CLAAS KUHNEN: OK. Hello, everybody. Welcome to Product Surfacing with T-Spline and Parametric Modeling Tools. My name is Claas Kuhnen. I teach industrial design at Wayne State in Detroit.

And a little bit about myself. I have my undergraduate degree in color design from Germany. I specialized in advanced color concepts for product design and graphic design. Always felt like these two are a nice match. And then, I decided I want to do something different, so I took two years, studied jewelry design and animation together. What I was always very interested in is just 3-D. I was always fascinated when I was already 14, like, everything I can do with 3-D programs.

So, as I mentioned I teach at Wayne State. I'm also a research assistant in the biomedical engineering department. And in my work, as well as my research, what we really tried to focus on is what type of tools, not programs, think about programs like tools-- are there outside. You can use. And put that together into a nice cohesive workflow.

So what I thought would be interesting for you to see is, maybe, what about showing those classes how you could use T-Splines, which, how many of you know T-Splines? I, for example, am an old Rhino user. So maybe we're used to making curved networks, surfacing, CV cage editing. And then there's Fusion, which doesn't provide you that ability, but it has a permanent timeline. And Fusion with T-Splines is kind of like T-spline, NURBS, kind of similar.

So what I would like to introduce you is to this idea of thinking about T-splines as NURBS cage editing, but inside Fusion with the parametric timeline. So we will focus a little bit about how you can use T-splines to create the NURBS surfaces. And I will also talk a little bit about proper topology and what are good workflows to maximize the quality you get with T-splines.

So the key learning is that, in the end, you can create T-splines for your sketches or primitives in a good way; sculpt T-spline surfaces with proper topology in your mind; how to use T-splines, then, together with the timeline, so you can do further manipulation; and understand what is the best practice, how to structure your design in the timeline; and for example, move data, also, from Fusion attributed to other programs, and bring the information back to T-splines, and then back into Fusion.

But before we continue, let's maybe compare NURBS and T-splines. Essentially, those are two very different ways you can generate geometry. There are a lot of similarities. Actually, all of

this, if you take photos, all the information is online as well, in a PDF you can download later.

If you compare these two, they're very precise. So NURBS is very precise. T-splines, the way how it works when we create the [? Breps ?] is very precise. So it's a nice match. For both, we can use the curvature graph to, for example, analyze the surface flows. Must be at full control.

And then the differences start to show up. So with NURBS, we're limited to four-sided patches. Somebody works in transportation design here? And you know, you can make hard bodies with Alias, but it's a lot, a lot of work to get them really perfect. With T-splines, however, you have, actually, the ability to sculpt with no limitation to the topology. The nice thing, what I really love about T-splines is, like with NURBS, I can insert more geometry at a certain point, and it maintains exactly the same surface. It doesn't change it. Well, with traditional subD modeling, it will change.

So if we summarize this, if you think about the advantage of NURBS, it's very lightweight. You have full control over the patch layout. But the disadvantage is it's very labor-intensive. And it also requires very good profiles. Otherwise, you will have very strong issues creating really nice surface flows. And then, if you then have to create an adjustment to the complicated surface patch, that's a lot of work.

On the other side, with T-splines, it's incredibly easy to sculpt. We're not limited to single NURBS patches, because it's just all one connected surface. So I can quite easily manipulate the surface just by pushing and pulling certain CVs. The disadvantage can be that the patch layout Fusion can generate later can be messy. But if you try to use T-splines in a good way, like NURBS likes to be used, then you actually have more control over the quality. So that disadvantage can actually be limited. And to achieve smoother curvature can also be a lot of work. But it's kind of the same, also, with NURBS.

So the conclusion of this is, basically, think about T-splines like a NURBS tool. So you can combine, basically, the best of both worlds. That means you have the precision of NURBS, but you have the easy manipulation of a [? subD ?] system. And in Fusion, because T-splines can be used inside the parametric timeline, you can manipulate the CV, sculpt nicely, and then Fusion creates for you automatically the NURBS surfaces, which, then, you can continue using for further design refinements.

Excited? OK, let's get started. I have a lot of demos prepared to simply show you some of the

workflows I show my students, which I also use inside my own practice. It's very heavily influenced the way how I actually work in Alias or Rhino with NURBS. But I found, if I take this mentality and apply that to T-splines, I didn't really use Rhino for a really long time anymore, because I can do everything right inside Fusion.

So Fusion, for example, this is a project I did with my students in furniture design. It is very great when you have to create something-- this looks rather simple. It's just a shell of its seat. But it's not flat. It's very bent. And that already to sculpt this just with NURBS will be a lot of work.

So the way, for example, you could start is, obviously, you create your sketches-- side profile, front profile, maybe a top view-- so you get an idea of how your design could look like. Also, these files, if you go to the course website, there is one download with all files I'm going to show today for you to use. I know we only have one hour, so I only can scratch on the surface. But I felt like, if I give you the finished files, then you can see everything I did and learn from it.

So creating the shell now with T-splines is actually an incredibly easy task. So all I have to do is create a T-spline feature inside the timeline. I can, for example, start with the plane. Then you maybe drag something out. Edit. Two edges too much. Then maybe I can select three edges-- left, right, and the back-- go to the Modify command.

For those who don't know T-splines, read the tooltip. It's very useful, because it tells you, if I drag this one up, it moves up. And then, if I hold the Alt key, I drag out the surfaces. Automatically, in the back, I have some creased edges. So I can actually soften these edges by uncreasing them.

And on the task, we'd basically go into Detail. Maybe I select the whole object, rotate it a little bit, move it into position. And then I could start-- maybe select this edge, pull it down a little bit. Select this whole row, move it up. So I apply typical NURBS ideas. So I overbuild and make the surfaces bigger, because I know, later, I will create another surface. And then I will split and trim everything. Maybe this point here, I will push a little bit back. Let's switch to the front view. Oh, these didn't move up together. So maybe to there. OK.

The nice thing, again, because this is like subD modeling, but it will later end up with a NURBS surface, I want to scale these two edges symmetrically apart. So instead of moving the left and then the right one, I simply select these two edges. I work with a symmetrical object. So I can make use of the Scale command and gently scale it into the position I want. Maybe let's take a

look from the top. Maybe here, these two I scale apart a little bit. So I use Scale, actually, very--

AUDIENCE: That very first part, where you got 90% of the shape right away?

CLAAS KUHNEN: Oh, of course. Sure. So this one. From here?

AUDIENCE: Yeah.

CLAAS KUHNEN: OK.

Fusion has a lot of the modeling commands-- for example, Extrude and such here-- listed. But when you also work with the Modify or the Edit Form command, and when you move something up, it just moves the object. But when you press and hold the Alt key, then actually, it extrudes these edges out.

AUDIENCE: Why is the center-- oh, so you're just grabbing the edges.

CLAAS KUHNEN: Yeah, yeah. Just the edges. Because with NURBS, you're limited to a sheet, where, with subD modeling or T-splines, you're not limited to it. So you can just build exactly the shape you want out of a single surface, which is kind of the beauty behind it.

So let's uncrease this one. I will quickly try to push it back into the shape I need. Say, there, there. OK, so let's say that's good.

Now the beauty of the timeline in Fusion together with T-splines is, when I click Finish Form, I'm now employing what I know from building animation characters, like polygon subD modeling. And then, if I click Finish Form, now Fusion generates NURBS surfaces for me. So it's a different type of geometry.

Now I have this side sketch here, which actually defines the front and the top profile in an arc. So you can create a sketch. And you could say, well, I could now, if I want to, go to the Patch Modes, select Extrude, select this one, and extrude it out. But I don't use, actually, this type of workflow. Even there, creating this flat surface, I use T-spline as well, because it gives me more control over sculpting the shapes. I'm not saying it's wrong to use sketch and extrude something out. But if you want to be able to sculpt the surface, then it's not really an optimal way.

So I will create another T-spline object, which is already one of the tips I can give you.

Currently, this is a very simple object. You could build everything inside one T-spline module. But if something becomes very dense, it makes sense to build individual T-spline modules or containers. Because every time, when you go into Edit mode and you leave it, it recalculates and reconverts the NURBS surface. And if you have everything in one container, it can slow down that process. If you break it up into smaller problems, then the computation time is much shorter.

So we'll create a new surface. In here, I also have traditional surfacing commands like Extrude, Revolve, or Sweep. For those who do not know T-splines-- so there are two interesting ways now how I can extrude this surface. I can extrude it out with an even spacing of topology. So let me best show you how this looks. So I can click on it, and then say Uniform. Let me drag this one out. And then you see it has a nice and uniform spacing of all of these faces. Or I could, for example, say, well, I rather would the topology to be adjusted so it matches more the input curve.

For me, the sketch I created is actually more a visual reference. I don't really care about the transition, because I would like to have more control over it. So I will here employ something. Like, coming from Alias, you build your primary surfaces. And then the secondary surface we create afterwards.

So when you have a sketch-- so the sketch I have has two lines and a fillet-- you can chain select all edges and extrude everything at once. Or I would simply say, well, this edge, and maybe this edge, those I would like to extrude with very slim faces. So single surfaces, move this one out, maybe go both directions. And also, here, I overbuild so it will be bigger than the shell's surface.

OK, so one thing that maybe is very tempting with T-splines when you're new it. You start sculpting, you start adding geometry and details because it's quite fun and very different. But that's always a recipe for disaster afterwards, because, like with NURBS, simplicity is really your best friend. It's like one of the biggest tips I can give you when you're serious about T-splines.

Always try to work with the least amount of control points to get the most of curvature out of what you want to build. Two reasons-- less points, less work. So it's an economical question. Also, more points, the NURBS surface T-splines will create can be more irregular. So you can help the conversion process by also really limiting the amount of geometry you throw, actually,

at the task of converting T-splines to NURBS.

So that's the reason why, now, I have two very basic surfaces. I could, for example, maybe select the basic Bridge command and bridge this edge to this edge, maybe with, let's say, two faces. OK, good. So there you see, now I have really nice and fluid transition.

Since I work a lot in surfacing-- for example, a G1 transition is, aesthetically, something for me, I really try to prevent. I really like very fluid flows. And specifically, in this case, I feel like creating the surface this way with a nice transition gives me a much more pleasing result.

For those who don't know about T-splines-- so right now, you only see the soft result. But essentially, that's the reason why I mentioned think about this, actually, like NURBS. So when you sculpt the CVs in NURBS, you actually sculpt a low-polygon cage. And we have the same here. So there's, for example, one edge. There's one edge. There is the other edge. Or if I go one step backwards, this is now the brute flat geometry. And T-splines, for me, smooths this one nicely out. So you can always switch between these two view modes. Sometimes, it's a lot easier, when you're with linear mode, to select some edges to see where they're positioned.

So let's say I would like to sculpt, actually, the flow of that surface a little bit more. So I have this edge selected. And now I can just move it around. Maybe I want to turn on the sketch, so I have my reference, so I know, maybe, where was my sketch, where do I want my surface to be? And you see, one of the problems I start running into-- the more I push this point to a lower-right direction, the more my surface starts to really arc.

So one technique that, for example, can really help in this case is these two surfaces I'm selecting here right now, they need one additional loop cut. And T-splines, again, works very much like a NURBS surface. When you have points closer together or in a line, you start straightening or pinching the surface. So I could go ahead and, with the Insert Edge, maybe select this edge, move this one to the other side and say, at this position, maybe I would like to have an edge inserted. And I can do this one more time. Maybe there. Slide this one back. And if I take a look at this now, there you can see that, actually, from the right, the surface is nice and flat, then it bends, and then becomes nice and straight again.

Any questions so far? Makes sense? So you see, it's actually-- you have two ways. You can work with a sketch which you have to manipulate. And then you always generate the surface out of it. And with T-spline, you simply build the surface, and you manipulate the CVs or the edges. And you can sculpt it directly.

So the nice part, as I mentioned, if I now, again, click the Finish Form, now we have, actually, two surfaces that intersect. So this is basically now when the real fun really starts. So I could go ahead and, let's say, thicken this shell. Oh, we have millimeters. Let's say 2 centimeters. And now this shell, or that solid I can use and split by that other surface I created.

So there we are. So really nice the way how it works. And because, again, this is all parametric-- this is not the way how, maybe, an engineer thinks about parametric. It's not sketch-driven. But I'm using T-splines to sculpt my surfaces. And I use these surfaces to do surface-to-surface or surface-to-volume calculations. So that means, if I go back and say, nah, I don't really like the way how this one flows-- it's maybe too flat. I would like to take this edge and maybe pull this. So let's say we go a little bit more like there. OK, Finish Form, and it's updated.

So we have altered this opening there. Another thing that's really nice with this type of geometry modeling, you can work with global space. And in T-spline, the next one is called local space. Different word, maybe for those who are familiar with subD modeling, like normal orientation.

So I can create another T-spline container. And I start doing the same. Create a basic face. And let me hide all this. First, [? I'm going to ?] extrude this one out a little bit. Can select a face, and if it's possible, you can simply press Delete, and the face, then, is gone. So now I have a nice tube.

And this geometry, now I can select and move, maybe, to there, this area. So it's a little bit important that you really know the shape you want to model. Also, doing some sketches at the beginning can really help, so you understand what you're dealing with, where you have to position these parts. Because it's not sketch-driven. So you need to visualize a little bit where you want to be, so you can structure your modeling steps efficiently.

And inside the Edit Form command, here, you have coordinate space. So currently, I'm in this world space, or global. And I can switch to the local one. And if, let's say, I select only this face, and I select this face, I can scale them along-- or not. Oh. Should actually work with scaling, call it. Well-- Or other demo.

I can just move this face exactly along its own orientation, so I don't deal with move up, move left, or try to hit the right angle. I can rope my object, and then select a face. And then,

because each face has a normal, I simply say, well, move this face along the normal direction. So it's a nice geometry helper for precisely manipulating these parts.

So maybe, let's go to the front view, there and there, bring those together. So you see, I want to create a symmetrical object, so I don't work on the left side and then I'm going to work on the right side. I always try to have symmetrical geometry so I can select opposite parts, and then I just scale or move them together. This is a huge time-saver, because nothing is more annoying than moving individual parts, and then you have to match them later. Or you use the Mirror command, which you could use as well. Then you only have to deal with one side.

So let's finish the form. And then we could exactly do the same again. We go Split Body. This body, I would like to split by this surface. And there, now we have the opening.

So then, if I go back to this file, this is pretty much, then, the way how everything was created. So all the geometry you see here, besides the pipe, is all actually sculpted. And it literally took me a few minutes to build this type of a chair. Now I'm not saying that this is superior to other modeling approaches. But if you want to sculpt more, this is a really fast way to do it. And because it's all inside the parametric timeline, it's not you're giving up control. You just generate your geometry through a different method. So actually quite nice.

Then you see, then, edges, they can be filleted. Because after you leave the timeline, you deal with B-reps. So everything you know about solid modeling or surface modeling can then be applied to it.

AUDIENCE: What'd you use to have the maps to the bottom of the chair?

CLAAS KUHNEN: Sir?

AUDIENCE: How'd you add the mounts to the bottom of the chair? [? Still could-- ?]

CLAAS KUHNEN: Those?

AUDIENCE: Yeah.

CLAAS KUHNEN: Let's-- OK. Well, let's go back. This is all my input geometry. Great you brought this up. If you learn Alias, in the tutorials, there's one thing they tell you-- hard-edge models, really block out basic geometry, and don't really get distracted by details, for example, like edge roundings, et cetera. So you see here, I built the very basic proportions I only need. And then edge

roundings, transitions, that I actually, then, later do with the fillet commands.

I could, for example, model, also, here the transition from this surface to this surface in T-splines. But it's actually a lot easier to simply say, well, I can later use the fillet command. So why would I spend time on modeling it? Because when you're using the Fillet command, you can always adjust the radius afterwards. So it's kind of like you use the best of both two worlds.

OK. Any questions? Yeah.

AUDIENCE: Did you connect those points to your T-spline? Are they actually [? connecting? ?] Did you do a bridge or anything to actually make it one model, or are they separate models? So we're talking about your [? connecting parts? ?]

CLAAS KUHNEN: Ah, OK. Good. Sorry, I didn't explain this properly. So this is all the basic geometry. Let me go back, even, to the beginning. So there's just my shell. I use [? these containers ?] to really structure, sometimes, logically, what do I put into it? So here, it made sense. I only put everything in that will generate the surfaces for the shell.

Because another thing is you can also, because it's a timeline, the cool stuff is you can have, let's say, one container with the seat. And then I have two containers with the surface that's split, and maybe have two different variations. And then via suppressing in T-spline, I can turn the visibility of the one surface off. So you can even have different design ideas inside your timeline.

One step further. Oh, that's it, upholstery. Then there are all the different parts. I think the next one, they're all the caps. So even here, I didn't model the surface close, because that later, then, I do it with the Patch command and just perfectly fill it.

So when you work with T-splines, don't try to force everything into it. Really try to see, where is it best applied to? What really makes sense? Where does it save time, give me also more control? And where can I use other surface or solid modeling in a more efficient way?

And then, I think, till there, I started splitting, actually, the shell. Then I started stitching all these parts together. You also can see in the timeline how I structure all the different features. I find this, for me, very good, because sometimes, I come back a semester or two semesters, show a student. And if I have everywhere features in no noticeable visual order, I would have to go through all the steps to understand how I built it.

And when you group these tasks, it's very easy to understand, oh, this is where I did this, this is where I did all the extrusion, this is where I stitched everything. So a small tip for yourself, try to see what can you do in what order, also part by part, so when you come back, it's always easy to understand how you actually constructed something.

And here, I start, now, stitching and filleting these parts together. And then, at the end, I start doing all the solid commands. I think those here at the end. Yeah. Actually, the gliders are solid. And then I put the pipe into it, and then said, well, take the volume of the pipe and cut it out of the glide. So I don't build the negative space. I simply later calculate it on the fly. Because it could easily be that I have to change the pipe diameter. And then I would have to rebuild the glider. So I always try to minimize unnecessary tasks. It was basically the same done with here-- built them separately, fused them together, and then I rounded the edges.

AUDIENCE: So then using this, there's no join or [? going anything ?] or anything like that? You said stitching [INAUDIBLE]?

CLAAS KUHNEN: Well, the solid combine is basically-- oh, you mean like stitching in T-splines?

AUDIENCE: Yeah.

AUDIENCE: Right, just a bit of confusion around what's happening. If you start with a T-spline model, and you save, and you export it out-- when Claas is moving in and out of the T-spline sculptor, when he converts it to finished, if it's a watertight solid-- the T-spline's a watertight solid, it will convert it to a solid B-rep, so that a system will consider it to be a solid B-rep. And then you can any of the model surface modeling or solid modeling tools. If it has a hole in it, it's considered a surface. And then all the surfacing tools would work. So when he creates the tubes or the connection points, they are cylinders, technically, and they come over as an open surface. And then he uses the commands to stitch them up like he would any other surface that's not stitched before you convert it to a solid.

Once it's converted to a solid, then you can use any of the other surface tools or solid modeling tools that he needs to in order to finish up the model.

AUDIENCE: When you take a model out of this and you use it in a 3D engine, add them to the respective group-- I have problems with Rhino sometimes, when I need to use the software, in the groups all the respective groups, and things just fall apart easily with moving around.

CLAAS KUHNEN: Can you rephrase the question?

AUDIENCE: Like, when you have a bunch of unstitched surfaces, and then you try to move them, and then they break apart because they're not related to each other there--

CLAAS KUHNEN: Yeah. You don't really want-- well, essentially, if you want to move something, then-- so let's say I go back to here, and I want to move the shell. Essentially, you either select all surfaces that are not stitched yet, and then you move it, or you stitch it all together. Or in this case here, I created the solid, and then I [? solid-combined ?] the posts. And then the end result-- that end, for example, I can move Surface Select, the Move command, and maybe this one, and then just move it away. You can see it just moves the complete object.

That's another nice part about the timeline here. It really shows you visually how did you you approach your design. And you can just always go forward and backwards. Yeah.

AUDIENCE: Maybe, how compatible is this geometry with, let's say, if you download it to Alias? Could you export this geometry out, and it would remain the same in terms of your patches?

CLAAS KUHNEN: Yeah. Yeah. So you just go Export, STEP. And then you see, actually-- so this would be one patch, this would be one patch, this would be one patch. Yeah.

AUDIENCE: And it converts it to a NURBS?

CLAAS KUHNEN: Yeah, you can export it as STEP, and then into Alias or Rhino, load it in. I work primarily between Fusion, Alias, and Blender. So we move the data a lot between them. There's really no issue.

AUDIENCE: [INAUDIBLE].

CLAAS KUHNEN: I don't know if they--

AUDIENCE: Oh, here it is. I see-- the translator [INAUDIBLE].

CLAAS KUHNEN: Ah, it could be. I always export from the app.

AUDIENCE: Yeah.

CLAAS KUHNEN: But the STEP file always works perfect.

AUDIENCE: So we have two ways of doing exporting. Hey, Matt.

AUDIENCE: Hey.

AUDIENCE: We have two ways of doing exporting. Because one of the reasons that we were able to get Fusion running on Mac and on Windows was because we took a lot of the things, like exporting tools, that were not available on OS X, and we put them in the cloud instead of making Mac versions of them. So if you go to your A360 account--

AUDIENCE: Now it's not A360. It's Fusion.

AUDIENCE: Team.

AUDIENCE: Fusion Team, thank you. If you go to your Fusion Team account, then there's another exporter. That exporter runs in the cloud, so you'll have a lot more options, because you'll have other ones that are not available on the desktop if you're running [? Mac OS X. ?] And I believe we have a .wire exporter on there, too, so you actually can export it as a wire file. I know you can also import it as a wire file.

AUDIENCE: Oh, yeah.

AUDIENCE: And then taking wire files, [INAUDIBLE].

CLAAS KUHNEN: The way how I structure this demo, I think it's important for you to understand also that, primarily, my job is teaching. And I teach in industrial design. So for me, the biggest requirement is my students can quickly explore ideas. So the way how I even structure how to approach something inside Fusion is less about-- later, the engineer will do it differently, because the design could even have to be redone. So when you see the timeline, it would say, well, this is not really later for manufacturing they way we'd do it. The main reason is everything I show you here right now is actually for the explorative phase.

And I have two other demo files I would like to show you. So this is another exercise I did with my students. Sometimes there's also a skill-building exercise I do with them where we take a piece and we try to rebuild it, teach them a lot about, actually, the details of a product and how to do it. So this is a very basic Pantene bottle.

And also, here, I followed the same methodology. So let's turn this one on. So it's a very basic surface and extrusion. Then, for example, I refined it. So here at the top, I extruded more out, added more loop cuts so I can bend the surface, sculpt it nicely. Did anybody go to the

ReMake-- Autodesk ReMake? This is terrific when you have full models, and you make a scan of it and bring it in as a blueprint. Because then you can sculpt over it. It's really great, by the way, as a tip. Sketches and profiles in 2D are great, but they're not 3D. But if you make something on the foam, you can touch it, you can digitize it, put it in, sculpt over it. Works perfect.

And then, for example, here, now I started building all the different parts. I broke those up into different T-spline objects so you can see the different steps I'm doing. That's the main reason what's there. And then I combine it with traditional surfacing, like creating the loft at the neck. For example, I would like to sculpt the sides.

So also here, again, I start with a very basic surface, nice and flat. It's always a good way, when you start working with T-splines, really start simple. You can always add details afterwards, because it makes it a lot easier work on basic proportions, and then, step by step, put details in. Go one step further. And you see, for example, there, the result. I added some more loop cuts, one on the bottom, the center. And then, to create this nice curve, I started just push and pull these points and create really nice, fluid shapes.

And then this resulting NURBS surface, when I leave the T-spline environment. Again, then I can use with the Mirror command, so it's mirrored over. And again, if I go in and adjust one point-- let's maybe give an idea. Let's quickly push this one to there, and I Finish Form. You see the other part mirrors that. So it's super interactive. There's no double work you have to do. And I would have to show, actually, this object there. Then I start trimming all these parts. So I end up with this result.

And even here, again, if I go back and say, well, this is my finished part. Let's maybe go to here. I would like to adjust this flow. I could go back to the T-spline object, select, maybe, this point, push it a little bit more inwards. And there was a little warning. A fillet broke somewhere. But you see, then, it got completely updated.

Pay attention to how many features I have inside my timeline. I'm going to show you, now, the amount of work you would have to do when you do this with pure NURBS-- so like Rhino. Nothing against Rhino, I'm just trying to show you, like, process-wise.

So this is it. So there's really, really a lot. But the thing is I have the same outcome. The only question is, how much time do you want to spend on it?

AUDIENCE: So yeah. My question-- and this may relate to [INAUDIBLE]-- if you make multiple T-splines in the same form, as soon as you finish the form, does it become one solid, or does each T-spline get its own model?

CLAAS KUHNEN: If you have one sphere, and you offset the surface, and you leave the T-spline environment, you end up with two surfaces.

AUDIENCE: OK.

AUDIENCE: Again, this shouldn't be general, make one, only one surface for one object, whatever--

CLAAS KUHNEN: Well, let's say you have a sphere, and you offset it. And then you export, and you have two surfaces. And then you could say, well, take the inner surface and remove it out of-- so the inner sphere, remove out of the bigger sphere. And then you have a sphere with a thickness. Yeah.

What you actually set-- let me go back to-- I think, let me see where I did this. This was here, yeah. So here I have one surface. The nice thing about T-spline is, also, you can join parts together. Now with NURBS, it's called stitching. And with polygon or subD modeling, it's most times called welding. You take two points, and when they touch the same point, you just glue them together. So for example, let's say I select this edge. I go to Modify, and then Unweld. OK, now we see there's a nice, sharp crease.

And this surface, I, for example, can select and move away. So I disconnect it. Like, I use a scissor, I cut it off. I can always, later, just glue it back together. That's kind of what I meant. That's really the beauty of subD modeling with T-splines, so you're not restricted to any topology. You're very free with the way how you can work. And if I finish the form, now we see here, I end up with an individual surface.

So it's really up to you how you structure your T-spline model. I can just all weld it together, all these separate parts. And for me-- let me quickly undo this step. So I selected this surface. Then I went to the Thicken command. With the Thickness command, you can give a surface a thickness. That makes sense-- Thicken.

But for those who don't know it, or are looking for the Offset command, that's actually also the Offset command. Because when you thicken it, you have the ability to have sharp edges, soft edges-- for example, great when you want to do upholstery. Then you make a surface, extrude it out, and you get nice, round edges. Or you go with no edges, and you end up with

two surfaces, which is then your surface offset.

Any questions? OK. So let me go to this. No, actually, let's go back to this one first. This one has another interesting combination of how you can harness your creativity and really channel it perfectly by using the right tool to create the geometry. So don't think it has to be done this way. Really think, what makes the most sense, where I'm the most productive with?

So if I turn this one on, let's rotate the view. So here, you can see, I modeled all the surfaces. The shelling is there. It has the thickness. The cap doesn't have a live hinge in it, but as you can see, I tried to also build all the intersecting parts.

And the way how I structured everything, let me show you the sketch. So everywhere where I needed perfect precision-- and I know with injection molding, these two sides will be half and half and then fused together. It's not really a perfect cylinder. But let's assume you want to have a really nice perfect cylinder. Or the bottle itself can be very organic. So I find it makes sense to sculpt the vessel. And then there, we have cylindrical parts. And then, actually, I switch to solid modeling. So that's the reason why I created all these sketches that will define, actually, the parts.

So let's go back in the timeline a little bit. Let's go one further to here, I think. Yeah. OK.

So for example, this surface which I'm selecting here was very difficult, because it's not a sphere. If this would be just part of a dome, I could've just created a sphere, cut the sphere, shell it, easy-peasy. But this is more an ellipse. I can't really create this with a geometrical primitive. Surfacing that with NURBS is possible, but would require me making complicated sketches and way too much time.

And I find it a lot easier to simply create a very basic input surface. There we can see it, now, better. There you can see the wireframe. So I have a certain amount of edges. So I have exactly the control to bend it nicely. And then the central points or edges I pulled up to nicely dome it. And then, this I then created into the NURBS surface.

For example, here, the Shelling command-- or in my case, I used the Thicken command here. I have the T-spline input surface. And in the timeline, I create the thickness. It's other tip. You have the Shelling command built in into T-spline. But when you want, later, to always create a wall thickness, don't do this inside T-spline. Do that inside the parametric timeline. Because I can always go back to the T-spline object, adjust the geometry, finish the form, and then the

Thicken feature creates the new offset surface for me.

And so you can see here, I start then extruding, actually, the rings for the tubes out. And that's, again, very typical solid modeling. You can see, I extrude the profile out. I extend it so it touches, actually, the dome geometry, and then terminate it, and it's joined to it.

I could have these cylinders also sculpted, with the top part being slightly arced so they'd fit the dome. But then, if I adjust the dome, I would have to readjust the cylinders. In that case, it was more common sense to just extrude and just project them right onto the dome surface.

So even for designs with packaging where you have internal surfaces, you can do everything with a traditional approach, with sketches. Or if it's possible, maybe take a look at creating basic surfaces, sculpt it with T-splines, and then use the Shell command to create all the thicknesses. And then, with the solid combine, you can join all of these parts back together.

So I must have changed something. Sorry for that. So let me-- there's one last thing inside this file I would like to show you. Let me turn this one off, there and there.

So you see, I also used the Group command very often to logically block parts together. Everybody who knows [? stipulate. ?] I'm not applying rule number one. The main reason why I'm doing that here, again, I'm just quickly only exploring ideas. If this really would go for building, then I would approach it differently. So if you see my timeline, keep that in mind. This is really more for my students to teach them how to surface something. OK, so there it is.

Because the cap has a flat part. And then the second cap, as you can see, also has a thumb part. And then, even here from the side, you see this is nicely arced. So it looks very simple, but those can be very tricky, tricky tasks to build. But again, using T-splines here was very, very easy.

AUDIENCE: Is that hole in the corner purposely made?

CLAAS KUHNEN: The hole in the corner, there?

AUDIENCE: For water, I guess. Oh, yeah.

CLAAS KUHNEN: There? Yeah. Purposely for fluid to flow down, I assume. Which I don't know why I did it there, because this is actually not the highest point. But it was in the reference model, so I put it in here.

Colin, do you have an idea of why the points don't show up right now? Any idea? Shoot.

OK. Let's go to this one. Are you guys familiar with proportional editing? So for those who are not, so you see this? Actually a nice, nice arc. And you have two ways how to build this. You select points and point to move them up the way how you want. Or you use proportional editing, or in some other programs, they call it Magnetic Tool. Basically, you have a center, and you pull something. And to the edge, you have a [? falloff. ?] And you can say it's linear, it's a dome, or it's a sharp transition.

So the way how I sculpted it, actually, with this really nice, beautiful transition was simply-- maybe I will just select this point and this point just as some demo. And you have here in Fusion, I call it Soft Modification. If you activate it, you have three patterns-- everything grows like a circle, everything grows like a line, or everything grows like a square. And basically, when I mean grow, it grows the selection-- like, how many of the neighbor points do you select?

So when I have this point, and I need to select this point. And then, if I push this one down, maybe go-- oh, I used the wrong orientation. Yeah. My fault. Sorry. So let's turn this one on, pull this one down. And let's maybe turn this one to this way or this way. You can see that, actually, it's smooths the transition differently. So those transitions can be very easily modeled by just using the Soft Modification.

So I'm going to go back. I have to go back, I think, to here. Yeah. So the tricky task was not to figure out-- well, when I have these surfaces, how do I actually create the material thickness with this front part cut out? And again, because at the time, it's so nice you can explore different strategies. If it doesn't work out well, you just delete the features, go back, and restart. Or you can maybe move these features around. So it's a really nice, nice way. It's better than just undo and redo.

So what I did was, actually, I kept the top and the bottom. Then I stitched these NURBS surfaces together, because now I have a volume, the solid. With the surface, which I also created via T-splines to sculpt it, then I have, actually, the ability to split these parts off, as you can see.

Is everybody familiar with the Remove command in the timeline with Fusion? Somebody who doesn't? So there are two ways of delete. You can delete, but then it's really gone. It's really out of your design. But with the Remove command, it's kind of like hide, but it's just temporarily

gone. So when you go to an object, and you say right-click, Remove, it simply takes it out of the timeline. So this surface, for example, I don't need anymore. So via the Remove command, I just take it out.

And you see, it's a solid. And then, with the Shell command, you can thicken it. So it was a very easy task. You just sculpt the basic shape, make it solid, split it, and then shell it. Running out of time now. Yeah. I prepared way too much.

[LAUGHTER]

Give me three minutes. So I just want to show you some other examples what you can do with it, so you have an idea of what, really, the power of T-splines is. So this was another project. Marvin, a veteran, he had his own construction company. And they needed to design a box cutter. And he worked alone in roofing. And he always was upset about his knuckles. When he cuts, he needs to wear gloves. So he came up with this idea to build in a guard.

And keep in mind, Marvin is a lot older than I am. He's retired. And this is basically the design he came up with. And everybody who knows Alias or Rhino, and this is a Y-connection. You can understand how difficult that connection actually is. But with T-splines, it was really very, very easy to build.

This was a project I was involved in. All I needed to do, for example, was create a nice crease and bend it. So there, we used T-splines to create all the different surfaces, bent them, and then we just stitched it. Specifically, you see this is a sharp edge. So there, we used the creasing in T-splines to crease an edge. And then we put it to a solid, split the solid. And now we can always go back to the T-spline object, manipulate, and then recreate kind of the way how this edge is actually on the surface.

Yeah. Well, I have more to say, but we're out of time, unfortunately.

AUDIENCE: All of the parts are [INAUDIBLE] file?

CLAAS KUHNEN: All are in there. If somebody is familiar with Maya or Blender, there are also Blender files in it for those who are interested in it. Fusion doesn't have deformation tools, but it's not a problem. A lot of other programs have deformation tools. And the cool part about T-splines is you can start building something in T-spline, export it, load it into Blender, manipulate it, bend it, export it, bring it back in. And the awesome stuff is it fits right into the same position.

So my biggest tip would be, don't think about one program has to do everything. Really try to see what tools do you have-- tools in terms of programs, what do they offer? If one program has something that does something better, use it, and bring it back into Fusion. That's basically how we work in our department. And for me, it was always the biggest pain to see a student not being able to do a design because the software wasn't able to do it, or the student wasn't at that level to do it yet in the software. And just using a combination, yeah, it really works.

[APPLAUSE]