig box is something that's provided by the Burke Museum at University of Washington to K through 12 teachers. And it comes with a bunch of lesson plans, but the like real highlight feature of this box is that there's sand material and then actual fossils, um, that go along with the lesson plan for students to like do various things with, And those fossils belong to the museum and so you can't keep them and these boxes are only loaned out to people and then give them back.

Um, and so what we wanted to do is replicate these boxes, but 3D print the fossils instead of having them be museum specimens that are only on loan. And so that's something that we're, we're planning to do. I've got 3D models of a couple of different fossils, but I'm actually hoping to find a lot more. Ideally they would be like temporally relevant to the time scale that we're, uh, looking at with sort of the geologic time scale that we're looking at. But of any fossil 3D renderings would be useful. Um, so yeah, the plan is to 3D print a bunch of those and then put these kits together and so they can be given to or loaned out, depend. We haven't quite figured that out, um, to local K through 12 teachers for geology based lessons. Yeah.

SH: Sounds so interesting. Yeah. So keep us posted. Maybe the libraries can help in some way with the 3D printing or…

PT: For sure. Yeah, our…

SH: Makerspace program programming too.

PT: And if listeners have ideas for places where I can find these, these fossil 3D models, that would be very helpful. Small ones though, not, not big dinosaur bones. So yeah.

SH: Can you share your email address

PT: Okay. If anyone can reach out to you. So my email is tremblam@purdue.edu.

SH: Thank you for being with us today. This was really interesting. You showed a really practical way of use using 3D printing and great resources and like a beginner's way into 3D printing.

PT: Yeah, I enjoyed it and I hope I can continue to use it. So thank you Sarah.

<Break. Part 3 of episode 1.>

SH: Our guests for the third interview. In this episode, were part of a team that created 3D models of a resilient extraterrestrial habitat, otherwise known as RETH. The goal of Purdue RETH Institute is to quote --, “Develop the expertise needed to address the grand challenge of permanent human settlements outside Earth.” Taka Igarashi, Jake Zuckerman and Ben Wogan are going to talk with us about their process and purpose for creating models of a RETH habitat. Thank you for being with us today.

BW: Yeah, thank you for, thank you for having us Sarah.

TI: And thank you. Thank you for having us.

JZ: Yeah, thank you. Really appreciate this opportunity.

SH: Well welcome. We'll just dive right into questions. So would each of you mind introducing yourselves, give your name program you're affiliated with and or job you're at?

JZ: Yeah, so I could start off first. My name's Jake Zuckerman. Uh, I recently graduated from Purdue, last May, with a Bachelor's of Science in mechanical engineering. I now just started working at General Motors. I've been here or at GM for about three months and I'm a, a project uh, engineer there.

BW: Yeah, so my name is Ben Wogan. I am a graduate student, a master's student in the civil engineering department, uh, where I focus on structures and I also serve as the operations coordinator for the Resilient ExtraTerrestrial Habitats Institute or RETHi. And so as operations coordinator, I, you know, help with reporting and logistics for reviews and workshops and things of that nature. So yeah, happy to be here.

TI: So my name is Taka Igarashi. I'm currently a PhD candidate at the School of Aeronautics and Astronautics. This is like my fourth year as a Purdue student. I'm not kind of officially like affiliated with RETHi Institute, but I had a chance to, um, work with a team to develop some kind of architectural designs and layouts because I have a background in architecture. I did my undergrad and my first master's degree in architecture. So that's why I became part of this work.

SH: Both say have said RETH and RETHi. Can you, uh, clarify the difference between those two?

BW: Yeah, so I guess we just internally we say RETHi is like, you know, the RETH Institute and then RETH is like the, uh, you know, the, the main part of the acronym. But, uh, so RETH Institute or RETHi either is fine. And then we also have our habitats, which are RETHs if they're

resilient, extraterrestrial space habitats. But I think the, the common terminology with NASA and with the industry is to refer to them as smart habs or smart habitats.

SH: Where is that housed out of?

BW: Yeah, so RETHi is headquartered at Purdue, but it is a, a partnership between, uh, Purdue, Purdue University, Harvard University, the University of Connecticut, and the University of Texas at San Antonio. Uh, so we have four universities working together on different parts of this, this project. Some really interesting work happening at Harvard, uh, where they're kind of focused on the robotics aspect of our project. So we have three major research thrusts, robotics, resilience and awareness. Uh, and they're all very, you know, inter-tied, but robotics is centered at Harvard. And then the other three universities really are very, I guess, mixed and intermingled in terms of, uh, who's working on what. It's a, it's a large project. It's a five year NASA grant.

JZ: Yeah. And then just to add, um, to kind of figure out my affiliation with RETHi, I helped Ben out over this past summer. So I was like Takaharu, I wasn't exactly affiliated with the research program. I was just living on campus over the past summer and Ben needed, uh, a hand with their annual convention and then also that's how we got into developing the 3D model of the habitat. So I kind of just assisted over the two or so month period this past summer.

SH: Yeah. If we could start with explaining to us a little bit of background on what this project is to help us understand at what point it got turned into 3D models.

TI: Yeah, so I guess, uh, from a high level, the project is not focused so much on designing one particular smart hab, but actually on doing kind of the fundamental research that is needed to make design decisions about this, the space habitat. So like a good analogy, I'm a structural engineer. Uh, so on earth we, you know, build according to building codes generally. So like, you know, reinforce concrete has its own codes and structural steel has its own codes, but there's no code that exists right for the moon because nobody's ever built a structure on the moon. Um, and so what we're really doing is some of that fundamental research that would kind of start to enable us to make some of those design decisions. Uh, so as a part of that we have a, a lot of the research is, uh, in simulation environments. So we have like three major simulation environments that we're working on, uh, so that we can run different scenarios in those simulation environments and start to kind of pick out the best space habitat architectures that, that we would need, uh, and to kind of figure out what the most important decisions would be.

BW: Part of that is doing like trade off studies, like, uh, if I have a certain type of structure versus another certain type of structure, which one of those is gonna give us better performance over a 50 year lifespan. And, and running that through kind of the, the in-house made simulation environment. So that's kind of the rundown on what the, the project does overall. And this particularly, uh, the, the 3D print started out as an idea from the director to have something to look at and point at when we're kind of talking geometry, right? Uh, about the, the habitats. And Takaharu can probably definitely address the, the actual design cuz uh, he knows what all went into that from an architectural perspective. But in terms of making the actual 3D printed model and not the, you know, the 3D software model that he made, uh, it was really the, the motivation there is to kind of have something that we can point at when we're having these discussions and brainstorming sessions and, you know, say, Oh what if the robot was over here, but you know, we need something to happen over here. Right. That was kind of the motivation. And it's something fun to show NASA too, like when they're here on campus for their site visits. Right. So I guess Takaharu, you'd be really good to elaborate on what went into the architectural design and what, what you guys needed that for at the time. Because I wasn't even involved with the project yet at that point.

TI: Right. So the original like architecture design and the 3D model of the habitat was, I

worked on that, that design back in the first half of 2020 actually. So two years ago. Basically everything is running on like simulation in, in the Institute, so everything's pretty much virtual, but there's has to be some kind of like basic architectural like physical like configuration and like dimensions to, to have that simulation model to be simulating. So some, some kind of design that, that makes sense. How to say?

SH: It can be really abstract when you're looking at the simulation versus reading something in front of you and seeing how it fits in an environment.

TI: So as Ben mentioned, we're not, um, directed to like designing the best habitat design, but we need a design. So that means we kind of need to make something that's feasible or like that makes sense enough, but not, not in that sense that it, it's like the best design. Um, I worked on that part of like making sense in an architectural context, like when there's four to six crew members in the habitat, you need this much space and you would need this much storage. Sorting out those, Yeah, all those stuff was like my work.

SH: Can you give us a little bit of a picture? I'm like, what kinds of habitats? Like for the average person?

BW: I'm gonna, Yeah, I'm gonna do two things. I'll pull up the renderings that we have for the project that Takaharu made and then I'll, I can also show you the actual 3D print that we have too.

JZ: And while Ben's digging those up, I was given, when I started working with over the summer, his, one of his iterations of the architectural model, it was in Rhino 3D, which was a program I wasn't exactly familiar with cuz I spent majority of my time in other CAD software packages. So the work that I did wasn't necessarily building a 3D model, it was more rebuilding the model that he did in a separate CAD package that I was more familiar with. So I exported what I could from Rhino 3D into solid works. And then for whatever reason, I don't know if I was using Rhino 3D wrong, or for whatever other reason, some of the models were just 2D planes in space, which you can't print 2D on a 3D printer. So I filled those voids and basically simplified the complex arch, architectural design that Takaharu did so that we could then print it on a smaller scale for a 3D printer. So that was majority of my work was rebuilding what was already done into a PR printable form.

SH: It seems really complex to be taking these, these ideas into, uh, buildings or, or objects that are proportional in an environment.

JZ: That's, Yes. Yeah, and I, I would say Takaharu definitely did all the, the legwork for that. I was merely just, you know, if there was something that didn't translate directly from the model from my import, I would measure it on his architectural model and then imported my design. So we tried to keep those proportions for the smaller scale model.

TI: You know, when I made the design, there was no intention to make it into a 3D printed version. So, you know, I just made the 3D model using software called Rhinoceros. It's kind of popular in the architectural design field, but not in like mechanical engineering, other like engineering fields. But it's, you know, best pretty much use this for doing architectural design. So that's why I use that, um, software. But you know, that that file or the model isn't necessarily like suited for, you know, direct export as a, as a 3D printing material. So there's some, some work to do to get between those 3D model to, into the 3D printed model.

BW: Okay. I have those, uh, pictures finally ready. Okay. So the first one I'll show you is a rendering from the 3D model of the exterior. So like the basic idea is that right?
We have these sort of, it's it's sort of modularized, right? Yeah. Uh, and so it's easily expandable and, and reconfigurable. So you have these kind of like dome like, and I don't know if you can see my mouse or not, you have these dome like structures that are where people would congregate and sleep and eat and things of that nature. And then you kind of have these

reconfigurable tunnels that go between the different modules. And then also, so this is the, the lunar dirt. They refer to it as like the lunar regolith is what they call the kind of the, the moon soil. And the thinking right now is that any sort of habitat would most likely be kind of buried in lunar regolith to help with sort of the thermal management of the interior. Uh, so it's kind of like free insulation, right? And also, uh, acting as a radioactive barrier, uh, from solar radiation cuz the moon doesn't have an atmosphere to protect it. Right? So that serves a few different purposes. And then this is all, uh, again, these, these were all Takaharu work. I don't know if you wanna talk about this one at all Takaharu?

TI: So the, this is not exactly the same with the, the 3D printed version of the model, right. Um, it's like the cutout view of the do one of the domes or, well it's, it has planes so it's not like, um, exactly a dome, but, so just showing the interior of, um, where the astronauts would be, um, like sleeping or, um, having taking shower or the third floor. Yeah.

BW: And then here's the <laugh>, here's the 3D print that we have <laugh>. So it's, uh, again, it's very simplified from like the 3D models, right? But I think it's, uh, it's really cool and we have it all set up on like, some kinetic stand, I don't know, like a play and right, so you mold it, it's kinda like brown sugar, you mold it and it holds its shape, right? So I think that's pretty cool. And then we have like kind of the interior set up on this dome where we have all of our little people doing their little tasks.

SH: That is so cool. And this was 3D printed in the libraries?

JZ: Yeah, so like methodology behind transforming Takaharu' 3D model into the actual printed model was first that his model's really complicated and, and we're printing these domes are about eight inches in diameter, so it's a smaller space to be printing something so complex, uh, that Takaharu did. So I did take some liberties and simplifying the, the floor design. So there's only three rooms as opposed to some of the domes that Takaharu designed had like four or five or six depending on, you know, what floor you had. And then also since we wanted to have this model done in a shorter timeframe, we simplified the model to only have one floor. While if you looked at that cutout from before, it had three different floors. This just has, you know, one floor in it to kind of show a proof of concept of, you know, what's a dome floor could look at, look like.

And then I'll kind of explain the parts. So I don't know, Ben, if you could hover while I'm talking. The, you have the orange tubes, so those are one piece each, so there's three of 'em per dome, if you would call it. And those are all printed in one piece. And then they will slide and fit into that outer radiation shield, which is that outer cylindrical ring part of the dome. And then on the inside that whole plate is printed itself. So that's one piece that kind of could, uh, when you angle you can put it in and it slides in and you could take it out. And then all the little chairs and tables and beds were all, and people were printed individually and then glued and placed, uh, into the model itself. And then that, uh, the final touch was that top cylinder of the dome that's just printed and then it sits on top. So it was, it wasn't too difficult of a print, uh, cuz we tried to keep it pretty simple so we wouldn't have to print a million things and put it all together.

SH: That is amazing. I didn't see this picture beforehand. I mean, it's different than anything I've seen go through the 3D printing lab.

JZ: Yeah, so I, it was over the summer <laugh>, so I don't think there was a huge queue. For printing. So I was sending in prints every day for like probably a month and a half straight. And I think I was like the only one who was printing over the summer, but I could give a more formal answer in a second.

SH: How did you hear about the libraries as a place to print?

JZ: Yeah, so originally my first thought when I was told like, Hey, can we do a 3D printed model

of the, the Smart Hab, I thought of going to print at the two places I printed before. The first was the mechanical engineering building because they have the print lab for their senior design program. So I, my first thought was that that was not available over the summer. And then my second thought was to go to Bechtel Innovation Design Center because I was affiliated with Purdue Electric Racing. So they have a 3D print lab up there as well. They were also closed. So the two places that I was familiar with were both closed. So a simple Google search actually, I just said 3D printing at Google, the Library's website was the first thing that came up. It ended up being that the library service was the only one that was available for me to use over the summer.

So I was really grateful for that. And then also a very streamlined process. You, there's a form online, you attach your 3D printed model, a little bit of a description, and then you send the print over to them. They make any changes that they need to make the print feasible, they print it, they send you an email, you pick it up. It was very streamlined and easy. Like I said, over the summer I would send in, you know, a print in the morning, two days later it'd be done. And it was, it was very helpful.

SH: What kind of research went into developing your, um, idea for 3D printing this?

JZ: Yeah, so it's a bit of a two part answer. I would say majority of it just came through like an education at Purdue. You know, being exposed to what 3D printing was, you know, through senior design, through what I did with electric racing. I had the opportunity to learn through different programs what the proper material is for these 3D printers, what works in a 3D printer, what doesn't work, and then the actual CAD work and you know, making sure how to like splice a file for a 3D printer. That it, for me that was more self-learned than anything. I'm sure there's plenty of resources online. I do know that the ME building had resources when we were doing like our senior design work with printing. But, um, majority of what I know how to do with 3D printers and CAD came from self-taught lessons or other people teaching me just kind of using what's available online.

SH: Is there a resource in particular you would recommend to people developing their three 3D print ideas or projects?

JZ: For me at least, my, I've always been a big fan of just going on. I know it's not the greatest answer, but going on, it's…

SH: Not a good library answer. I hear it coming <laugh>.

JZ: …going on, uh, going on YouTube and just searching up like how to, you know, splice a model, how to 3D print. There's a million different really good tutorials on how to do it.

SH: Is any of this, the work that you guys do, the, the renderings, the 3D printing models that you have, is it available for students or faculty or do you have tours? Is it any of it available to the public to see?

BW: I guess so a good resource to point people to would be our website, which is actually purdue.edu/rethi. Uh, so people on that website would be able to look at, you know, some of the renderings are available there. There's also link to our YouTube channel, which showcases a lot of the research that's being done in the models that are being built.

There's also a publications library, if anyone is interested in getting into all of the technical details. We have a lot of publications that are, uh, easily sortable and kind of explorable on our website, uh, as well as all of the team who, who all is all on the team if anyone wants to reach out, that sort of thing. But yeah, it's a, the website is a great resource I think.

SH: Thanks you guys. This was fascinating. I really appreciate the time you took to talk with us

about it

BW: Thank you so much for talking to us, Sarah.

JZ: Yeah, thank you so much. Appreciate it.

TI: Thank you