JAMES HERZING: All right so while you're doing that, I'm just going to do my quick spiel about the class. My name is James Herzing, I'm the Industry and Product Marketing Manager for the simulation portfolio. So pretty much everything simulation as well as a little bit of Inventor. Look how excited everybody gets. Another rule, you don't leave the class with one of those. Did everybody hear about? OK, don't leave the class with it, just drink it and throw it in the box.

All right, so let's get started here. Again, my name is James Herzing. I do lots of marketing, I do lots of simulation. It's a good time. Let's see here. What's this class all about? And unfortunately, I'm going to-- whoa-- have to stand by my computer a lot. So here's our staple thing. Everybody does simulation. They should do it early and often so they can reduce physical prototypes, blah, blah, blah, blah, blah. In this class we're going to be running through six different analyses in five different software packages. So when I started the class, I thought, you know, I'll just teach everyone how to use all the different software programs. But as I started doing that, I yet again realized that Autodesk loves to buy simulation software. And so we have about 82 solutions for any one analysis. So in addition to learning how to use it, I'm hopefully going to try and guide you more closely to what solution might work best for you. Don't hold me to it, it's not gospel, but it's good guidance. And it's with beer, so that's fun.

As you can see on the screen, there's our data set that we're going to be working with throughout the presentation. So like I said we're going to be doing a number of analyses and this is what we're doing. Linear stress and thermal inside of Fusion 360. We're also going to be doing a drop test and simulation mechanical, two different flavors of Moldflow for some injection molding fun, and a really sweet, saved it for last free surface flow in CFD. So we need to make sure that we don't break our keg. We need to keep the beer at the right temperature, we need to make sure it doesn't dent when we drop it, and we need to make sure that our flow is optimized.

Let's see, what else should you get out of this. Understand what simulation is right for you, and you should also understand that if you come see me after class, I can give you a sweet little sticker like this and you can come to a wonderful "thanks for being a simulation customer" event after the class, where you can continue to consume mass beverages.

Last but not least, if you could do me a favor and, let's say, tweet me a little bit. Tweet at adskSimulation or me at unproEng. Take pictures of the class, take pictures of the stuff you were given, do anything you want. I don't care, just put something on social so that my boss is happy with me, and then I can be done for the week, it'll be great. Let's see. If you have questions along the way, feel free to interrupt me. If I don't know the answer, I'll just tell you to ask me at the end of the class and I have all sorts of experts here that will. Or if it's going to sidetrack me too much, I'll say ask after. And then we're all going to want to go drink and so you won't ask, so we'll all win.

But think about how this ties back to your design as well. We don't all design kegs, because who does that. But you do design things that get dropped or that have thermal analyzes or that have stress, all sorts of different things. So think about how it ties back to you, and if you have questions about your particular analysis, let me know afterwards. I'll be around all week and I'm happy to talk to you.

So we're getting started here in Fusion 360. And so to start, we're going to be doing linear stress analysis. So to set up, we're going to be pulling on the tap handle, because you know it might have had a few beers and we're pulling it a little too hard. We don't want that thing to break, because then you don't get any more beverages. So you tug on it, it breaks. Well how do we test for that? Well we're using Fusion 360 to do that. So it was modeled and designed, everything in there. One click, you go over to the simulation environment and you can choose static stress out of all of these different analysis types.

So you can work left to right, just like, I think, all of our software, where you can define your materials, you can define your constraints and loads, all of that stuff. But the first step you pretty much always do when you're analyzing something is you're going to simplify your model. You need to suppress some of the parts, like the ice water keeping the keg cold. You don't need that in linear stress. The tub, not really worried about that. Mostly just the tap and the keg that it's connected to. So you can see that over here in the model tree, you just uncheck these little boxes and away the parts go. And so now we're all set to start our analysis.

So again, working left to right, we can define our materials and constraints. I also am hiding the bee in this one, because I guess the keg is empty and that's why we're angrily tugging on the handle. So here we go. Material study, and you can see everything already has material defined there, probably because I had already set this up at least one other time. By default, I believe that all of the materials in Fusion are going to be set to steel anyways. So you're at least going to have something in there. But again, garbage in, garbage out. If you don't have what it's actually created out of, you're not going to have accurate results.

So we're going to go ahead and define pretty much all of this to be stainless steel. And I think I'm going to go with a plastic for my tap handle. Let's see what I decided to do. Wow that's a lot of materials. So there we go, we have stainless. All right, we're going to just assume that everything is stainless. Now I recall why that happened. So when you look at the tap handle, it kind of connects to the keg, and those parts are metal. That part that I'm tugging on, probably wood or plastic or something, but I'm not really concerned about that. I'm concerned about bending those parts that are now screwed in together. So everything's stainless, that's one of my many assumptions that I make throughout this.

So next we're going to apply boundary conditions. And I think in Fusion it's a lot easier than in some other of our packages. We just click on those surfaces, they're automatically defined here as fixed, and now you can see that little lock symbol, saying that those surfaces aren't going to move anywhere. Next we apply our load and we're going to say 50 pounds of force all tugged on that surface. And we're almost ready to analyze already, so super simple.

So next we're going to press the Contacts button. You do this, you click Generate, and it automatically creates all of your surface contacts for you. And so when we do this, I think I go into the screen to show you a little bit more. I do, good for me. You can see that everything is set to bonded. Well now you can't, but you could see that everything was set to bonded. And so by default, that means all of the parts are completely stuck together. You can change that around if you want, where you could define surface to surface contact where they could kind of slide across each other, or in theory, separate from each other, but you don't really want that in a linear analysis.

All right, so with that defined, we can take a look at the display. And when we do this, it's going to show us our degrees of freedom. I pretty much only use this to tell myself, did everything connect together when I designed it, because sometimes I'm a little hasty and my parts don't touch. So you can see it's all green, everything's connected together, so it's all fixed. So solving the analysis, I press Solve. Well you don't see the solve screen but that's fine. And here's my results. Factor of safety. You can't really see it here apparently, but it is 1.01, and that's pretty crummy. I mean maybe airplanes like that, but kegs do not.

So zooming in here, we're just going to hide some of our parts and try and understand where this stress is at. And so parts that we're concerned about, not very good, looking a little shady.

But OK, at least we know where the problem is. But you start looking at it and you say, well, James, that's a pretty crappy mesh. Right? Look at how pointy everything is. And if we turn on some of the-- oh, well let's look at the stress. We can see that it's pretty close for what stainless steel is going to fail at. But we're going to turn on some more parts and see that our mesh doesn't really match up very well. And as I rotate this around, look in all these gaps in there, that's not a very good design. And so everywhere that you see where these points come together, it's kind of causing some stress rising, and you're going to get some hot spots there.

So what do we do? We leave this and go back to meshing it again. And we're just going to refine it a little bit. Now I was lazy, and I just did a smaller global mesh size because it ran pretty quickly, it's a one year stress analysis, optimizing isn't all that important. So we're going to claim that this is the mesh screen, it might be a little different now. We put in a five, that means smaller. You know, it's smaller than 10, I guess, so that's good. We re-mesh it and we're back in our results. So we still stayed in the same area, we didn't have to change anything with the model to make it stronger. We're just re-meshing it to try and get more accurate results. And now you still can't see, but it's like 1.4 something for the factor of safety. Still probably not great, but it's a lot better. And it shows that it was just that junky mesh that really caused the problem.

So one test down, one analysis down, very easy. Heath! Don't leave with that. Thank you. Throw it somewhere, thanks. Again, stress-- Mike, you're failing at your job. Looking at our displacement, this is pretty much it for linear stress. Now I'm going to stand over here, because with each one of these little things that I put together, I also have a little slide that I threw all together as well. So let's-- oh, I skipped past it. Let's skip ahead. That's really pretty looking, isn't it? It even says simulation on it, that's pretty great. All right, so let's pause this here for a quick review of what we already learned.

So you can see like every one of these analyses, you'll have a little quick guide here. What do you do every time you're doing a linear stress analysis? And this is super basic. You just apply your materials to your different parts, here are the things that you need to have defined for them if they're custom. You apply your loads, forces, your constraints on it like we had on the bottom, and any additional steps you might have, like suppressing parts because it's too detailed, activating gravity, and defining contact. Oh, I also included a fun fact, I forgot that. Define your parts properties in the design environment and then their colors carry over into the simulation world. So that's fun. Otherwise they don't stay colored and your model looks really crappy.

So what flavor of simulation is right for me? Well we just did this in Fusion. Why would we use Fusion? It's easy, you can share it with people, it's really inexpensive, we'll say, simple to mesh, like very quickly, and, I mean, obviously Fusion is the way of the future, so why wouldn't you be using it? So maybe do that. But you could also use simulation mechanical, which works with any CAD program. You can export the CAD data from there straight to Sim Mech in CAD, directly integrated into Inventor or SolidWorks or Inventor Pro. So if you have Inventor, you already have linear stress involved as well. So some of these don't have additional analysis types as others, but that's all well and good.

We also have some pro tips here. Have at least three elements through the thickness of your model. You saw how crappy our results were where the parts weren't meshed very nicely. Three elements through the thickness we'll say generally gives you decent results. Garbage in, garbage out. Make sure that you include anything that makes sense. Add gravity, which we didn't do. Use proper materials. Use surface contact if it's necessary. And ensure your mesh isn't creating hot spots, just like we talked about earlier.

So moving on, we're going to stay in Fusion 360 and we're going to be looking at thermal analysis. So now we have everything active. We're going to choose Study, we're going to click on Thermal and click OK, and it pops everything back up for us. So here we are starting new again. And this time, we're actually going to keep all of our parts around, because the goal here is to keep our beer at a good temperature. So all we have to do is go through and define our material properties again, but this time we're going to have a little trick, where-- well first we have the plastic tub, but we also have the ice water and the beer. So again we're making some assumptions on the material properties, because ice water is solid and liquid. Well that doesn't really matter, we just need to make sure that it's controlling the temperature properly.

So in my handout, as well as in my videos that I've uploaded for any of you who looked for handouts and content before this morning, it wasn't there. But don't worry. On the last moment, I uploaded my stuff for you. It will actually walk you through how to create a custom material library and custom materials. So we're skipping it here and just pretending ice water is available, but you can go through there and learn how to actually do it yourself.

So with all these things defined, we're again just going to work left to right and choose our loads and our contact and all of that good stuff. While we're looking at this, is anyone here from England? So here's the thing. Warm beer is unnatural, don't do that. I don't get it. So we're going to apply a couple of different loads here. We're going to have an applied temperature to some of the surfaces, and we're going to also have a convection load. So I like to think that you need at least two types of loads, so that you can tell where the temperature where to go. It's cold here and then it transfers somewhere else through the model. So on our ice, we're giving it an applied temperature of something just above freezing, because it's ice and it's water mixed together. I guess it can't be less than 32.

Then for these other surfaces, we're going to add a convection load, and we do this in two processes. One, we're going to apply it to the tub, and one we're going to apply it to the surfaces of the keg. And for all of those, we come up with some magical number of 1.093 e to the minus 6, because that's what some calculation in college told me this would work out too. So if you took thermal dynamics or something, thermodynamics I guess, heat transfer, there we go, you can find these calculations in your book that we all have and don't look at. So here we have this all selected, we click OK, and we're just going to repeat the process all over again.

All right, find chairs, guys. All right so we're going to move forward, and here you see we also define an ambient temperature of 68 degrees. So we're just saying that everything outside is room temperature. Seems pretty reasonable. And again, we use the same convection coefficient. So we've already done our materials, we've done our loads. We don't actually have to fix anything, like before, we had to fix the bottom and we were applying the stress, you don't have to do that in thermal. And now, again, you can apply contact to your parts. So turning it all back on to look pretty, we can again click Contact and Generate.

And so, again, it's going to default everything to bonded contact, which makes perfect sense. But the one thing I want to point out about this is you can then go into this the contact screen and you can actually define a resistance value in there. So let's say you're working with some sort of chip that has epoxy that it's using to connect. This epoxy might have some sort of resistance value where it's not completely transferring 100% of the heat through, so you can actually define that value in there. You can go press Solve, and of course you want to solve on the cloud because everybody loves the cloud. And off we go to the cloud. Super fast, super user friendly. You can see it's sending, it's complete sending, it's solving, and within seconds I'm sure I got my results. And off to the results environment we go. Maybe I'm actually showing the whole thing. No, all right.

So here we go. This is pretty awesome. I think this looks beautiful. 33 degrees at the bottom where the ice is, makes sense. 68 on the outside, makes pretty good sense, plastic's pretty good at what it does. Here's our other results, no one cares about heat flux or anything, so let's look at temperature. And this doesn't do much for me because I need to know, how cold is the beer inside the keg? Well I'm going to create a slice plane and find a nice flat surface, and now we can see the temperature distribution through here. So do I have enough ice in it, do I need more ice, what's the deal? Well playing around with this, we can get a better view of what's going on. But it looks like everything should be about 30 to 40 something degrees. And I feel like that's a pretty good mix, do you think that's a good mix? Yeah, she thinks so. All right.

So if we [? turn ?] our max, here's 33.8, that sounds about like the min. Or 68, that's fine, but more importantly, we can use a probe. So you can surface probe here and look inside to see what's the temperature of the beer. Now that's great roaming around here, look how nice and cold it is. It's going to come out and be delicious and refreshing, unlike in the UK. But you also have to watch out where you inspect and create some of these points. Like if you see this, I picked right in the middle, what the heck? No, it's actually picking on that outside surface of the keg, which does me absolutely no good. So you have to be a little bit careful, but if you move it to the side, you can see what happened. And now we understand why the temperature was not what we wanted it to be.

So that's about it. Let me hurry over, oh, am I going to get it in time? Pause. All right. So a refresher. Add all of those things that it says over there. Fun fact, if you're having trouble, you can use Screencast right inside of Fusion, and that's pretty awesome, right? You can document your problem that you're having, you can send it to our support guys, and off you go, they give you an answer and do your work for you, so that's cool. What products work for me? Again, Sim Mech, In-CAD, CFD, and Fusion. This was really easy in Fusion, so if you're just doing thermal analysis, I say stick with that one, because look how fast it was, super easy. Sim Mech, you know, it's fine. But you can also then tie that over to a stress analysis. There's also thermal stress available in Fusion, so it's just another analysis type. Mass trans, same advantages as last time. CFD, we didn't talk about it, but we will later. CAD agnostic, just like Sim Mech. You can also tie together fluid flow results, so if you're blowing air across something, that can change the temperature and then that can play into the thermal results that you're getting. So we'll say a lot more, I don't want to say high tech, but we'll go with high tech.

And then some pro tips. Well you can read those, and I think I'm probably running a little behind anyway, so let's just keep moving. So next, simulation mechanical, my old favorite. So this is the company I worked for before Autodesk acquired us and made us the great product we are today. You can see over here, we're going to-- oh, you can barely see-- we're going to click the Mesh button. Just like everything, we apply our mesh, we can apply our materials working left or right. So this is just a little bit of, it's kind of like the try harder button I just clicked. Like what you were going to do wasn't going to work, but what I unclicked is now making it mesh nicely. So look how beautiful that is. And you see that it's turned diagonally so that it can drop on its corner and get a nice high stress value, right.

Well we're going to have to first get rid of all of the red over in the model tree. So the materials, we don't like them being unnamed. Let's edit those and of course go with stainless steel, because that's what I'm saying it's made out of. I'm pretty sure it is. I think so. All right, so stainless steel. So now what do we need? We need to know how far are we dropping our keg. So I was pretty scientific about this, and I went like this and I was like, I bet that's about three feet. And so that's what we're going to make our impact plane. So we inquire, it's negative 12 inches right here, the lowest point on my model. So now my floor, I'm going to define to be down here, so that it can drop. So if we choose Select impact plane, we can choose what plane it's going to be acting on, and then use an offset of minus 38. And if I pause this and use Fully General.

So a little bit of honesty here. I'm doing this manually because I'm an old under Autodesk Sim user and this is the way we used to always have to do it. We also have a really cool impact plane wizard or drop test wizard, where you can pretty much just click a couple of buttons and it does all of this for you. I forgot about it, so I'm showing you the long way, but at least you know it's there. I also define this to be fairly general. There was another option that's slide, no bounce. This is going to let it bounce off the ground and rotate around to see what happens after it makes impact, if you happen to care about that. Last thing we need to do is go into the analysis parameters. And I've been told a long time ago people can't follow right clicks, so I try and do everything up in that bar.

Anyways, number of time steps, we'll go with 150. So that's just how many little calculations are we breaking this drop into, or how many little segments. We're putting the multiplier at 1, so that gravity is active the whole time because gravity doesn't go away. We're saying negative one is the direction for gravity, so it's pulling the thing down like we want, and then we can press Analyze. And then it's going to drop and bounce around, because that's awesome. Isn't it better-- so if I would have run this and it would have been set up right close to the impact plane, but had a velocity there, so still giving me the same results, would that be as fun to watch as it dropping for three feet and then bouncing around? No, OK, thank you. I just wanted to get that out there on the record, some people don't agree with me.

All right, so here we go. We're going to go find our load case. You see everything is displacing about the same amount, makes pretty good sense. But displacement's pretty worthless, other than it gives me a lot of cool colors. So this is dropping, dropping, dropping and then boom. At step about 115, it bounces around and spins. But this does me no good. What if I turn on stress? All right, no stress, I'd expect no stress until it drops and hits the ground. So let's go down to 115 like we saw, and now we can see the stress is about what 22.5. That's pretty high, but it's not really that high. We don't have to worry about it. I say it's not going to cause any damage, so you should be safe with that.

So you can see right where it impacts is where everything red is. And we all know that red always means bad, right? No, but in this case it does. So here we go. We turn our impact plane to opaque and it helps us see a little bit of what's going on. And we animate it again because it's cool to watch, and it bounces around, and we really enjoy watching this. Now if you notice, my keg just seems to get off to a little bit of a slow start. So what that's called is forgetting to apply gravity the whole time. Now there might have been a little bit of video magic going on there, where you saw I put a 1 in the gravity column each time. Well when I actually analyzed it, I didn't remember to do that, but you still got to see the cool drop. Would anyone have picked up on that if I wasn't such an honest person? No, OK.

So again, here's everything you need to set up, all sorts of loads. And this is probably, I guess, the most complex stress analysis that you're going to be running, is a drop test or some sort of collision between parts. Fun fact, Sim Mechanical can suck in both material properties from Moldflow as well as Moldflow fiber orientation results. So that's pretty cool, right? What else could do this for us? Well, I said Sim Mech, but we used that. In-CAD could do this for us. We actually had a class earlier today and there's another one later this week that's going to show you how to do this, and it's pretty awesome. It can do some pretty hard core analysis, and you can say you use NASTRAN just like NASA, so that's fun.

Fusion also has it integrated, and I believe it's in the beta test-- preview, preview, it's a preview. So give it a try in Fusion, it's pretty cool. I would suggest when you're doing that, move the keg very close to the part that it's impacting. Or I guess your design, not the keg, and then calculate the velocity that it should be falling at, and apply that to the part for the impact there, is just one caveat. So let's see, some tips. Use an impact plane instead of modeling another part. That reduces your elements, like we were saying, simplify everything. So if you're modeling the floor, you then have to mesh it, you have elements involved. That's no good, it takes longer. And there's more complications like contact elements and contact stiffness and all these horrible things that you're soon going to no longer have to worry about. So just do an impact plane.

It's more important to reduce parts in this analysis. If you saw, there were only four parts when we set this up. The design, I think, has something like 20, but I shut all those off to save on elements so that it could drop more quickly. And since it adds very little weight, the parts that I hid, it really wasn't impacting the analysis that much. And let's see, move your model close, I said that already. All right, I'm ahead of myself. So let's see, how are we doing on time? Looks like we have roughly 30 minutes and we have roughly three analysis, analyses to go.

So moving on, here we are in Inventor. How many Inventor users do we have? That's pretty good how many SolidWorks users do we have? Oh come on, really? You don't count. All right. So here we're using Moldflow design built right into our friend Inventor, if you have it. And it can show us all sorts of stuff. You see this little panel over to the left? It's telling us as you're designing this plastic tub and making design changes to it, how manufacturable is it? Is it very easy to manufacture? You see it's green, that's good. It also asks, what's the plastic material impact? Like for those of you worried about your carbon footprint, how bad is this for the world? Apparently, this is not good.

So are there things we can do to change that? Probably not, unless we change the material that we're using. But we can also use this for other things, like determining the best gate location for our plastic to go in. You see, there's one by default, and one is not good enough. I'm going to slap a couple more on there. Over here, we're just clicking that Add button and moving it over. And when you do that, you can then just press the animate button and you can also see that this didn't improve anything, which is too bad. But if I press the animate button, I'm able to see all the plastic flow through here. So I have three spots, so it has to be filling three times as fast, right? That's how it works. It turns out it doesn't work that way, but we'll get into that in a little bit. But you can see all the plastic coming together, it fills, not a problem. Well what does it look like?

This is another great part of Moldflow design, is the finished part of view. And you can look for defects. Now you can't really see it on the screen because of, I guess, the resolution or something. But when we eventually go to the View and look at the defects, you're actually able to see how poorly this part has been made by me. So View, Highlight Defects, and now you can see all of these red lines. So I'm claiming these lines weld lines to be bad visual problems. They're going to look like crap when I produce this part and nobody's going to want to buy it. Another thing about it is my part's going to be very weak in those locations. Well maybe not very weak, but weaker. So those are going to be spots that we might be concerned. So if I would drop it on its side, it might crack there because of that. So we don't want that.

Now what could have possibly caused all of this problem for me? Well probably those extra gate locations that I added, so that's no good. So we're just going to go back and remove those. So we're removing that one and that one. We're all good, you see our updates still. It updated, but it didn't actually change the numbers, but that's OK. But now when we press it, somehow magically, it fills faster. Now I'm not a plastics guy, so I don't really understand how that works, but Sean here is. So after class if you want to know about that magic, you ask him. So now we look at our part and we go to Highlight Defects. And look at that, none of those problems exist anymore. Now if we rotate is around a little bit, we have a few little red marks that you can see there. And I'm going to claim those to be synced marks or something like that on the surface of our part. And that's OK, because it turns out you can take something like this into Showcase or vRAD or some other product that does really cool visualization. And you say what if it's made out of green plastic? No, I can still see the dents. What if it's made out of red plastic? Well that kind of hides it, so apparently this is what these tricky plastic people do. Who does plastics around here? See, it's that sneaky, right?

AUDIENCE: It's about the texture, not the color.

JAMES HERZING: Oh, it's about the texture, not that color. Well there we go, that's why he's the expert here.

AUDIENCE: And it's like glitter.

JAMES HERZING: Glitter, see? Look at this. Everybody is learning something today. All right, so here are the little spots that we need to add some extra glitter, to make sure that it looks pretty. And circling it, apparently. All right, so I think that's about all I want to do, other than look at what's causing any problems with these exclamation points. Well you can see that weld lines is a problem. So it's nice that it tells us that in case we didn't know. Yep, no good. But look at that. It's pretty easy to make this thing, so that's great. So what about the other things? High mold cost, that's no good. High material cost and high production cost. All of these seems like pretty big deal, but that's OK. Look at that. High carbon footprint no good, but it's very recyclable. Now how does that make sense? OK that doesn't make sense. If you can recycle the thing, it's not affecting your carbon footprint, right?

AUDIENCE: It's a lot of plastic,

JAMES HERZING: It's a lot of plastic? But it gets recycled. OK well I don't understand it. But I drive a big truck, so I don't understand carbon footprint anyways. That's fine. So one last thing we can do after saving the model is we can just ship this thing right over to Moldflow. And if you click Export to, you can then export it to Moldflow, right. Oh and this one, I didn't apply a little slide for you, because that was so easy and there's like four buttons, so I don't think you need a slide to know how to use that. This class is really interfering with my intake.

So here we are in Moldflow insight. Moldflow insight is, I don't know, I think the hardest simulation package to use, but that scares you off, so don't worry about that. You have people like Sean who can do this for you, so thank you for setting up this analysis for me, that's wonderful. You see here we have our injection location defined on the bottom of our tub, and so that's where we're going to be filling from. So let's click Play. And again working through the task thing over there, we can define our mesh. And it's not really fitting on the screen, sorry about that, but all we're really doing is pressing a few buttons to refine the mesh around where the injection location is, as well as giving it a nice consistent mesh through everything. So something like six to eight layers is good for this analysis. But by default, I think we're meshing 10 layer thickness now.

So here's our results in our 3-D mesh wizard, repair wizard. So I'm going to pause this for a second because this is just outstanding. So if you don't know anything about simulation, you don't know about meshes. But I'm guessing all of you have done, have all of you have done some sort of simulation before? All right. So the mesh is pretty much all that matters. It needs to be really nice and fine and consistent, and whenever there's a problem it screws up your results. Now most of the time, you have to make sure that you're getting it meshed nicely on your own. Well in Moldflow you can be lazy, because if it doesn't mesh perfectly, it can go use this automatic mesh repair wizard and fix all the problems for you. So that's pretty great.

That's not entirely accurate, but it does help. So every time you mesh something, I suppose I would suggest that you would run through this mesh repair wizard then, and make sure that there aren't any significant problems that you're encountering, and see if it's able to fix them for you.

All right let's go back to playing. We repair all of this stuff, there's only three things to fix anyways. And everything's fixed, that's pretty wonderful. It's too bad that you can't see this screen. I do have videos for you to watch afterward. So now let's define our material. So fun fact, I think it's actually on my slide, Moldflow has nearly 10,000 materials in its material library. So that's a crazy number of things to scroll through. Remember in Fusion when I was showing it up there and it still took forever? It would take way longer in here, but fortunately you can search through everything and find the material that you're looking for. So as you see here, we're going with our family abbreviation, apparently that's pp. And then we're going to go ahead and choose Manufacturer. And we're just going with generic because this is a generic keg tub. And we can search for stuff. And after we do that, it's going to give us a list of materials that we're interested in using. We OK? We're all good. All right. And choose that and click OK.

And so now we're going to choose what type of analysis we want and what order we want it done in. And we have a fill pack warp analysis, which is what you just saw. So fill pack warp is the three things that we're going to be able to investigate as this is going on. So we chose that, and now we have to do is go through this set up. And apparently these values are pretty good as a first pass. So if you're going to be analyzing, you can run through with these default settings and get a pretty good feel for your model, and then change it accordingly when you're smart like him and know what to do.

So after that you can just press the Analyze button. Apparently you do everything in this taskbar in Moldflow. I don't know why, everything else is left to right from the top, but that's fine. So here we have our results. And you can't see it there, but we're looking at the warping of our tub. And so if we press Apply here, we've now shrunk the results down. And this is to help us better understand what's going on. So a little colors-- oh, I guess they're over here in Moldflow. Have to be different. They are telling us how much our part is warping after we injection mold it. Is this still in the mold it's warping, or once you take it out, like how does that work?

AUDIENCE: Because you take it out of the mold, it will simulate [INAUDIBLE] room temperature.

JAMES HERZING: There we go. And so it's kind of hard to tell what's going on with just those values, but when you shrink it down, you can actually kind of see the way it's warping, or get a better understanding of how it's warping. And so a big concern for us for something like this would be we make it and the bottom of it bows out. Well what good is that going to do? Then it's going to be rocking all over and you can't pour a nice beer with it, so we needed to make sure that with our chosen injection location, it was going to bow in properly and we weren't going to have any funniness with the sides. And fortunately for us so that we don't have to redo all of this, it worked out nicely, and we have a beautiful bowed in part.

And now we can go to our little slide and talk about this all over again. Oh no, I skipped ahead again. Well maybe we'll just have to be patient. All right so here we have it. Fun fact, the materials. Here's all the stuff that you define. Look at how many there are compared to all the other things that I said, this has a ton of stuff you have to define. So what product is right for me? Moldflow insight is the right product for you. That's what it comes down to. You get more control, you're able to work on the mesh better, you get more results, you get more analysis types. That's the right answer. And it turns out, I think most people get Moldflow insight if they have it. Moldflow designs the bottom one that we used for designer level, where you're designing the part and you want to have a general feel for if it's going to work or not, so that the guy that you send it to to do Moldflow doesn't send back to you. So that's acceptable as well. But Advisor, I don't think a ton of people use all the time.

Pro tips. Like I said, have six to eight layers of elements for a non-fiber filled material. I hope that was right, I forgot what Sean actually said. And 10 to 12 for fiber filled. So just because of the complexity of the materials, you have to have different levels of accuracy, we'll say. Use CADdoctor, SimStudio Tools-- if none of you have used that, give it a try-- or Fusion 360 to simplify your model before importing. If you have this many layers of elements, your analysis is going to take a long time. I think this like stupid little keg tub took like 30 minutes to analyze. And that was one simple part.

So make sure you're simplifying your model. Get rid of details, get rid of any raised lettering or other foolishness that people put on there, and then it'll save you time. And place your injection cone on the CAD geometry before you mesh, because then it will make sure that you have like a nice node right there and nice refinement around that cone location. So if you do it afterwards, you kind of screw yourself and you have to, I guess, refine it yourself, or redo the mesh.

So one more analysis type. Has everybody taken in everything that we've gone through so far? All right, we got the thumbs up, so I'm sure that's good. All right, so the last thing we're going to do, and I did save the best for last, is our CFD Analysis. And it's super sweet and I'm going to claim having done this completely on my own, because anyone who may have helped me is not here. So I absolutely did all of this by myself. But the last thing we need to do, after we know we're not going to break the handle off, we know that the beer is the right temperature, we know that it's not going to fall over because our tub's crooked, anything like that, is make sure that we're getting the best pour possible from our beer. So what we have here is, I believe we call it a free surface analysis, free surface flow. I always called it open channel flow, but that's fine. We're going to go with free surface.

So you might notice one little change compared to the normal model we were looking at, and that's now that we have a red solo cup up there to pour our beer into. And as we rotate this around a little bit more, you're also going to see that it kind of looks like there's already beer modeled inside of the cup, and that's because you have to define a domain for the beer to kind to flow into. So let's just press play and see what happens next.

AUDIENCE: It's not just Jim showing off.

JAMES HERZING: That's right. All right, so rotating around-- hey, here's that stuff I was talking about-- so we're hiding all these parts. And what we're going to see here is that everywhere that there's air, that there's beer, anything like that inside the enclosed system, is going to have a solid representing that, because in fluid flow you need to know where all the liquid is and where all of the air is. Fortunately for you when you import a model, so I guess I didn't show you in Fusion, but my beer was not up to the top. It was pretty full though, kind of like a keg would come if you haven't had any beer out of it. Well when I imported this into, when I imported this into CFD, it automatically filled those voids for me, because it was a closed off, encapsulated area. So that's wonderful.

Something else I'm probably going to forget if I don't bring it up now. You notice how everything seems to have a line through it? This, I said Moldflow takes a long time, this takes forever. So simplify everything. Like take away all the parts that don't matter. And what's great about CFD is even though they're suppressed, sometimes you can't see them again, you can turn them back on and make them the right color, and just add them so that you still have a great video to impress your boss or your Autodesk university class with. So let's keep moving.

All right, so what do we have to do? Well first, like always, we have to apply our materials. And we're not really going to show that because it's boring, but you have to apply your steels and you have to apply your beers and you have to apply your ices. Not in this so much because we're just doing flow, but typically we would be concerned about how that temperature also affects the flow of our beer, things like that. But we're not worried about that right now. Maybe we were and I just don't know about it. So we're going to hide this and we're going to apply our boundary conditions. So if we rotate this up, we're going to see this surface and we're going to see that we have applied a boundary condition to it. Maybe, if we ever get there. Wow, that's a lot of hiding.

All right, so you see that we have a load already there. So we have a flow rate of-- what did it say there? One inch per second, or I think it's two, two inch per second. And then we also have a pressure applied to the beer in the cup, and we're defining that to be zero. So basically what this is telling us is our beers coming out of whatever that is, the tube that the beer comes out of-- there we go, the straw-- at two inches per second, and then the pressure that we're defining in the red solo cup is telling it where to go. So if we didn't have anything there, it wouldn't really know what to do. So now we kind of have our two loads that we need to make sure things happen.

So with those two things defined, we're actually pretty much done. And I mean it looks pretty simple, right? We only did a couple of things. It's not, though. We don't look at our initial conditions-- going, going, boring, all right, looking at our mesh. And this is another important part. And again, all of you probably won't be doing this analysis. Someone might, it would be great if you do. Does anyone do this one chance? All right, good job guys. It's super important to have all sorts of elements where the beer is coming out. It's a pretty intense calculation to watch it flow through and down and splash around in the cup, so you have to have all sorts of elements. So if you can see, it's a little blurry up there, but right around that tap, there's all sorts of elements in there. And a little bit of the modeling that went into it, there's actually beer going up through that nozzle as well. So it's closed off and it's all one nice body.

So there's a little bit of upfront modeling, there's a little bit of defeaturing, and there's a whole lot of hocus pocus going on here to make it look like it's really simple. And so with all of that defined, we can now go into our little solve screen, and we're going to be able to set up the last parameters, which are just kind of checking a box that says, hey, let it do free surface flow, which is kind of odd. So we press Solve, go a little faster, Matt. All right, and we're defining our-- he said this was important, too. Right here, you need your results to be-- I meant it's important I say-- 0.05 seconds.

So you want it to be time-based results so that you're getting a nice, animated flow, instead of all of the very small steps that it can be calculating on. And it does very small steps. So if we click press, press play again, we go to the Physics tab, and we click free surface. So it has its own little option here. And what we have to do here is define gravity. So just like our drop test, remember we had to say that it's falling in the y direction? Well in the world of CFD here, you also have to define that gravity is working in this way, and now my beer is going to flow out and it's going to be delicious. Circling, circling, click OK.

And we're pretty much done. So we press Solve and off to the results we go. And there we have it. We see our results look pretty cool here and you can see that the beer was coming out. And these are all of our different time steps, you notice it's at that 0.05 interval that we defined, so that's nice. And so if we press backwards, you can see, OK at the start of our analysis, here is our beer, and how is it going to now flow through here? Ooh, and I missed something I wanted to tell you. If I press pause, remember back when we applied our volume flow rate to the beer in the straw? Well we did it way up here. I get it that the beer is way down here, but if you would apply it down here, it would take like seven years to get your results. So we moved it all the way up there. So I get it, it's not it's not exactly what you would be thinking, but it would have taken my whole life to make it show me my results.

So here we're showing you that although our parts are suppressed, we can go and make them transparent and define a color on them, and you can then have all of these great looking transparent parts for your animation to take a look at. We're going to be changing things and enabling visualization. So apparently to even watch it flow, you have to click yet another button. And then you can click through and see how the beer comes out. But that's boring, I don't want to click a bunch, I want to animate it. So I can set it back to the beginning and go back over to the animation button. This is just so beautiful to watch, you'll be so happy, I think.

And we're going to select all of our time steps and choose to animate it. And then we're going to say to find some frame interval, and then we're going to click play. And you're all going to cheer, I think. I think you should, but you know, that's up to you. So let's see, we're playing it and look at it flow. It comes down, and it splashes against the back, and it bounces off the cup. Like this is pretty awesome, right? Come on, there we go. Ah. And look, you can see how it fills up against the side. We don't want too much foam in there, so we're pouring it against the side, and it's filling up into the bottom. This is awesome.

AUDIENCE: Beerology.

JAMES HERZING: Beerology, yeah. This is great. So you can just keep watching this great result over and over again. But again, honest James here, this took two days to analyze, so it can be a pretty complex analysis, there's some high end stuff here. So it takes a little bit of time, but look at these awesome results. Totally worth it, right? Yeah, I thought so too. Zoom in a little bit. You can tell that a sales AE made this, because it's all about the sexy video at the end, doesn't matter about set up.

All right. So our open channel flow quick reference guide here. Our set up. Again the steps. And this I kind of call out in two things. Not that you can see it, because why would we have that set up right. You can define your parts to be fluids or solids. Now that's really not a full truth, because there's a whole lot more going on than that, but these are the two that we really care about. So if it's a fluid, these are the kind of things you need connectivity and density and specific heat. If it's a solid. If it's a fluid, all those half words, those are the things that you would need.

Next you need boundary conditions. And this is a giant list of boundary conditions, but there's actually even more than that. But these are the ones that I would say someone might actually use in an everyday kind of analysis. The other ones are rather specific. And then some additional steps, like initial conditions and solution mode like we were looking at. Compressibility, we won't even talk about, and enabling free surface. Fun fact, CFD results can be exported into a showcase or a VREAD or something, and then you can make pretty much the best looking models and pictures that we have, where you have a really sweet car and you can have flow lines going around it and all the reflections. And then people want to buy your software and then I stay employed. So it's like the best thing that we offer, I really like it.

So what product's right for me? Well currently, the only Autodesk fluid flow solution is what we just looked at. So I suppose that is the right option for you. Good for us, it also can export these results to simulation mechanical. So if you need the thermal results or the pressure results to then be applied to your model to figure out if there is some stress going on there as well, you can do that with Sim Mech. Sim Mech does thermal only, it doesn't do fluid flow anymore. In-CAD doesn't do it, and currently Fusion only does fluid flow as well, but who knows what will happen there.

CFD pro tips. CFD requires a high mesh density to capture accurate flow, especially free surface flow like we said. So a good tip is to divide the parts in the CAD model to-- or In-CAD, with the divide part or divide body option, so that you can increase the mesh density in the areas of interest, kind of like where the beer was coming out. And then you don't have to have so many elements everywhere else. Suppress all unneeded parts. You can add them back and for visualization and trick everyone. And enclose all spaces, or all enclosed spaces will automatically create geometry when imported into CFD. Welcome back. And you can also make an external fluid automatically in CFD as well. So if you want to look at the air flow around something, like a cityscape or a car or something like that, you can automatically make a giant rectangle around it and watch how air flows around and through stuff that way. So those are my, obviously, very pro tips about Autodesk CFD.

All right, so just a few more things. I think we have a little bit of time, that's awesome. So next steps. Go to the class download section, which now has everything uploaded to it, I promise, as of 8:00 o'clock this morning, and you can download all sorts of stuff. So not only is there a video with a voice summary of how to do all of these analyses for you to check out and watch at night when you miss me, but there's also a 40 page handout teaching you all the step by step by step things that we covered in this class, as well as a little extra information.

We also have some wonderful Fusion 360 videos that go into even more detail about working with the Cloud, working with all sorts of features that we didn't cover here, and it will encourage you to be trying Fusion simulation even more, as well as another hand out going with that. So you're getting 10 videos and two hand outs and a PowerPoint-- you want to go do that. So go do that sometime. Follow Simulation on the Twitter, and me too. adsksimulation. I mean it's going to show you all sorts of cool training videos, it's going to show you all sorts of cool renderings, probably get a meme sometimes, because we all love memes, because that's what Twitter is actually for. Follow us there, that's good.

Rate the class and the presenter. It's important for Autodesk. I say give it a 10. You should, but if you don't, that's fine. We do take this input into consideration every year to see who's going to get to present, to see what kind of topics are popular, to see what we could do different in the classes. So please go and rate the classes how you see fit, with tens. Any additional questions, James.Herzing at autodesk.com. Email them to me and I'll say, well I'm the marketing guy, and I'll forward them to somebody who will answer them. But you will get an answer. And last but not least, go to the social, if you want, at Public House. So we're up here, red arrow. There's more food and more beer down at the green arrow. So if you leave here, you find that, I mean you can't miss it, you can do that. But to get there, you have to come up and visit me. I have a limited number of stickers, so if you're not going to go, don't take one.

But that's probably about it for that. Let's see if I said anything else. That's it. So again, anyone who happens to have a little beer left, just throw it in one of those boxes or set it by a box. I don't want you leaving the room with it. Also if you want some stuff that I give away that's not one of those bags, come grab this thing. Grab some Fusion stickers, it's the way of the future. And if you have any questions for me, please come up and ask me after the class. So thanks a lot for coming, and I hope you learned something.

[APPLAUSE]