

**TATJANA**

OK. Thank you for those who came very early. We're ready to start. Welcome to our session.

**DZAMBAZOVA:**

We will keep you in the dark here because the projectors are really not good. So just please do not fall asleep.

Today we have Grant, who is a student and designer/engineer, absolute expert in Fusion, and aficionado of ReMake. And myself, I'm Tanja. I'm 16 years in Autodesk. I was an architect before, and in Autodesk usually in product management roles of any new technologies that have been in the first years of development, sales product manager of Revit, and then of the whole line of products of 123D and as of recently, ReMake.

So if you're Twitter people you can check our handles. I will try to keep this screen longer.

So the agenda for today is-- we have 90 minutes, and we will do first an introduction in reality capture, which will be really inspirational use cases across many different industries. I don't know if you know we created this conference, REAL, at which we have from engineers to doctors to architects to just about any different industry, and they all show what do they do with reality. And we realized how powerful it is to see what other industries are doing, because it's very inspirational for the others.

So I will cover many inspirational use cases across different industries, then design oriented use cases, then I will do an introduction with live demo of how ReMake actually works, then Grant will do Fusion workflows in Fusion-- ReMake in Fusion. And then for those of you who have tried and failed, the software works. What usually fails is the quality of the photos you take. So I will try to cover how do you take the photos well.

We'll start with a video, or a film, that should a little bit set the stage. [MUSIC PLAYING]

[MUSIC PLAYING]

I think that the divide between what's analog and what's digital is starting to merge. Our physical world is so unimaginably rich in texture and in depth. But until very recently our digital experiences, for the most part, have been limited to flat 2D impressions of reality. Today innovative technologies like 3D printing, WebGL, virtual reality, and augmented reality are all redefining the ways we can experience and recreate the world around us.

So what goal do these revolutionary technologies have in common? They all require high

quality 3D digital models. What does it take to make a 3D digital model? You can create a model from scratch, geometrically constructing it by extruding and revolving, with nerves, meshes, polys, and solids. It's a laborious process requiring complex software and high-end knowledge. Alternatively, you can capture the analog world as it exists. This can be achieved with specialized 3D scanners, but this type of hardware is prohibitively expensive and also require immense technical expertise.

Every day technology is becoming more accessible and easier to use, but the difficulty of generating high quality 3D assets has kept this trend out of the world of 3D, until now. A new process called photogrammetry utilizes state-of-the-art algorithms to convert regular 2D photos directly into 3D data with smart sensors that are now ubiquitous and use software that is exceptionally easy to use. Anyone with access to a modern smartphone or a camera can now capture and create a high quality, ready to use, 3D digital model.

What stories can be told when we can all digitize the world around us? For artists, being able to easily capture, modify, and recreate physical assets opens up a universe of possibilities. When we can sculpt any object, environment, or living thing, the entire world becomes clay in our hands. For marine biologists it's helping them better understand the world's ever-changing oceans. For the first time ever, using photogrammetry, scientists can measure coral reef systems with astonishing accuracy. Not only does this enable us to document the state of existing corals, but with repeated scanning, we can actually observe ecological changes as they happen over time.

The Buddhas of Bamiyan in Afghanistan were glorious statues carved into a massive cliff over a thousand years ago. In 2001 they were destroyed forever, when they were dynamited in an act of religious extremism. Like so many times in our history, an invariable piece of human heritage had been lost. Except this time, we decided to search for the lost statues in a place that previously nobody would have ever thought to look, the web.

Between Facebook, Flickr, and Google Images there are thousands of photos of the Bamiyan Buddhas taken by tourists through the decades and from almost every possible angle. Using photogrammetry and hundreds of these crowd-sourced images, a team was able to digitally reconstruct the Bamiyan Buddhas in a gloriously detailed 3D replica. One, which now celebrates the story of humanity, of all of us together preserving a vital legacy for future generations.

In the near future, we will be able to digitize our entire planet as it exists in every moment. This four dimensional impression of our world will enable future generations to literally scroll back and see what was really going on in this particular part of the world, at that time. We'll digitized ourselves, as well. Giving our great-great-grandchildren the chance to see us the way we were when we were their age. By being able to better document our achievements as well as our mistakes, we will help new generations build a future for themselves that we can't even imagine.

Some stories are simply too big to be told by one person or one group of people. From passive listeners to active participants, we all have the power to take initiative in this frontier of democratized capture and creation. We're able to connect dots differently, to find deeper meanings in the patterns that emerge, and consequently, we're able to begin asking better questions. These new stories can be experienced differently in all parallel ways across time, across geography, across cultures, and most importantly, these stories will mean so much more to us, because we were part of their creation in the first place. [MUSIC PLAYING]

So, yes, it has been never easier to digitize the analog world around us and bring it into the computer. And the first devices that were able to do that were laser scanners. Laser scanner, you can put it in a tripod, you can fly it through the drone. Basically what they do is shoot laser beams in space, they hit the first surface, register the coordinates, bring it back in the laser scanner, and through a software it translates into something that is called point cloud.

Laser scanners used to be really expensive. Now the price is dropping and they're getting better. But what's interesting is that there are myriad of new types of devices that are flooding the market now. There are white light scanners, blue light scanners, tango devices, connect devices. All of these devices have sensors that can sense, capture, and digitize the real world around us.

And photogrammetry-- by the way, in the video I say that photogrammetry is new. It's not new at all. What's new is that it finally works. And it works because the photos are now so much better thanks to the high resolution sensors, and the software that can convert these photos into 3D digital models has been never so powerful as it is today. If you're a modeler and if you know 3ds Max, or Maya, you can definitely model something like this but, will it be a direct replica of the actual object? No, it will be an interpretation. We have an opportunity for the first time to actually really capture the world as this and not re-interpreting.

And as if that was not enough, we live in the age of drones. Earlier to make just one survey you needed \$20, \$30, \$40K, order a drone to make a survey. Now you can buy a drone with a camera for \$2K and fly it every day and make as many surveys as you want. So this usually is a moment where the Autodesk sees when hardware is democratizing and trends are converging, that it's time to offer solutions that can help our customers. And we focused in the last couple of years on two types of solutions. One is ReCap, and the other one is ReMake. Today we offer them separately as separate products. We're looking into how to streamline the offerings so that it's easier for you and more convenient.

So let's take a look at ReCap. What ReCap is trying to solve is what we were observing with all our customers. Big factory designers or architects, engineers, civil infrastructure, et cetera, almost always they start the project on a blank screen, but the world is not a blank screen. There is always some context. So the context was missing. And the second thing is they usually need to manage change or track change or plan.

So we realized that by being able to offer in the CAD solutions, the ability to smartly read captured data, it will really help their workflows. And about six, seven years ago, or even later, we started the first-- this was in AutoCAD-- the first point cloud reading. And it was black and white, and it looked like a swarm of bees, and you could not understand anything. Today that point cloud through ReCap looks like this. It really looks like it has been modeled, like you're really in the space. But all of these are just millions, billions of points, colored points, that know their position in space and that can recreate the space.

So how does this work? You plant your laser scanner on a tripod, couple of positions in the space, and then you need to register the different scan positions to each other. That was quite painful. We made it easy. But then we made it even easier. We made just auto registration. Instead of looking at common points between the scans, we just ask you now in ReCap to load the scans and the software will auto register them and result in a beautiful model looking like point cloud. So its all about point cloud. ReCap is currently mainly dealing with point cloud solutions.

Now, the value proposition of ReCap is we create it in Autodesk, we have an SDK, we put that SDK in almost all our hero products. So that instead of what I showed you with the black and white point cloud in AutoCAD, it queued AutoCAD, because it had too much data that AutoCAD could not handle. Now it can handle the data, not just easily, but it makes the data smart. You can read the radius of a cylinder that is not a cylinder. It's just a point cloud that looks like a

cylinder, but we know its a cylinder etc. So we start really becoming smart about it.

Where are we going with the product is really what we call perception, meaning making the data smart. Getting a point cloud without remodeling, you can ask tomorrow, how many doors do I have in this space? How many fire extinguishers et cetera? So that is where we are going with this.

Now, laser scanner's are a little bit limited because, yes, you have to place them usually on the ground. Flying helicopters with the laser scanners on them is a little bit expensive. So what that means is that very often you would be, for example, missing the top of a building, because you have to be on a higher building in order to scan the lower building. And that is when we said, wait, there are UAV's now, and they have photos, photogrammetry, and here is the scanners. So can make something that can combine both of the data so that the drone captured photo data can combine with the laser scanned ground data and create the full experience.

Here again, this is laser scanned, and then with photogrammetry we could capture with drones the bigger environment and then combine them in one point cloud. We're still talking about point cloud and not meshes.

As of recently we kept started to have data services that are reaching to the cloud to create more value of the data. And one of the most interesting one is create mesh out of this point cloud. So now in ReCap you can select a certain area, and you can call up the service, and the service will shoot that point cloud to the cloud and will convert it into a mesh that you can see later, we can open in ReMake and prepare it for further use. Be it, do you just need to create an asset of it, or do you want it 3D printed, or do you want to tell a story with it et cetera. So that was what we did first when we looked at our current customers and what you guys are usually doing.

But we're also interested in two other trends, the trend of digital fabrication, and the fact that today there are computer numerically controlled machines that help us easier than ever make physical artifacts of almost anything that we designed or capture. And then the powerful 3D web. Today with WebGL we can deal with 3D models as we never could on the cloud. And with VIA and AI devices we can experience 3D models.

Now, these two trends, the 3D web and the digital fabrication, what do they need? They need

3D models. What do the sensors do? They create 3D models easier than ever. So we said, there is something about this convergence of real data and digitized data, and that was our inspiration to make ReMake. The idea was combine these three trends in one solution and help the transition of what's real to become digital to become real again.

When we started the process we realized from the first pioneers that to create really, a really useful 3D asset from captured reality, it was really painful. You needed six, seven different software, and know-how, the software costs also. And not even many people knew that this is the combination of software that you need. So we said, this sucks. We have to make this easier.

The other thing was, when you design something-- this bottle or something-- it will be probably 300, 400 kilobytes. If you capture it to be really high resolution, it can be millions, billions of polygons. No CAD software has been ever designed or conceived to consume that type of data. But that type of data is coming towards us as an avalanche because, as I showed you, there are so many sensor types of devices that will bring data to the CAD environment. So we said it seems like we have really two challenges to solve. One is, make software that can create useful 3D models in one go, in one software, out of any type of capture. And also, be able to handle billions of polygons. So we had to build a really strong messaging engine to handle this, and this you will see. We created a tool that does that in one go.

Now, when we looked at these opportunities we said, oh my God, this will not just be useful for architects and engineers and the usual media entertainment customers, etc. This can be a groundbreaking new way of working for scientists, for medical personnel, for artists, for sculptors, and for the whole world of personal design, et cetera. So we said, we will start working with these people first to make the software so easy that any one of them, who never knows CAD and definitely not anything about 3D, can use it. If we make it good for them, we'll make it good for you.

Because there is some strange misconception in the world today that if it's for professionals it has to be difficult to use. And after 16 years in Autodesk, I will tell you for me it's not any more interesting to make software that is powerful, but software that can be used. I would like to enable small players to play the big game, and I think with the team we really manage to do that.

So let me show you a quick marketing video about ReMake, and I'll continue with use cases.

[MUSIC PLAYING]

So as you can see from this short video, ReMake is really a generic solution. It can be applicable to any industry. So I would like to show you just a couple of really inspirational use cases that hopefully will show you the power of the tool.

So one of the first people we worked with was Dr. Louis from the famous Leakey family, who operates for three generations, six decades, in Kenya and Tanzania. And they have discovered the oldest ever fossils of the first humans, of the first animals, of the first tools. Unfortunately for all of us, those tools, or those fossils, are dusting in the Museum of Nairobi where not many people go. So Dr. Louis Leakey came to TED when we had one of our photo booths in which people were sitting down to get digitized. And she said, what is this? And we explained it to her, and she said, oh my God, I know a much better use of your technology.

So she started to learn how to capture and how to convert, basically, photos to digital replicas of the skulls that she had, and today she's creating these beautiful digitized replicas that she generously shares with the whole world on a site called [africanfossils.org](http://africanfossils.org). That basically replaced the site that was really just photos and text to something that is fully interactive. This is, by the way, the real lab in Lake Turkana. I was there last year where they're working. So basically on that site you can experience the 3D models in browser. You can, if you're a scientist, search by a scientific number. If you're a teacher who teaches about them, you can search by species, by age, etc.

The models can be also compared. I will show you later with the latest ReMake viewer, based on project play technology, we can not only compare in the same scale at the same time in browser, but we can also superimpose and compare, really, to see the differences.

And by the way, what you're seeing with the skulls is the same with designed objects, with anything. You can download the 3D digitized replica so that you can 3D print them, or with another product 123D make, you can download puzzles that can be assembled out of cardboard. So imagine at school, instead of learning from books, the teacher tells you, why don't you assemble this, or why don't you 3D print and tell me, why was the neanderthal smarter than the African guy? Oh, well, the skull had more space for a brain, etc. So the kids learn really differently.

What's beautiful is that many anthropology schools and departments now are using these

fossils for teaching. And I was last week teaching at the CCA in San Francisco, and the kids artists showed me that they just finished an art program in which they used the skulls to make some interactive sculpture. So the second one is when you approach the branches started to shake, and they connected with Arduino, etc.

The next story is about the common raven, the most intelligent bird on the planet. And it's getting a lot of fun in the California desert lately. It's killing off almost all desert tortoises. Unfortunately, they have taken the baby tortoises and we're down to the last generation of tortoises. If we don't stop this, we have no more. So one tortoise scientist, William Boarman and an entrepreneur, Tim Schields, said, we know how to solve this. We will use technology to fix this problem. And they said, we will make techno tortoises, that is, fake tortoises, and place them all around in the desert and teach the ravens not to attack them.

Well, how does that work? Well, first, I helped them learn how to take really good photos, to create in ReMake beautiful replicas, and I will pass out this 3D printed tortoise so you can see the quality of it. And then, after creating 3D models in ReMake, they 3D printed the tortoises. Only one here is real. And then, started placing these tortoises in the desert to, number one, observe the ravens. This raven was for 10 minutes trying to find the body in the fake tortoise. But more importantly, they're now developing a sensor on top of the tortoises so that when the raven attacks, it sprays a little pepper spray, and it teaches the ravens not to attack. And because the ravens, we are told, are smart, after three or four times they'll say, man I'm out of here, I don't like this. And this really, really can work.

This is one of probably my favorite stories in 16 years in technology, because this is when you make technology affordable and accessible, what can happen. They used photography on their phones. They used ReMake that was free. They used 3D printing which is affordable making physical artifacts, Arduino to make them move, and Kickstarter to fund the campaign, and that's really the brave new world we live in.

Another project, very quickly, this was in Sweden. The Mediterranean Museum wanted to use technology to improve the in-museum experience, so they gave us the body of Priest Neswaiu and said, do something. So we took the body, we put it in an MRI scanner, and then we cut off the sarcophagus and the cartonnage and regenerated 3D digital replicas of every single part of the sarcophagi and the body, with the idea to put it on an interactive table that sits in the museum in front of the glass behind which the dusty mummy is actually sitting. You cannot even look closely, let alone, touch it. Here you can touch the bones, the hair, you can slice

through the spine, you can see the hieroglyphs in detail, all the pearls, et cetera. And, because it was 3D, we could also 3D print them and assemble them as Russian babushka dolls.

Now, when we did the MRI, we found out that there were 120 hidden amulets under the wrappings of the mummy, which we could also 3D print. We actually 3D printed the negative, made a mold, and then we casted them out bronze. Obviously at the opening of the museum exhibition the kids were thrilled. Usually they're the ones who want to leave the museum, and in this case they just did not want to move away. This is the way the kids of the future will be learning.

The next story was with Sly Lee. He is a marine scientist and marine biologist, and he was researching corals and found out that actually there is no scientific method to say if a coral is shrinking or growing. So he said, he learned about photogrammetry, and said, [INAUDIBLE] corals under water, and I'll capture them today, and then I'll capture them after six months, compare the state of the two models, and see what happened after [INAUDIBLE] the health of the ocean. Here, some of the models that he has made in ReMake. And thanks to his requirement to compare corals over time, we made the functionality in ReMake to actually compare two states of model, which you can basically call almost like a time machine, because it allows you to go through different stages of the model. He's also sharing his models on his website, the Hydrous so you can take a look and see what's up.

I will switch now to another PowerPoint because sadly PowerPoint does not want more than a certain number of slides.

So the next big project that we're working on was with the Smithsonian. Smithsonian is the biggest collection of museums in the world. They're 19 museums, and they have over 154 million objects. When you go to museums you only see 2% of that, because they don't have enough space to expose it. So they realize digitization is one way to offer the whole collection to the whole world, not only those who come.

And when they started they really didn't know anything, and there were very few experts to ask around in the world. So they started to test with photogrammetry, laser scanners, [? surfacers, ?] structured light scanners, micro-CT scanners, and they figured it out. Painfully, but they did. They started making these beautiful 3D digital replicas, and then they came to us and said, you guys have Maya and Max, all these beautiful visualization solutions. Can you help us show this content beautifully to the world?

And after a couple of conversation we realized, they didn't want videos. They didn't want marketing material. They wanted a tool that works online that anybody in the world can access from whatever computer, whatever operating system and can see the data really beautifully. And that was what we did under the project called Smithsonian X 3D. This was a prototype pilot project. We picked about 20 iconic objects from the museums from as small as a bee, to as big as a supernova remnant, with different complexity, with different textures, etc to see what will this be. And it resulted in this tool.

So we said, number one, the objects have to be as beautiful online as in real life and not as a second life. Secondly, we want to augment them. This relief was so shallow, the curator could not read it, read the story of Buddha. Just by deepening the occlusion net, we could then show the relief actually, to be readable and really understandable. We gave the curators bunch of tools to define hot zones and hot spots to tell the story in a 21st century way. And when you go there-- it's Smithsonian X 3D-- you can explore on your own or follow a tour that the curator did. If you're a teacher, you can teach about the mammoths and say, instead of open the page [INAUDIBLE], you can say, open the mammoth online and measure the leg. How tall was he? Or just make some art, make a sticker for your t-shirt, etc.

We continue the collaboration with the Smithsonian, and we were part of the digitization of President Obama, who is the first president to not to have to wear a plaster mask on his face, but he was simply captured with different types of capture devices, photogrammetry, structured light scanner, and then 3D printed and eternalized.

And our last project that we worked with the Smithsonian was the famous Apollo that was sitting like this in the museum in a Plexiglas capsule, and they needed to prepare it for exhibition, and we said, this is the chance, they're opening the capsule

**PRESENTER:**

Capsule, it can capture it. And there was a team, Elmer is here, that's him in the photo. There were many people who participated in the capture. We developed devices, rigs for cameras. We had to put the scanners on long sticks because you could not enter the Apollo out of respect, really, the Apollo. And we end up with a beautiful, beautiful, 3D digital replica that you can see online. But you can also come to our booth downstairs. You can actually be experience it in VR, and really see it as the astronauts were seeing.

And here are just some of the interiors. And this is one of the original astronauts who was in it. And we showed him how today others can experience what he experienced. And he was quite

thrilled. The stories are endless. I always have to pick what to show. This is something new. I have no idea if they're using any of our tools. But just to show you, these are live animals that are now captured by our [INAUDIBLE] lab. And as you will see, and I will cover that at the end. Many people, depending on what they need, they start to develop different types of rigs. But it's all about positioning cameras in the right spot. And as fast as you capture, you can even capture living beings. Although you know--

This is Factum Foundation. They developed this particular scanner for capturing portraits. We did a project together in the Royal Academy, in London, where-- this, by the way, if you have heard of that famous priest who built in Spain, a whole church, all his life, on his own, single handedly It's Father Justo. And then so this is a real high quality 3D capture. This is not, oh, you know, you go and you look like a wax figure. This is very serious capture.

And then we also showed how you can CNC the captures, as well. And what they also did, if some of you know who Messerschmidt was. It was a very famous sculptor who was doing grimaces in the 18th century, and will now do new type of live portraiture of people. You can check out the website. All of these are 3D models open. So I'll open later, the website, where you can see them. And these are regular people who came to be eternalized in 3D and high resolution capture.

But let's bring it a little bit him. This is Craig Barr. He's an artist who used to work for for some time in Autodesk. But he's a true artist. He's making assets for film and game. And in this case he's making some creature that he then captured, and then digitized through ReMake, brought in Maya, and did all the wonders with Maya, which I absolutely adore. And continued in Mudbox, editing a bunch of little details, you know? But Mudbox has this scratching functionality to add a little bit of detail to stuff. And then continued adding texture, color.

So basically he started with something done with the hands. And many of us artists like to use the hands. There's no mask, and no devices can ever exchange that. And then you can convert that into a digital world, and making a new digital reality that you can use in film game. Or making a new physical reality by 3D printing the mask, 3D printing the figurine, et cetera.

Same now. A lot in the main entertainment world is happening with props. Usually you start making a prop out of cardboard boxes, Styrofoam, this and that. You can capture it, and then modelers can model around it, and then bring it back into the physical world. Another one is interesting, what we call Scan to Fab. This is a photographer professor in London. He was so

impressed by ReMake, and he was just a pure photographer, that he developed this bronze reliefs by using ReMake, and ArtCAM.

Basically he combined ArtCAM's functionality of using a photo, and then making a 2D relief and then 3D models with ReMake, and combining them in this CNC casted, or bronze casted area of panels. And this is an exhibition that is going on in London in terminal 5. I don't know if it's still going on. It just finished. It was all summer. But the idea that you can capture something and directly cut it is very, very appealing. So sometimes we'll say, almost you don't need CAD, you know? You can capture something, and in Fusion you just create the footpath, without having to design anything.

And then the world of personalized design is very interesting. We work with UNYQ, who motivated by the idea that we are all unique and focusing on five million amputees in the world that are wearing these quite outdated prosthetics. They are hard because people stare at you. If you're a kid, the kids are making fun of you. They wanted to make the life of amputees kind of more fun, and beautiful by creating these super fancy prosthetic covers that are not only matching the body in shape, but also the style of the person.

So the idea is they connected with a network of doctors all around the world. Taught them how to take photos. You go, if you're an amputee, to the doctor's office. The doctor captures your healthy leg. Uploads the photos. UNYQ gets them, creates a 3-D model of the leg, mirrors it, and then designs around it. And together, with the amputee, they work online to design the style, to design the thing.

And these are two Iraqi-- to soldiers who both of them lost their legs in Iraq. They're just beautiful stories. Then the other idea around design is what Alex Lobos showed us for the first time last year. We never even thought of this really. He's a fusion expert and aficionado, but industrial designer and professor at industrial design school. He showed how he actually works. He actually likes to create physical artifacts first. And then he digitizes it in ReMake, and brings it in Fusion, designs around it, and then prints it. It did not feel really-- the touch was not there. Adds a little bit of clay, fixes it again, digitizes designed around it, et cetera.

In the meantime, he advanced so much that now he does not design around it but he uses the captured physical objects already directly into the model without redesigning them. And that's possible for many use cases. Not for all but it's possible for many. And then just think about how many beautiful references we have in nature that are quite difficult to model in CAD. Well,

you don't have to. In this case he took a pine cone, took a bunch of photos, and then designed a glass infusion that used the pine cone as a basic reference.

This is Christoph Unbechedit. He's a student in Germany. Also crazy about Fusion. Expert in Fusion. But then he was really intrigued about this idea that he can capture and design around it. So his mom was making apparently cabbage soup, and he was looking at all these leaves on the kitchen table. He said this is beautiful. I could never design this. I could never model this. So he captured it. Created high definition 3D replica remake. And then made it into a jewelry in Fusion, and actually really produced. And it's really absolutely beautiful.

And this is the pedal that was quickly shown. Also made by Alex Lobos. He was annoyed that this pedal was always breaking. The design had a flaw. So he captured it. This is ReMake. He brings it in ReMake. Some times when you don't do enough photos. Oh, there are some parts of the model missing. No problem. We can fix that. He even used parts of ReMake to model, which is not what we actually planned to do. But we have this bridge functionality to bridge holes, and he used it to do some supports here. Then he didn't want these bumps here, so just simply, with our smart brush select them and then close the hole. And he's ready.

The model is huge. It's difficult for Fusion to read this. So we decimate it and export in quads. And then in fusion, with one click, these quads become [INAUDIBLE]. Meaning it behaves now the same way as if h had actually designed it in fusion. And now you can do all the operations that you're usually do in Fusion. You can do booleaning, and editing, remodeling, and also combining with parts that have already been modeled, and being able to simulate the captured part with the design part, and do everything that you usually do in design, and 3D print it at the end.

We believe that this can be actually a valid workflow in the future. This was the reason why Autodesk got at all interested, because, who knows? Maybe in the future we don't have to start from scratch. Maybe if I want to design a mouse, I can start with the closest mouse that I ever found, and then start improving it. So we will see.

This is another use case with one of the horses that I've captured. And Phillip Vedor, a colleague of ours, also crazy about Fusion. Loved the possibilities of ReMake. And we together were talking about designing a walking cane that he did. So in this case he used the head, sliced it, and then exported it infusion. There he edit-- I will try to speed it up. Not possible in. Windows make machine to speed up stuff.

So here he's importing in Fusion. And you first orient the model. And then he will be converting this model, and then design around it. I will not talk, and just let you watch a little bit. I'm 40? Good. That's good in time. And a couple more use cases, and then we'll go to a live demo. So now he did the conversion to [INAUDIBLE] and from now on this behaves like a CAD model, and you start to use Fusion as you would use it normally. All of these videos, by the way, you can find on the web site. And some of these that are new, we will post them right after AU. This session is also recorded, for those of you who are capturing photos, and stuff, just so you know. And if you need ever anything, you can come to me and I'll give you my card.

So you can see here he is first designing the stake. I actually made a shorter version of this video, and obviously did not change it. Sorry about that. But you can enjoy the process. So first here is a stake. Then he will design the connection between the stake and the head. It's actually quite inspiring to see how Fusion can arrive to something quite amazing in a few steps. So first he connects all of these two shapes. But then he wants actually to have a curve. So he picks the plane on which he will design the curve, and then connects the two shapes again, in a much more meaningful way.

These things used to be really complicated. And it's really amazing. OK. I'll stop here and you can watch it online later. But it goes up to simulation and analysis if the cane will be bending, et cetera. It all happens in the Fusion environment, and that's the beauty of it. There are other use cases. You design something and you want to see if part of what you're designing, if it needs to be compared, combined with something in the real world, if it will fit. This is a carburetor that was scanned with Arctic Scanner. Again, you can, instead of modeling, you can just scan it in, and see if it will fit.

And then there are lots of use cases on creating new art. What I showed the about comparing the corals, you can do it with actually mechanical models. You can compare a CAD model with the 3D printed scanned model. And as of recently we have this comparison also happening in browser, where you can, this for example, optimized fusion file, and non-optimized file, and you can compare them as I showed you before, with the [INAUDIBLE].

So basically all these concepts that I was talking about, we call them rip, fix, burn. Or rip, fix, learn. You have get a reality. You rip it. You mix it. Fix it. And then you reburn it back into the real world with CNC, or 3D printing, and the same rip, fix, learn, for teaching and educating in a new way. Now, before I move to the live demo of ReMake, I would like to show you a video just to give you an idea how they actually take the photos in a way that is appropriate for the

photogrammetry.

[MUSIC PLAYING]

## **VIDEO**

### **NARRATOR:**

Photogrammetry is the process of creating models with textures of existing objects or spaces by shooting many overlapping photos from different angles. ReMake has a fully automatic 3D reconstruction engine. All you need to do is upload all your photos and it does everything to create a textured model for you. To inform shooting better photos for photogrammetry, it's important to understand some of the basics of how the photogrammetry process works behind the scenes.

Photogrammetry relies on feature detection. First, the software will go through all of your images and detect common points between any pair of overlapping photos. Many thousands of features will be detected in each pair with significant overlap. Using the 2D features in a pair of photos simultaneously it is possible to solve for the camera and feature point location in 3D space. ReMake simultaneously solves all pairs, creating accurate camera locations and surface points for all the photos submitted. Then it reconstructs the geometry, and creates textures using the positions of the cameras.

For feature matching to work, just make sure that nothing moves in your scene while you're shooting. Also make sure to get plenty of overlap between your photos. Some objects will not work with photogrammetry. Transparent, translucent, shiny, heavily specular, or reflective objects, all look different when viewed from different angles, and can cause the matching algorithms to fail. One solution for these types of objects is to use a matte chalk spray paint that you can find in most art stores. This paint is temporary and can easily be wiped off after your shoot.

In this example the designer wanted to capture a glass skull to test out new design ideas for different finishes.

Let's take a look at some of the common shooting strategies. First let's look at the high end technique of photo booths. Photo booths have hundreds of cameras in a spherical or cylindrical set up around your object. Often they have flat diffused lighting built in, as well. They are the perfect solution for shooting moving objects like people since all cameras fire at the same time. Of course, not everyone is going to have access to a large studio and hundreds of cameras to build a photo booth of their own. But it's a good idea to keep this

technique in mind as you can try to replicate the camera angles and the flat even lighting when using a single camera.

The most common and accessible technique is moving your camera around your subject. For high quality results when shooting objects the basic idea is to go around the object shooting full loops of photos in increments of 5 to 15 degrees. If the object is complex and has lots of occlusions shoot in smaller increments. Make several loops at different heights. Then add extra photos to fill in any heavily occluded areas at the end. Any surface on your object must be visible in at least two or more photos to be reconstructed in 3D.

When shooting your photos try to fill as much of the frame as possible with the object. For larger objects or to get higher resolution textures at the end, you can move in closer to your object and shoot in overlapping rows. Just make sure to get plenty of overlap between your rows. A good rule of thumb is 40% overlap. The next shooting strategy is flying a camera on a drone or UAV. This technique is essentially the same as shooting an object on the ground. Only all rules of thumb are applied at a larger scale. Keep in mind that, although consumer level drone cameras with fisheye lenses will work, a light mirrorless DSLR will give a huge leap in the 3D reconstruction quality.

The next technique is automated turntables. A turntable spins your object in increments and triggers a stationary camera. The advantage of a turntable is you can move your objective to shoot all sides. Thus capturing the entire object. For a turntable to work properly follow these guidelines. Use a perfectly flat background so no stationary features are detected in the background. Use a soft light from the direction of the camera, such as an LCD ring light. Frame your photos so any clamping mechanisms are cropped out.

To shoot this intricate quadcopter frame, rows were shot every 45 degrees for the top and bottom of the frame. Another option to improve the results with a turntable is to cross polarize your light. Simply add a linear polarizing film to your light, and a circular polarizer to your lens. This will remove most specular highlights. To shoot this old kitchen grinder, notice that we aligned several rows to see inside the holes on the top. This enabled us to capture the entire inside of the grinder.

The final technique is moving your object manually. The idea with this technique is to make a curved solid background, with no features, and manually move your object. Like the turntable this technique captures all sides of your object. It also relies on a soft light source from the

direction of the camera and absolutely no features in the background. This is Dennis Martin with Autodesk. Thanks for watching.

OK. So let's see the software in action. I'll just close stuff here. By the way, I don't want to forget, the web site is [remake.autodesk.com](http://remake.autodesk.com). If you go to the gallery you can see all kinds of projects that different types of professionals are doing. Under the Learning page there are lots of workflow videos, tips, and tricks and then some webinars in which we teach online longer. And there is a Getting Started guide to download. In case you've been missing these things, they're here.

All right, so I will start just by opening a couple of scenes made in ReMake. So this is a scene made with drones. And when you have the cameras on you can actually see how the drone was flying. This drone has not been very controlled. But the results are quite good. Another one, scaled down. Let's see the Apollo, and the positions of the cameras of Apollo. Sorry. This happens every time when I'm connected to a projector. It's not much to do with ReMake. I'll have to start the thing up again. It's the projector, trust me. And I don't want this [INAUDIBLE].

So let's open the Apollo. The Apollo is quite a big data set, so it will take a while to open. And it's only at the beginning of the large datasets that it takes a while to open, but then the working on it is totally pleasurable, and super fast as you will see. We'll show you a couple of the sizes of the models so you can-- Yeah I think that everything that was opened before connected at the shoot. OK. Sorry guys. Never good idea to open the software before.

OK. Get I'm starting fresh. Why is it still on? OK. All right. So this was recently captured by a colleague of mine who made a project in Italy. It's a Roman column. And again, here, I'll turn on the cameras. So just to get a feeling, these are about 150 photos. And this one was captured by Brendan Foley who is digitizing the entire Antikythera Shipwreck in Greece now, underwater. And some of the pieces that ended up in museums, if we turn on the cameras here you can see the number of photos that he took. And you can kind of see the circles around it.

So all of this just to show you different levels of capture. But let's not get ahead of ourselves. Let's imagine that we made the photos, and we start from scratch. So this is how ReMake looks like when you start it. You end up in the dashboard. Your dashboard will probably have less objects, because you have not yet maybe used it. My dashboard shows all my recent objects. So let's say I took photos the way we showed them how, and I wanted to create 3D.

So I say create 3D.

Where do I want to create the 3D? Do I want to create using cloud computing online? And that is perfect because you don't have to have a strong machine. Or you're working on some sensitive data, maybe entertainment and government do not like very much posting stuff online, although all our medical records and money's online, but they kind of don't trust this part. So you have both of the options. Let's say I want to create online.

Then the next one asks me, where are your photos? In this case, my photos are locally on my drive. And I will use our beloved hero product, Garuda, which is a sculpture in Singapore. So you load the photos. This capture, was done with about 250 photos. In this canvas here you have the last chance to see if a dog passed by, or if your finger was in front of the camera, or if the photo is blurry. And then those photos are not good. Just eliminate them because they can mess up the reconstruction.

And all you need to do is just click Create model. When you click Create model, which is always lower when you're connected to the projector. I have no idea why. All you're asked to do, really, is give a name to the reconstruction and pick the level of quality. And that's pretty much it. At that moment the software uploads the photos to the cloud, invisibly to you. And after an hour, two hours, three hours, depending on the size and the number of the photos, you will get an email saying that your model is ready.

So the algorithms are in the cloud. You uploaded your photos on the cloud. They get generated into a 3D model on the cloud. The email tells you it's ready-- I'll cancel this now-- when the email is ready, it will appear here. When the email is ready to appear here. And using this blue button you will download it on your desktop. In the meantime it was stored on your A360 account where also the photos were stored. Be aware our A360 accounts have a limit. You cannot buy more storage. So at some point, start to delete the photos and the models after you save them. Sometimes if you get a message you cannot create them and it fails, it's because you don't have enough space on your 360 account for the model to be written.

And you downloaded the model and you're opening it, and in this case I'll open the Garuda. I've not touched it. This is what you get from the cloud. And this is the big first turnoff. People comment and say, your software does not work. And because they get this. Where is my beautiful sculpture, right? So this sculpture is here, and it's gorgeous. The problem is, of

course, the photos didn't stop where you wanted them to stop. The camera just shoots whatever is around. We had the crop feature automatically that was being a little bit smarter, but it cropped sometimes more than what we wanted. So we let it be. So if you get some crazy results, first check if what you were shooting is not really there.

So the first thing what you want in this scene, obviously, is to clean up the scene, because you don't want that environment around. So this is, by the way, the UI of ReMake. You will say, oh my god, it only has 10 buttons. It probably cannot do anything. This is a children's toy. And this is a misleading thing. I said it said at the beginning, people think only because its simple it's not professional.

So here I will pick one of the selection methods. In this case, the windows selection method is totally fine for me. I will select this and I'll say, invert the selection, and delete with the Delete key everything else. This model was huge. Just to show you, now when it is deleted it's is 8 million polygons. And yet, the action was only this. That is what I was telling you that we build this mesh engine that can handle billions of polygons.

And by the way, don't get fooled when you capture. With texture, everything looks beautiful. Take off the texture and take a look. Do you have a level of detail? Because that is the first thing. If you want to print, or something, you want this to really have captured the geometry well. If you just want to show it online and stuff you probably would have done with half of the number of the photos, half of the resolution. It will look still the same. But it won't have the detail of geometry.

Now, in which scale is this? Photogrammetry does not know scale. A photo has no idea of scale. So for those who care about scale they usually put a known object that is known in size, either a little tape measure, or a coin, or a banknote, anything. Even under water, that is how [? Slilu ?] was doing. He was putting an object that he knows how big it is. And then you will go to our tool that is called set scale and units, and click on value, and you click on one point, two point. And let's say I know that the distance between the eyes is 10 centimeters, and I'll just change that here. This is my-- that's another program. OK. So basically you just said the known scale. And from now on your model is in the correct.

The next thing that we always say to do first, actually, is to orient your model correctly in space. It's a little bit to the left and not parallel to the ground. Imagine this is the ground. So using this circle here and also the left mouse button you can orient the model to be exactly

parallel to the ground this is important later when you want to use other tools, or to create a video, or to export to other places it doesn't show up like this.

The next thing is, hey, hooray, this has a hole in it. And if I want to print it, it's a zero thickness surface with a hole. You cannot do anything with it. We realize this is happening to the majority of the models. So we created a special tool that is called slice and fill. And basically, it allows you to decide up to where you want to slice, and even with the inner circle you can change the angle, and with the outer circle you just go up and down. And you slice up to wherever you want it. You can decide if you're filling it automatically, or leaving it open. Apply. In this case, I said fill it automatically.

So what it will do in one go is decide it where, decide the direction, decide it to slice, and close the tool. Without you having to pick the edge and close et cetera. So with all the tools in ReMake, and we really tried to look at the workflows. And instead of asking you to make-- oops. So as you can see here, this is now completely closed. Something is acting up. And I'm rotating. Hmm.

OK so then let me see which one to show you next. Yeah. I often use this model to show some other tricks. This is, for example, a drawn capture. And it's a zero thickness surface. You know, you just capture it from above. But you want it as a model. You want it either because you want to build a CAD CNC, 3D print it, et cetera. In this case we have a tool that is called extrude. And what it will ask is just to select the boundary. You go close to that boundary and you click on it. So you see. I don't know if you can see. It becomes blue.

And then you can either define to extrude to the plane, to the base plane, or you can set an exact value that you want extruded to. So I'll just now accept to extrude up to this grade plane. And what it does it smoothens the boundary, and it will extrude in one go. And from then on it will actually be already a 3D model that can be printable etc.

In many conflagrations you can actually extrude in the other directions. So we had, for example, scanned teeth. If you extrude in the opposite direction you get an Invisalign. It's really as simple as that. Where is my little horse? Something's happening I'm not liking. Something feels weird. By the way, I've never been prouder of another software that I've been working on, because it's really stable, and I'm very annoyed when projects are missing.

So in this case I want to show you a couple of more tricks. I'm switching the selection method to lasso. I'm seeing some particles here. I'll delete them. I'm going to clean this up like this. I'm

going to delete this. I think there is a particle here. But what happens now if I want to delete this thing? Let me switch to this mode so you can see. So I want to delete this stick here. But when I do that so often you capture something that you didn't want. And this happens way too often and is very annoying.

So when we realized that this is happening often we built a tool that is specific for that allows you to isolate. And then you isolate that and you can then here clean it up nicely, and then you turn off the isolation. And now you have nicely, without ruining the rest of the model, a cleanup.

And let's imagine that I have no idea that you can not 3-D printing something that has a hole. I want to 3-D print, so I go to the 3D printing feature. And it says, do you want to check for print issues? Well, you better check, because if you don't know, 3D printers are very finicky animals. They don't like double meshes, zero thickness surfaces, spikes, tunnels. Just name it. And you don't need to know that detail. So we're trying to take away all that unnecessary technology talk and really enjoy what you're trying to do.

So in this case I'm told hey, you cannot 3D print, do you want to fix it? I want to fix it, but I want to see why. It says well, you have three holes. Show me. Next. Uh oh, one hole, another hole. OK. So now I have two choices. If I'm big entertainment, quickly design, I'll just ask the software to fix this stuff automatically. If I'm a scientist I'll probably not want it automatically to be fixed because Louis Leakey will not be happy if the neanderthal gets an extra cheek which maybe it didn't have.

So here you can fix the holes automatically. Select also if you want it smooth or flat, and just fix all holes. So let's see, what will the software do. If I'm happy I'll accept it. If I'm not happy I will undo it and do something else. So here it fixed all the holes. But maybe I was not really happy with this line that was generated here. So for that we created these surface doors that are sculpting and smoothing tools so I can control the brush size. This is huge brush. So I can control it here. And the strength. And either I'm sculpting or just really patting the surface. And I will start, you know, changing whatever I was not happy about.

And by the way, if you do the sculpt tool really strong, you can push or pull. Just to show you you can really start sculpting in areas that you felt it was not captured correctly. We don't want that here. OK. So I was undoing stuff. OK. The other thing, what can happen sometimes is, let's say this area here-- and just undo this. OK. So let's imagine this area here was not

captured well, and it's missing, and it's a hole. And I'd like to fix this hole.

So for this, if you just fix it with flat, it will be flat. You don't want that. There is a cheek here, right? If you do it's smooth, it might be really bulky. So for that we made a tool called bridge. And all the bridge wants is that you connect one triangle on one side, and the triangle on the opposite side of the hole, and say, do you want a flat or a smooth bridge? And it will make a bridge. And if you take a look, the bridge is actually understanding the pendants of the areas that it needs to connect and makes it really smart.

And you can then continue to build a bridge between here and here, another one. Sometimes you have to make sure that it doesn't end with this schpitzzy thingy. So I would say I'll select this one and this one. Smooth. And then you have the holes. You say, I want to fix holes. You go close to the holes. The mouse finds the entire hole. Select it, and again, do you want it to fill it smoothly or not?

So these are the tools that you have available to you to manage really any kind of in front of problem that you might have with the tool. Then let me see if I have them. Let's open this chair. I'll close this again. I don't know what's going on. The mouse is not behaving at all. I'll try again. Just a couple of more examples and then I'll Gran show the workflows of these models with Fusion.

So this was a chair, actually. I think it was captured the laser scanner. And then scanned to mesh. And in this case, let's just make sure that the chair is correctly oriented. So I'll go here. You see it's a little bit tipping. I'll do this. Something like that. Apply. And now we have a chance to export this chair in different formats, depending on what you want to do with it.

So we shift quick export, or advanced export. Quick export comes with the free version. And we tried to help you not having to know how many polygons can the target application open. What kind of file format can target the application read? What orientation? With one click-- my menus are not working because this is Windows 10 issue. Here we have a list of bunch of other products. You can with one click expert to Fusion, you can export for Mesh Mixer, expert to Maya, expert to Max, export to AutoCAD, et cetera, with simple one click.

What that does is decimates the model to the number of polygons, bakes the texture, and it just exports it. Under Advanced you have control over all of these things. This is only available in the paying version. And again, you can here-- however you want, decimate the model, reduce the number of polygons, pick the file format, and bake the textures, if you want to

rebake them, and then export.

And just to explain this baking of textures. Why is it important? This chair was, let's say, described with about 300 million polygons. And now you want to put it on a VR device, or on Web GL, to see it online. They can only read 150k. So what do you do? You have to now, something that was described with millions of triangles, has to be described only with hundreds of triangles. It will look like origami, right? And it will not really look pretty. If you don't rebake the texture, the texture will not spread evenly from the millions of polygons to the hundreds of polygons. So by rebaking we simply make it look better on a much smaller model that will not really have the feeling that it has so low a level of polygons.

Another thing that we edited recently is publishing online. And this is the interesting thing to see. When you publish the models, what's happening is we are using that tool that we created for the Smithsonian, which we now call Project Play. It's on labs. You can sign up for it. It's basically an online platform that allows you to create multimedia interactive experiences for VR and for web and mobile.

And we created with that Project Play templates for export from ReMake. So when you click Publish to the Autodesk Gallery, it first goes to this intermediate Play environment. So you have to be logged in. It opens Play online. And here you can decide if you want to change the background, the lighting, if you want to apply a template that can measure and slice, or just see it, or to compare two models at the same time. Those are just different templates in this publishing facility. And then from then on you just click Publish to Autodesk Gallery, and it goes to the Gallery.

The internet here is also a little bit slow. That is a little bit of a challenge. So wait. So this is that intermediate published environment. Here is the chair. And you can change the background color. You know there are lots of parameters here. You can apply different templates just by dragging and dropping them. This template allows you, for example, to measure, or to slice the model. Let's say you can slice the model. And whatever do, you say publish to Autodesk Gallery. And then it appears on the Autodesk Gallery, and people can use this.

So that is the general overview. I have many, many more models to show you. But let's see how the time goes. So Grant, now bring it back to Fusion.

**GRANT:**

All right. Let's go.

**PRESENTER:** Do you have a microphone?

**GRANT:** I do not.

**PRESENTER:** OK. Here.

**GRANT:** All right. Can you hear me well? Sweet.

**PRESENTER:** Is the guy not here yet to change the resolution?

**GRANT:** No. Technical difficulties. We'll We're with you in a moment.

All right we're going to do this, actually. Apologies.

All right. So I'm going to talk through ReMake, Fusion, and what it takes to take captured data and bring it into-- couldn't figure it out. So we're making it work. Bringing it in with something that we've mentioned before, which is the turtle shells. And that, to me, was something that I dealt with this summer, in like kind of wanting get headphones that were noise canceling. And I really liked the kind of design aesthetic of that, and wanted to work with them in Fusion. So here we go.

So within ReMake. I don't know how to deal with it. And we don't have much time so-- thank. So we have the turtle up here, and we have this and remake. So we can go around, and we can take a look at this guy. And what I like about this model is the texture of it. So we can see the shell and kind of the dimensions of it here. And so what I'm going to do is I'm going to use some of the tools here to clip out certain parts. So I'm going into orthographic mode at this point so that I can get a proper part of the screen, and click off what I don't want. So I'm going to remove everything that I'm not selecting. And then I'm left with the top of that turtle shell there.

And this is a good start for me and what I'm going to do is I'm going to take this guy, and I'm going to export this for Fusion 360. So this is going to export as quads, which is going to let me do some things with T Splines later. So what that means is it's going to give me a surface that I can machine off of, if I want, from Fusion. Or I can 3D print, and make solid, and different models.

**PRESENTER:** Click menu, so they can see the other [INAUDIBLE]--

**GRANT:** Yeah. So we have Fusion 360. We have Maya. We have Mesh Mixer, Mudbox, Stingray,

ArtCAM, Blender. As well as an advanced option, if you just want to get that raw data out right now. So--

**PRESENTER:** [INAUDIBLE] Yeah, and you can rebake here. And you can also do a quad export here if you want a really high accuracy quad model. So I'm going to use the medium fusion export. And I already have that baked in. So I'm going to go to Fusion 360 here. And I'm going to use some of the tools here to make a set of headphones for you guys. So what we're going to do is we're going to start with the Create Mesh. And I'm going to go, insert Mesh.

Now, I just want to explain something here. If I go upload here-- so this is going to put it into my cloud-- I'm going to get a different result. And what I can do first is I'm going to go into preferences and I'm going to make sure that I have the preview for mesh enabled. So that's here. So this is the mesh workspace. And I'm going to go within the mesh environment and go-- this will be automatically turned on, and I'm going to turn that off. And what that's going to do is it's going to let me bring the quads into Fusion. So I'm going to say apply.

**PRESENTER:** This is super important. If you don't do that your quads will arrive as triangles, and you get a triangle that will not convert to t-splines. So just make sure you do that.

**GRANT:** So we're going to go insert here, insert mesh. And I'm going to choose the turtle shell that I have. Which is somewhere else, but I've already bought it in. So we will drag it up here. So the mesh files we have we bring into Fusion. And we get to convert those to t-splines through-- So here's my face for reference. So this is done using an iPhone. So something that's available to pretty much anyone. And I'm going to say, OK. And from earlier I have a version of the turtle shells that I've put over here.

So this is t-spline at this point.

**PRESENTER:** [INAUDIBLE]

**GRANT:** Exactly. And so I can check it out. I'm always going to want to check the body for issues. So I'm going into repair. This is going to let me identify star points, t points. Things that could possibly cause a problem later down the road. So I'm going to live with that. And I'm going to take this guy and I'm going to use kind of some parametric models. So I'm going to go duplicate. Throw that to the other side. And then I can create pieces off the actual form of my head later as well. Big black box is a good thing. Means it's working.

**PRESENTER:** You didn't show it, but basically you're just saying, create mesh, import mesh, it arrives, and then with one click you convert it to t-splines.

**GRANT:** Right. So we have that on both sides now. So next I'm going to use the mesh as a reference geometry. And I'm going to use the object snapping, which is going to let me pull from the actual physical object in space here. So I'm going to kind of draw on top of my head. For that first one I'm going to use the next tool set, which is going to let me drag this bar out. Kind of takes away some of that work. I'm going to do that again. And I am going to call that today right there.

So I'm also going to go into the mesh here, and check the opacity. I'm going to turn that down to about 40 so I can see some of the things that I'm working with in the environment. Next I'm going to take the top that headphone piece, and I'm going to mirror that over. So I have something that's starting to work. Hotkey tips for Fusion, s is kind of your search. So I want to do a bridge. There we go. And now I'm going to select s, the top piece here, top piece here.

And making sure to keep preview on. What this is going to do is going to see, at times-- because I can move this point around. See how it doesn't really appear right now? You want to make sure that you have your bridges consistent there. So I'm going to say OK. So we're getting somewhere. So I'm going to take this headphone, top strap that's in the general area, where I want it, and I'm going to expand it a little bit. I'm going to look at it from the sides and the angles, keeping things kind of head on, and lined up, right? Bringing things in.

And I'm going to drag this guy down just a little bit and pop it out. I want to keep in mind the actual dimensions of the user, so kind of leaving some flat spots up top and such. So let's bring this guy over and I want to squeeze that in. So right here, this kind of edit and modify, this is my primary tool in Fusion in sculpt mode. So I'm doing a lot of modeling and editing with this feature.

Next I'm going to create a taurus. And I'm going to do it based off of this plane. Again, always making sure to move into the orientation you want for modeling. So I'm really that guy there. And at times the mesh can get in the way. So what I'm going to do for the moment is turn that off, bring this over, compress it a little bit. A little bit more. We're getting somewhere. Again. OK. And I'm going to mirror this guy across the active plain here. And that's looking like a pair of headphones to me. So let's give this guy an OK.

Just be aware of those large t-spline bodies. They can take a while to convert at times. So be

patient. And hopefully things will work out for you.

**PRESENTER:** [INAUDIBLE]

**GRANT:** Yeah.

**PRESENTER:** [INAUDIBLE] that they can control the t-spline, and maybe just the fork.

**GRANT:** So let's turn this guy on again. And I'm going to change opacity back to 100. And we can just throw this into a quick render. And if I want to pitch a product or I am kind of working on an idea I'm not totally sure about yet, I can kind of see how things are starting to line up on, well, me. So let's go first common use case. So my hotkey, I'm using a bunch of different keys here. And you can pick up some stickers, if you want, that will help you out with this. So I'm going to use a, which is appearance. And I am going to go into my pants and change the appearance of the turtle shells. And I'm going to get those kind of nice, I don't know. What would you call this? Fusion Orange? Something like that?

**PRESENTER:** [INAUDIBLE]

**GRANT:** So there is just a quick model. You can see that the textures from that turtle shell ear are coming through. And we can use that design. And maybe I want to create a Kickstarter or something with a percentage of the donations going to, say Hardshell Labs, or something like that. So a way that people can get involved with the data that exists. Not only did that they capture, but data that other people create, because there's kind of a derivatives market to be made and I think that's something that ReMake can help with.

So next we have the fork. Yeah. So I'm going to do some tips and tricks really quickly. So quads, scales, and t-spline repairs. These are the things to watch out for. To give you a brief intro, this is a fork that was laser scanned, and I want to use it as a starting point. Now, some of the time when you go to quads you get these failure points. And I just want to talk through a quick rip and repair.

So what that means is that we take the forks, that we do the same export pattern with the quads, and we're going to get into the t-splines and do the same check, but we're going to do a little repair this time. A couple of other projects that I've just worked on recently for fun, to kind of demonstrate some of the capabilities. So I built a fixie bike. And I wanted to clean up the mesh in ReMake. And then I wanted to create a tensioner for my rear axle, because I had

dropouts in my bike, because it's an old 70s road bike, and it wasn't really meant to be a fixie. There wasn't any good solution on the market that I particularly liked so I went and created something that would work on a bunch of different types of bikes.

So I have the points here that screw in and let me work with the actual geometry of my bike, instead of just kind of faking it and seeing if it works. So I'm working with the context of the actual models in real time. So we have the fork here. And what we're going to do is we're going to check out the--

**PRESENTER:** Why don't they show up, I'm confused.

**GRANT:** No, I turned them off.

**PRESENTER:** All right.

**GRANT:** So I have the fork here. And as we can see, it's come in with quads. And I'm going to check this guy out, and just see first if we can get-- let's see-- convert the mesh. And we're going to say OK. So what that's going to do is it's going to generate that t-spline off of those quads. And the reason we're doing this is because quads like four points. T-spline like those four points as well. You can do three points, or five points, and stuff with t-splines, but it's going to be a lot more friendly.

So as you can see, we're pretty dense here. And if I wanted to like pick certain points and design patterns, and stuff like that, we can pull these out. So these are pretty malleable at this point, and we can kind of have some fun.

**PRESENTER:** You can change points, lines, and surface.

**GRANT:** Yeah, and we can increase things, and do that. So let's see if this converts. Let that run. Other things you can do with photogrammetry. I have my car. It's a kind of fun Jetta. It's not particularly fast, but I can dream. So I did photogrammetry. Really rough with my iPhone. I learned about the surface types and how you want to make sure that you have kind of dull surfaces. So I went back again later, after doing some fun simulation, and made sure to get myself some of that spray powder, and put that all over my car, and I used that to make a much better model, and then do a lot of conversions.

Now, I got to about here, and then, well it was the weekend, so I just put a truck on the back of it. So why not? The thing with the t-spline conversion is it does take a moment for it all to go

through. There's a lot it's looking at. It's looking for interference. It's looking to turn it into as minimal of a BREP as it needs.

**PRESENTER:** While it's converting, I just wanted to show you, this is the latest Maltese hand scanner. They've not yet decided on a price, but this thing, you can capture [INAUDIBLE] something, and it brings a super good quality model. This is how the world changes. [INAUDIBLE] from Artic, a great scanner. [INAUDIBLE] by the way, is also a [INAUDIBLE] scanner. But, in architecture \$1000 scanners. This will be probably \$500 and \$1,000. It's going down in price.

**GRANT:** All right Tanya, I think we've got it.

**AUDIENCE:** Yes?

**PRESENTER:** Yeah. This one no texture. This one--

**AUDIENCE:** Oh yes, it does have texture.

**PRESENTER:** Oh that's the latest one? oh, I'm one week late, or [INAUDIBLE]

**AUDIENCE:** [INAUDIBLE]

**PRESENTER:** If we have time I'll show you, just so you know, we're working with Mantis, that when you plug this in, and you scan it, it immediately builds up in ReMake. It shows real time what it scans. And the model is already in ReMake, because second with all these companies their devices are great. Their software users tell us are very difficult to use, and they can not handle the scale of those models. So they can capture it, and then in the software of the scanner, you can not generate the mesh model. So we're trying to provide machines to help in that problem.

**GRANT:** All right. Thank you so much today. So again, just really quickly, that was a rip and repair. Some I'm literally ripping out that problem area, and doing a fill hole move. And then we don't have any more issues. So you keep doing that with the failures that you get, and you'll be able to fix your models and convert. So that is what we have for today. Thank you.