TATJANA DZAMBAZOVA: OK, let's get going. Welcome to New Reality, or if we call it, Rip, Mix, and Burn, and Rip, Mix, and Learn. This session is streamed live, and you'll be able to ask questions during the session. So first of all, I want to welcome you who are here, but also, many of those who are watching us from their homes, or from their offices who could not join us here in Vegas.

You'll be able to ask questions during the session. You here, the attendees in the room, should check in to the session on the mobile app, and then look under the Activity tab and ask questions. And the online live viewers can ask questions through Twitter. This would be the hashtag for Twitter.

OK. So my name is Tatjana Dzambazova, and believe it or not, two days ago was my 13th year in Autodesk. I started in London in technical support for AEC. Then I was application engineer for Europe, Middle East, and Africa. Then I moved to Paris, being the Technical Evangelist for Revit, for which I lost my heart so much, that I moved from Paris to Boston to become the Product Manager of Revit.

Then I was in global business development in AEC, for which I moved to San Francisco, trying to show architects that there are other tools for them, like Inventor and Maya, from which some very interesting interoperabilities happened. And then, for a while, I was Product Manager and leading Alias Design in some of the sketching tools. Then I was one of the founders of the Consumer Group and worked on tools like 123D and 123D Make. And today, I'm in the Reality Computing Team, Product Manager of Photo, Memento, and some other sexy stuff.

And to help me today is Elmer Bol, a friend, a colleague, and my boss, who is the director of the product management in the Reality Computing Group. He's an established speaker and thought leader in all things Reality Capture, and was one of the founders of Alice Labs, which was a start-up company focused on democratizing reality capture software. And that is how he found his place in Autodesk.

So we call this session New Reality, and to be very frank with you, when I, six months ago, set up the session, I thought that we would be so advanced with our new tool, that I can spend the entire hour only on that tool. But we're trying to solve some hard problems and some new problems, so things don't happen as fast as we wish them.

So I decided to extend the session today with actually giving the bigger picture about the entire reality computing world-- what is it, why does it matter, and what can you do it? So after this class, you would be able to get a good overview of reality capture techniques. I will teach you very quickly, the best practices for photogrammetry as one of the capturing techniques. Then we will dive in Recap Photo, our photogrammetry solution.

Then we will have a deeper dive in Memento, our new tool that is focused on post processing reality capture data. Then we will look at how can you use the data, either in a digital domain, or in physical prototyping. And a sneak peek in what's coming next, and all of that interwoven with lots of case studies on which we've worked.

So let's get started. Fasten your seat belts. There is so much material, I have no idea if I'll be talking for five hours or, I'm joking. I hope I'll make it in an hour.

So reality computing. For 25 or almost 30 years, actually, although this has been serving professionals, helping them imagine, design, and create a better world. And this is how they all were starting, blank screen. Regardless which software you would have used, this was the way to start.

Now, it might make sense for some things, but for the majority of things, if you think about it, we don't do things in the ether. We design always, something next to something, inside something, about something, we change something. So it was kind of weird that, for such a long time, we have been starting from zero.

And you know, it's intimidating, It's hard, and imagine if you have a very simple task of redecorating something like this, where not one single wall is straight, or even your kitchen, without the reality. Or if you think that this is difficult, then imagine the job of somebody who's laying a water line for this reality, and has to start from scratch.

We observed that many of our customers were spending quite a lot of time recreating the reality in which they need to do something, or which they needed to change. So obviously, there was a need to be able to capture and digitize the reality, and bring it into the computers. So lucky for us, laser scanning was invented around 10 years ago.

And what laser scanners are, for those who have never seen, or heard, or understand what they do, basically, a laser scanner emits a laser beam from a rotating mirror towards a target. And the moment it hits an area, it shoots the beam back. But while shooting the beam back,

actually, it records the x-, y-, z-coordinates of all the points on where it hit. So the data is captured and usually, this is how the data looked like. It's a bunch of points, black and white. It looks like 3D, but it's not 3D. It's just points positioned correctly in space.

Well, that's the past. Because of that need, the emerging need, there were many, many new devices, laser scanners, invented, of every shape, color, size, and price, but most importantly, the price has gone so down, they've been completely democratized. The most expensive ones used to cost half a million dollars. Now, they're around $100K. There is democratizing laser scanning with their scanners. They're around $35K. There's is next gen for $2K, and now, even for $1.5 K, you can get a laser scanner.

But most importantly, the software that can handle their presentation, and the processing of the laser scan data has improved dramatically. On the left side is how it used to look like. On the right side is how it looks today. This is still a point cloud. This is still not modeled data. And you have a feeling that you're really in reality.

Just look at this. This is a point cloud. It's unbelievable. You didn't need to remodel anything. You can just work in in, and be almost in the space. We enabled this with our new solution that we have launched this year that is called Autodesk Recap.

Autodesk Recap can handle a humongous amount of point clouds, visualize them really beautifully. You can measure, you can section, you can region. You can then edit the data, clean it up. It reads almost any laser scan file format type. It does phenomenally fast registration. Laser scanning is great, but the post processing is still quite slow. It's very tedious to register scan by scan. Register means you put them together in order to recreate the space.

Now we have targetless registration that is really, really fast, and makes the time of processing really much better. We can also add survey points to be in the correct position in space. You can collaborate very efficiently, due to interoperability, and export to almost any of the major Hero products of Autodesk.

What that means, is that now you can, in Revit, to open a point cloud-- first of all, it will not make Revit to lose its head and say, what happened to me? That was happening earlier when the laser scans were so big and not dealt with. Now, Recap Pro is actually paying them in a way that Revit can read it. And then you start designing in that space, instead of first recreating it. And it's same for AutoCAD, for 3ds Max, for InfraWorks, et cetera.

Scanning of data is not only interesting for designing new stuff, but also if you think about culture heritage, we're losing our heritage through wars, through tsunamis, through earthquakes, through acidic rains. And lots of the conservationists, and archaeologists, and heritage organizations are starting to reach to these new technologies in order to capture what's out there for posterity, but also for conservation. Once you capture this data, you can then use our tools, AutoCAD, other tools, to actually create, also, documentation. So aside from the 3D documentation, you can actually have drawings and help your restoration process.

Laser scanners are great, but they're still not available for everybody. And the processing time, we are making it much faster, but it still, you know, it takes time. They are, however, very precise. If you need to work with precise data, you will need to reach to laser scanning.

There are other methods to capture reality, and that is the second method I would like to talk about. That's photogrammetry. Photogrammetry is really turning photos into 3D models. Let's take a look first at some examples.

This is one of our first examples that we made five, six years ago, when we started the technology. This is Chris Anderson, the ex-Chief Editor of *Wired Magazine.* He was our first test rip, and these were just some photos of him. But you could see the mesh that was created. So this is not just a 3D panoramic photo, but actually a 3D mesh.

Since then, we have come very far. This is a small building in Napa. The next one is a dragon panel. My colleague, Ronald and I went to Singapore with our team, and went to this Chinese temple. And there was this beautiful golden panel, and it was high up, so we could not take photos. So we bought a monopod and we put the camera on it, and took about 30 photos. And that's what we got.

There are beautiful skulls coming from Kenya, and we'll talk about it a little bit more later, but just look at this beauty. It was made with photos. This is a friend of mine from South Africa, who I always find quite fascinating in look. And then, this is a good example that usually fascinates when I show it.

We were having dinner at my friend's place, Emil, and Ronald was taking photos from a little Krishna statue that was at his desk, and this is what we got from 70 photos. Take look at the level of detail of this. Can you even imagine that this was done just from photos? This is no

magic. I've not cheated anything. This comes directly from the photos. If you had to model this, even if you knew Maya, and Mudbox, and 3D Studio Max, you would need a lot of time.

So how do we do this magic? You take photos, and then you upload them to our cloud service. We leverage the cloud, the power of the supercomputing, and we start comparing pixels between the photos. We calculate the camera position, the lens distortion, and then we start triangulating, and we create a triangulated mesh. We also build a texture atlas for the mesh, build the texture images, and export a very beautiful, high-precision 3D mesh with beautiful texture.

This technology first really found public acceptance in the form of 123D Catch, so many of you probably have already heard about 123D Catch. It's our free version of, and the consumer tool of photogrammetry solution. We have it on the cloud, and the mobile devices, and on the desktop. And last week, we launched, actually, 123D Catch for iOS 7.

It's a lot of fun. You can do captures with your phone. And it produces quite amazing quality, obviously. It's free. It's our consumer solution. You can then share, have fun with your friends. And what do people do with it? You have no idea.

I'm going constantly to the forum to see what people do, and they're sharing some artworks that are temporarily, like this watermelon sculpture. There's a lot of sleeping dogs and cats. I always think that, if Martians come, or if some future generations look at our data, everybody's sleeping. Why? Because for photogrammetry, you have to be still, so you can only catch, really, animals or babies if they're sound asleep.

But it's a lot of fun to see how the consumers are leveraging high-end technology. In the meantime, we have been heavily improving the engine for professional use of the photogrammetry solution. We have improved the global stitch rate, the accuracy of the calibrated cameras, the less distortion, and we are now handling unlimited resolution, all in order to create high-quality, detailed meshes and textures. And that, we are offering in our tool called the Recap Photo, which you can find on http://recap.autodesk.com.

So let me show you how does that look like. So this is the website. So first, this website holds the entire relevant information about the software. We have tutorials. Please read them. We spend a lot of time writing them. And trust me, many of the questions on the forum are answered in those tutorials, if you read them.

You have access to your previous work, but most importantly, you can create a new project. All you need to do is to give it a name. You can pick the resolution, the mesh density, if you want a preview. That means, give me the results quickly. I just want to see how it is. But if you use high or ultra, you'll get, really, the best possible mesh, and best possible texture.

You click Next, then you upload photos. These are photos of a sculpture of a horse that I took at a friend of mine in DC with my pocket camera that is really a small Canon 100s. Now, this might take some time. This is a little bit sped up so we don't have to wait, uploading the photos. But what's happening here, we are uploading the photos to the cloud.

Here is the next step where, just in case you uploaded erroneously some other photo, you can delete it in order not to mess up the algorithm, and then you say, Next. And that's it, you're done. What's happening now, your photos are sent to the cloud, and you see 0%. They're starting to get chewed up and processed.

In the meantime, you can work on something else, you can go and look at your gallery, or the projects that you've done before. And you see there, there are signs for download, and sign for A360. In the meantime, when your session is ready, you receive an email that your model is ready to be viewed. You click on the link, and basically, you can see your model.

This is that horse that I took about 60 photos of. And actually, it's quite impressive. I will show you later the same horse, where you can see the level of detail of the mesh. But I could not believe my eyes that this was-- and this is one of my first personal projects.

By the way, when you switch to mesh in Recap Photo, this is not the mesh quality this is actually produced. This is limited to what the viewer can support to view. But only when you download the OBJ or the ISM, et cetera, you can actually see the quality of what you've done.

You can also exported it to a mesh format to be imported in Recap Pro, so point cloud format. So you can actually combine the results of the two software. In this case, I exported it as RCM, and I can download that RCM later, when it's ready from that little icon.

Now, if you have done good photos, this is just about it. You created a great mesh, and you can now work with it wherever you want. You can publish it online, you can go use it in Maya, Mudbox, et cetera, or save it as a point cloud and use it in Recap. But if you want, for example, to give a workflow with Recap Pro, and you want to add exact coordinates of where this object that you want to then match what your Recap Pro data is, you can add survey

points.

For that, we have advanced features. You click on one point, and it opens two sessions of your photos. You select two photos that have similar features, pick one point on the one, pick the same point on the other, and down there, you name the point. And in this case, we just set it to 0, 0, 0, which is the origin.

Or if you know a distance on your photo, because, as you can imagine, photos don't have a sense for scale, you can put points. In this case, we added point 2 and point 3, and then the same point 2 and point 3. When you do it on the second photo, it's important that you select first, the point 2, so that when you click on the second photo, that click is also point 2. Then you select point 3 on the left photo, click, et cetera. And then, once you have both of the double points, you can set the distance down in the right lower corner, and from then on, you're all set.

There are situations where you'll notice that, after your construction is done, on the left side where the photos are shown, you have actually lots of unstitched images. What does that mean, and what does manual stitch, which you might have heard, mean? That means that when you're taking the photos, some of the photos due to light contrast, or due to you not having good overlap over the photos, the system has not understood that they also belong to these other photos. So you have a couple of unstitched photos that you can actually ask the system later to manually stitch so that you're reconstruction is improved.

How do you do it? You select one of the unstitched photos, select Stitch on the right side. On the left side, you will have the unstitched photo. On the right side, you pick a photo that is, again, having similar features, and then you'd have to pick at least three points in four different images.

So click point 1. Find an image, in this case it is the Lycon's belly. We click from the left side, click from the right side, and we repeat that for three points. And then we change, on the right side, the photo with the other two photos, so that you have at least three points on four different photos matched.

On the lower left corner, you will see there is a color bar around your points. When the color bar is just a quarter filled, that means you matched it with one photo. When it's 90 degrees, then it's with two points, three-quarters, it's at three points, and four-quarters, when it becomes green, that means you're all set to go. That is all that this software does.

The last two things I showed you are really advanced, and only in case you have not done enough photos, or your photos had some problems, of which I will talk later. Otherwise, it's what I showed you before. You upload photos, click Next, And you get wonders.

Now, where can this be useful? When we talk about traditional-- traditional to Autodesk industries-- these cases can be site planning. And this, by the way, is one of the news that we're announcing. This is done with Go Pro camera, this particular one. So we start to support Go Pro. And it will be, soon, in the next update of Recap Photo.

We have cases of users who are doing this to calculate retention volumes for a drainage retention pond, for example, in this case. Many of these things, earlier have been done with laser scanning, but for that, our customers had to rent a laser scanner, and rent a company who would do the service. And for many use cases, photogrammetry would be just fine. All they want is to capture it, and then calculate the volumes.

You can also do equipment fit. So you capture some old machines, and then either export them as a point cloud and read them in Recap Pro, where you've captured the rest of the factory, or just in any of the modeling applications. Also, for media entertainment, it's a no-brainer. You can do all of this phenomenal, complex 3D models without ever modeling anything.

And I just got this video yesterday, and I had to show, from my colleague, Cody Austin. He works in the oil and gas industry, and he said very often, again, they would use laser scanning to capture existing conditions. In this case, they just used photogrammetry, made enough photos, uploaded into the cloud, and received a perfect 3D model of this, whatever it is, pump? What is this?

AUDIENCE: Valve.

TATJANA DZAMBAZOVA: I'm an architect. I don't know too much about valves. And then you'd export it to Recap Pro and use it further. So the most important thing is that we're all still discovering where all of these things can be useful. Nobody knows.

There's some obvious cases, but we're seeing that even our customers are trying-- wait, maybe this can also be good for maintenance and servicing. We don't know, so we need creative brains. And we're surprised on a daily basis on some use cases that we, even, didn't

think of. But there are other-- which we're noticing that the reality capture solutions are starting to intrigue interest in many new industries non-typical to Autodesk.

So for example, I would start with a use case that we've been working on in the past year. Probably many of you know the Leakey family. They're a family of fossil hunters. They work in Kenya. And there are three generations of fossil hunters, and in those three generations, they've gathered enormous amount of fossils, thousands and thousands of fossils that, sadly, dust in the Museum of Nairobi. And one of the mottos the Leakey family, starting from Richard Leakey was, how can we share what we find with the world?

Not many people go to Kenya. They want kids to be educated, other scientists to have access, and they simply were not enabled until now. Lois Leakey, third generation of this family, a little bit savvier on the technology side, heard about our technologies, and was very excited. She said, maybe that will finally allow me to share this with kids, and with other professionals, and she started taking photos in Kenya. And at the beginning, she was sending us the photos, because she would not deal with software at the beginning.

Now, she's rocking it. She's doing photos, and scans, and everything. But she started digitizing all of this because-- so instead of having a website where you usually just have photos and text, and you have to read, now, almost all of her fossils are in 3D. You can almost touch them, rotate, orient.

And you go, first, to the lobby. By the way, the site is called africanfossils.org. I recommend you check it. If you have kids, show it to them. They should show it at school. But you can basically pick a skull, start rotating, start learning about it, learning from it, start comparing. But now, she has about, 1 think, 50, 60 fossils, but she's now regularly creating a pipeline. You can search to fossils by type, or by age.

We even have a modern human fossil so you can compare. And our brain's a little bit smaller than the previous guys, so it seems that they were smarter than us. And most importantly, she's allowing you to download all the prepared 3D data digitally, so you can 3D print them, or you can make cardboard patterns of it.

So imagine what this means for school kids. Instead of learning boringly from school, from books, to actually touch it, feel it, compare it, and share it. Because she's also inviting everybody who joins the site to share the artwork that they've done, or the classes they've lived, or the hour of science that you've done together with your kid.

We're seeing a lot of interesting adoption in the arts. For me, very interesting was also, on the natural sciences side, Dr. Brian Fisher in San Francisco, and California Academy of Arts is trying to make a world library of ants. He's the expert on Ants. This is another example where this is actually used to support the healthy and border control, so that everybody on the border has on the screen types of insects that are not allowed to be imported in the country, so they don't mess up the ecosystem. And with this, they actually compare and see if they're right.

J G Brown is [INAUDIBLE] conservator from the Field Museum in Chicago, recently shared with me this case. This is a beautiful cheetah that they have in the museum. So they used photogrammetry for this, but then they also had a pickled cheetah that they CT scanned.

And unlike laser scanning and photogrammetry, which are what we call line of sight, meaning you only capture what you see, CT scanning is actually capturing everything through the body. So that is why you can now see the muscles and the bones. But basically, finally, he created this, both for educational purposes-- they're going to not 3D print it, and just imagine how much more fun science can be when we're equipped with stuff like this.

Another similar, but yet, different type of project was one that I was personally involved with, with Interactive Institute Swedish ICT AB. And Medelhavs museum in Stockholm. They have a beautiful collection of Egyptian mummies, and they wanted to improve the museum experience. And the ICT Institute suggested that we do a collaborative project, where they took-- so as you know, there's a mummy.

There is a first sarcophagus, a second, a third, and depending how much money you had, you'd go on and on. This guy was not very rich, and I'll tell you one anecdote why we know that. So you have the mummy, and there were three sarcophagi. Actually, a cartonnage and then two sarcophagi.

So first, they did a CT scan of the mummy itself, so they can get all the bones, and hairs, and whatever is the remaining, including some falcons. And then we used the photogrammetry to capture the cartonnage. This is the first layer that comes over the mummy, the head and the skin. And then, there are two sarcophagi. So I hate to show this video, because the whole beauty of this tablet is how beautiful the presentation is in the visualization. But this is a view from a video, so you'll have to imagine it.

Those of you who are here, you can go to the Autodesk gallery, and we actually have this

there. This is not the final version. We're still working on perfecting the textures and stuff, but you can unwrap the mummy. You can actually see now, instead of looking through the glass in the museum, the mummy, you can see what's inside, and what's inside, and start sectioning, and slicing through. And so go and try it in the Autodesk gallery.

As said, it will look even better. And for those of you online, just follow the news on ICT, and we'll share with you the final results when they're ready. By the way, we found couple of falcons around the heart zone, when we CT-scanned it. And it's just amazing, if you think about where have we arrived with the technology.

OK, so all of that is beautiful dreams, and some of you are skeptical. Really? You can really do that with photos? I must tell you, I was the first skeptic. When I made the first photo sessions, nothing worked. And I was like, this software doesn't work, you know, start bitching in the company.

And then I realized, it was all in the photos. I didn't know how to take photos. Now, when I say, it's all in the photos, it's not all in an expensive camera, not at all. It's just that there are a couple of rules, very simple rules. I have published them in the tutorial for Recap Photo, at the end of the tutorial. But if you remember anything from today, the photos must be sharp.

No depth of field, artistic photos. Everything has to be in focus. For that, you need to use a tripod. Ideally, use a clicker. The light is enormously important. No flash, no strong shadows. Don't shoot in Sahara on lunchtime. Try early in the morning, or late in the afternoon, when it's diffused light. And have enough photos.

Common mistakes on why sometimes the reconstructions do not look as beautiful as those that I showed you are blurry photos, there were enough photos, but then, they didn't have enough overlap, so the one photo and the other do not give enough points to be matched. Moving objects. You're taking photos and somebody's just running around. That doesn't work.

Or as I did it once-- almost all of these, I've done it myself, mistakes, so I'm just sharing with you. Once I was taking photos, and then when I moved on the other side, oh the bicycle was on my way, and I moved it. And actually, no, you don't move references, because when we compare photos, we're trying to find the same pixels on all the photos. So there are a couple of common mistakes. I'll publish this so you can have them after the session.

But usually what makes a photography good for art photography is bad for photogrammetry,

like this beautiful photo from Joe Burull. It's like, no blurriness is accepted. And the light is very important. Imagine if you have a target light, or a very strong sun. What do you expect the software to do, when part of the Buddha is black, and the other part is gray, and then when you turn, that part is black? And it cannot compare the pixels and it doesn't know what to do. So diffused light would be ideal.

This is also one mistake that I did in London. I love this old post booths. And I shot photos, and this was, again, early stages for me, and I was so proud I didn't forget to take photos also from the above, so to cover the top. Unfortunately, I covered the top so well, that it had absolutely no connection point with the bottom of the booth. So all unstitched images. The software is freaking out, and yeah, I have to go back to London.

[LAUGHTER]

TATJANA DZAMBAZOVA: And finally-- I hope my boss is hearing me. And finally, whatever you do, try to-- it's good to have lots of references around your object, but try the main object, that is, the object of your interest, to fill the majority of the photo. Not like here, where it's not even a half of the photo. Try to fill the majority of the photo frame.

Now, the technology has limitations. And these are not Autodesk limitations. Photogrammetry as a technology has limitations. It doesn't like shiny objects. You can guess why. When it's shiny, if I wear something glossy and shiny, and Elmer looks from there, he will see black because he's wearing black, and then you can see some other color, because it's reflecting. So anything shiny, transplant, reflecting, it's not working. And then, moving objects, as I said, it's not working.

For shiny and transparent, if you're into photography, try to use polarizers. They do help, and we have had success. Just, it's not what it should be.

So what's next for Recap Photo. Everything I showed until not exists. Go and get it. Go and try it. It's currently free, but we're going to start charging soon, by no means, a lot. So go and see it, and make some tests.

What's new? The first thing was, this was my first experience with this software, when I made the horse. And actually, this is only because, currently, the software takes in account all the photos, and everything that is behind me when I take photos. So, actually, yeah, my horse was there. It's here, but it's somewhere in that mess of-- I didn't even understand that that is what

was happening. And many users don't understand that that whole unwrapped paper is actually just the surrounding, and your model is inside.

So in order to avoid any confusion in the future, we now focus on the main object, so the reconstruction will look like this, instead of having all the surrounding around you. But it will be an option, so if you're somebody who needs the surrounding still, you don't have to crop it to get the cropped version.

Another thing that users had a little bit of trouble was the manual stitch survey points. Sometimes, it was not clear, or the points would disappear and stuff. There was a little bit more work on our side to do. And our really talented designers now have come with a solution that we really hope will work well, where, while you're putting the points for manual stitch or survey points, you're getting the menu of, oh, what do you want to do? Do you want it to be a survey point, do you want to measure, et cetera? So we hope that it will be much better.

And through projects that we're personally involved in, like the Egyptian mummy, we uncovered that, while we really had good textures, they were not good enough. On the left side is how it used to be, and thanks to the Mummy Project, we've realized that we have to improve the texture. And now we can read every single hieroglyph and writing on the mummies, which is fantastic. All of these new things will come soon. They're not in the current version, but very, very soon.

Now, you don't have to capture only things that exist. You can capture things that don't exist anymore. Now, you must be thinking that I've been drinking when I say that, but I really have not. These are the Bamiyan Buddhas that were bombed by the Taliban in Afghanistan, and this is what's left, gone forever. No documentation, nothing.

Well, actually there is a documentation. And we all made it together. Anybody who has ever been there, and taken a photo as a tourist and uploaded it to Flicker has participated in the creation of a documentation for this Buddha. And all we do, is download the photos. Of course, it won't be as perfect as laser, and of course, it won't be as perfect as if you consciously took the photos of this. But hey, we've reconstructed something that doesn't exist anymore. And that's quite amazing.

I have to speed up, because, oh my god, I have so much more to tell you. So now we captured the reality. We captured it with lasers. We captured it with photos. And now we can go in two directions. Either we will use it digitally for a new digital reality, or publish it on the

web, use it in Maya, Mudbox, whatever, games and movies, or we can recreate it in a physical environment.

Now, that last mile, between capture it, and then prepare it to be useful for other places is actually quite long, and this is the shortest one. There are many other workflows that are even more fascinating than this one, but basically, you usually need five, six, seven different types of software to really make it the way it would be useful for publishing digitally or for fabrication. Second problem is that reality capture data, when you want to convert them to a 3D model, produce a huge model. They are so dense, those meshes, that the memory becomes a bottleneck. So soon there will be meshes that are significantly bigger than the available system memory on the machine.

And finally, because we realize that reality capture will be very interesting for many professionals who are not in the CAD world, do not understand 3D very well, we wanted to create a tool that will be able to be used by other professionals, like curators and conservators, who are not geeks like us who know technology a lot. So we decided to make Memento. Memento is a new product. We launched it softly on the labs shyly, because we have big aspirations for this product, and I was like, no, wait, wait. We need to make more in order to show it first.

But what Memento is, and who is it for? It'll be an end-to-end solution, from reality capture input to high-quality output. It'll be agnostic to input. We are, today, supporting meshes created from photos, or from scans, or from CT scans, but we would like you to be able to start with the mesh, to start with the scan, to start with the CT scan in the software, create a mesh. And then, we have a streaming mesh engine that can read these huge meshes that, today, are really a big trouble to be read in any of the existing software that has been done for something else. It's a software done for 3D modeling, or for mechanical engineer for something. None of the softwares that are currently used in these workflows have been designed with reality capture data in mind.

This is the first tool that was started from scratch, using some of the knowledge of Ryan Schmidt, who is our guru in the research group, and who has made Meshmixer, to make this tool that will be preparing huge meshes for publishing digitally or physically. And here are just some of the captures on the left side, and now, you can see the density of the mesh in Memento of whatever's showing.

So here is what we have currently in Memento. We keep a very clean UI, as you can see. It's a tool that will only have the tools that you need for editing this data. You're not going to get thousands of buttons, and anybody can use it, after five minutes of showing.

So we open my horse, that I just exported from Recap Photo, and here is that messy scene. The first thing that we wanted to do is, OK, where is x, y, z? Where is up and down? It's confusing. We don't want people to have to understand a coordinate system, so we just ask, hey, where is the sky?

You click on one horizontal surface, the sky is up, and my scene is all set. Now it feels comfortable to move around. The next thing I would like to do here is to actually-- so I'm feeling happy about this and now, I'm going to need to clean up, first, the mess around. For that, I just need to select the area that I want to keep, right click, and we have just four or five tools, and the one is, Clean Up the Mess.

So we're cleaning up the mess. Depending on the size, it will be a little bit of time, but usually it's-- this is real-time. It's not sped up, this video. I'm always being very honest when I speed up something. This is live, and would have actually gladly demonstrated everything live, had I not wanted to show you too many things at the same time.

We have various tools for selecting and cleaning up the data. Almost every reality capture model will result with a hole on the bottom, because, obviously, you're not under the ground to scan it. So we made a special tool how to just cut and cap it, so I don't have to figure out how to close it, in order to then 3D print, for example, this model.

So I select it, and just right-click can say, cap it. And again, depending on the size of the model, you'll get the result very quickly, or you'll wait just a little bit, and this is now fixed and cleaned. But it's fixed and cleaned in all the mistakes that I could see. But there are lots of mistakes in these models, and holes, and tunnels, and particles that will be a problem for 3D printing, or when you bring it in, in a web browser, et cetera.

So we made a tool, and by the way, I'm switching here to mesh just so you can see how dense, actually, this mesh that comes from Recap Photo is. This is unbelievably beautiful, and really detailed. And I'm really angry that my horse is not here, because we forgot to bring it. But I had the printout to show you.

But most importantly, we now made a tool that can find all the hidden mistakes. It's a Mesh

Analyzer Tool, I just clicked on the top, detects issues and it gives me report, huh, you have-- I cannot read this now-- four mistakes, couple of holes, couple of particles. I say, show me. Oh, fix it. Show me again, next one. Oh, that one? Fix it.

And it just rotates, and I say, fix it. If I don't like it to be fixed automatically, I can reach to the menu of tools, and then smoothen it up, et cetera. So this is unbelievably fast, unbelievably powerful, and nobody has done it in such an easy way to be used. And then you can save those models in different formats-- at the moment, OBJ and SDL-- and use it further. After this, you can immediately 3D print is as-is. I have to speed up.

OK. If you're interested in this tool, it's called Memento, Project Memento. It's on Autodesk Labs. What's next in Project Memento? I actually wanted to show that live, and I hope I, oh my God. OK, we need to switch. OK. God help me with live software. OK.

So what we're announcing new is that we can now create meshes from scans. We could not do that in Autodesk until now. So for that, we have now a new button, it say Create. But let me just expand this. And that is under Datasets, here is the [INAUDIBLE]. By the way, I have rock stars developers, both in France, as well as in Singapore. And they have sweated a lot to make this happen so I can show it to you. And I really hope I will not disappoint them.

So what are we doing here? I am opening a already-registered scan that we registered in Recap Pro. So we're now finding the scan files. Hm. It's not showing the preview. Yeah. So here are the registered scans. Look at this beauty. These are scans that [? register ?] and stuff. Eight scans found. I have now possibility to create a mesh. This is a cloud service that we reach from Memento.

And I can pick to do it in basic, high, or best view. There will be also information on how long will this take, and I say, Create Mesh. What will happen now, first, the software will be really uploading this to the cloud. Now, this is sped up, of course, because otherwise, we will be sitting here for hours, depending on how big a scene, and how many scans you had. But it's uploading the scans to the cloud, and it's calculating the mesh. It's triangulating between all the points there. And it's spitting back to me a 3D mesh model that is unbelievably beautiful, and that Memento can read, which is very important, because those meshes are just so huge.

So you have, also, fun to learn how it's really done. It will basically load scan by scan, as they were taken, and you can see the people who are actually scanning, where they were putting the scan, and what was that scan capturing. So this is not only fun to watch. You are learning

about stuff. And this will take a while. I will have to stop, because I will have some more stuff to show you.

I'm stopping this one. I'll just show you how the results would look like. OK, so I'll open-- Sorry. My machine is confused now. OK, I will just keep this. Oh, come on. Are you going to kill this? Ah, it doesn't want to kill it. Sorry. Hey, that's the beauty of presenting live, right?

But I will show you, because it's important-- OK. So I'll open-- OK. So this is the mesh. And just to show you that it's really a mesh. It's beautiful.

OK. So I need to go back there now. So we have another tool in the new release that is fantastic. It's for bridging holes that are 3D. I unfortunately don't have time to show you that live now. But there are some holes that-- if a hole has not been just on one surface, but it goes on two planes, it was a problem to fix it automatically. And now we have phenomenally good bridge tool that does this. So skin to mesh for the first in Autodesk.

And then I said we can use reality capture to creating a new physical reality. This is that horse that I showed you. It came directly from Memento, printed in Object 3D Printer, unbelievably beautiful.

Here I wanted to cover, actually, Cosmo Wenman, who is a guy who started to use 123D Catch, loves art, and started making these replicas. But not only he makes these replicas with the MakerBot, which means producing them so small. No. He makes them this big by making parts and then assembling them together. And he invented a method to use 3D printing to make actual lost wax casting method, where he makes them part out bronze, which is unheard of.

When you ask him why is he doing it, he said, I'm doing this because I want to make my mark in the art history, and I want to approach art to everybody. He's sharing his files for free. His name is Cosmo Wenman. And next week, he will be publicly sharing the first high-quality 3D service of the *Venus de Milo* and the *Winged Victory* that he just scanned in-- actually photogrammetrized-- in Switzerland.

Oh, my God. I am a little bit late, but I really want to finish with two things. One is, all of these is interesting also from another aspect. All this means that we, maybe, can design the future a little bit differently. Jeff Kowalski was talking a little bit about this today, but imagine this scenario.

You take photos. You go to Memento, you make the mesh, you fit it, you clean it, but it's still kind of a messy mesh. And then you, go to Mudbox, and Mudbox makes a little smarter quads out of it. And then you go to Fusion, translate those quads into T-Splines and now you can change it. So this is, basically, why start from scratch when you can start from something you like, and you just improve it and change it.

Try it. All of that is possible today, as well. I will finish with something that I'm very proud of. We announced, three weeks ago, a beautiful project that we did with the Smithsonian Museums.

For those of you who don't know Smithsonian, it's one of the biggest group of museums. Seriously amazing. 17 museums, mainly in DC, but also in New York. They have 134 million objects that they wanted to share with the world. They wanted everybody who will never go to the museum to be able to experience them. But also, those of us who do go to museums, we only see 1% of their collection, because there are not enough buildings to cover everything that they have.

So they had this desire to be able to share, and to offer new ways of learning about science, and culture, and art, and our past. So they have a couple of smart cookies, Vince and Adam, Vince Rossi, Adam Metallo, and Gunter Waibel at the Digitization Office, who knew what's going on in the technology world, and started early efforts to digitize stuff. Then they approached us, and we did something amazingly beautiful.

Now, sadly, I will not be able to show it to you live because of time, so I have to run this video. But basically, we created a website called The Smithsonian X 3D that has, for the moment, 21 sample objects that are fully digitized that you can experience live. You can touch them, feel them. We joke that this is the end of the "No Touch" in museums, because now you can experience them from home or in your classroom. Open, learn from it.

The tool that we made specifically for them, called The Explorer, allows curators who, until yesterday, were only using email and apologizing that they don't know anything about technology, create tours that you can follow. Or if you want experience yourself and explore, you can measure, you can-- In this case, I was changing the [INAUDIBLE] maps. You can explore them in a deep level, change the surroundings, section through, et cetera. It is a beautiful, beautiful new world.

The software would have never looked like this if we didn't actually work with the Smithsonian.

And it has a lot of potential for something in the future that I hope you will see. This is the Wright's Flyer, an iconic object. And just go yourself, and check it out. Again, show it to your kids.

The website is www.3d.si.edu. You have gorgeous Buddha, who, by the way this Buddha, the curator could not see that relief because it was very flat in real life, and once we digitized it and applied that map, he could actually read the stories of the Buddha on this sculpture. So there is amazing empowerment of curators, of museums, scientists, to present the stories, but also for them to do their research better. There are hot spots that they can assign so you can learn about the walking leg of a crab.

And this is a beautiful model of the Wright's Flyer. You can compare the two life masks of Abraham Lincoln, and then share with your friends. Most importantly, they allow you to download any of these models so you can 3D print them, or you can cardboard them. Here is a 3D print of a whale. This is Nick, a paleontologist. This is Abraham Lincoln, 3D printed. And then, you can also take that 123D Make, and make a cardboard version of it, and have fun at home for Christmas.

Finally, this is also useful for conservationists. We did this sample. This is a Noguchi sculpture. Very expensive. It has a very difficult maintenance, because they have to exchange the light bulb, so they need to turn it around, but then everything falls down. And we made, first, the cardboard replica of the sculpture, but then, the negative of it for a custom crate with 123D Make. This is a custom crate that costed us $70. This is unheard of. And they're very excited to with that.

So to finish, there is rip, fix, burn. You can capture it, you can fix it, and you can burn it on a material. Or rip, fix, learn. Thank you very much. I'm so sorry that I'm always too late, too much.

[APPLAUSE]