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|  | Timespan | Content | Speaker |
| 1 | 0:00.0 - 2:07.4 | Thank you ID11 to be here... Roughly how many products or components have you designed for additive manufacturing? | Interviewer A |
| 2 | 2:07.3 - 2:50.1 | So this is kind of a tricky answer already, I help a lot of people with design for manufacturing. On a day to day basis I would not be the actual designer for this. So I advise people on design for additive manufacturing and this really depends on the time of the year. So you ask the total number, right? A few hundred. For the simple reason is that we have such a turnover in students in what we do, is that, they come and get advise on 3D print, how can I make this better and they just keep coming in, coming in, coming in. | ID11 |
| 3 | 2:50.1 - 2:54.0 | And how often did they come up? | Interviewer A |
| 4 | 2:54.0 - 3:18.4 | Again it really depends on the time of the year, it goes up and down and, I would say on average two to three projects a month at least depending on how long they take, could be as short as day to a longer to one project. | ID11 |
| 5 | 3:18.4 - 3:32.3 | and what proportion of your projects with additive manufacturing are series production of end user products as oppose to tooling, prototypes or one-off? | Interviewer A |
| 6 | 3:32.3 - 4:00.3 | I think about two to three a year actually I am going straight there are actually prototyping especially for manufacturing. Again because we work so many with students, it's all mock-up prototypes than other real projects, so they don’t tend to end up there, but there is a few projects (that now we are going to get) we are really excited, they are actually going towards mass manufacturing. | ID11 |
| 7 | 4:00.3 - 4:08.6 | So these products or components that they go towards mass manufacturing they are two to three, right? | Interviewer A |
| 8 | 4:08.5 - 4:10.3 | Yeah, give or take. | ID11 |
| 9 | 4:10.2 - 4:19.7 | And how many of those projects they will actually be produced with additive? | Interviewer A |
| 10 | 4:19.7 - 4:38.3 | None. Unfortunately, it's not where additive is for most of the projects, because most of the projects we do will end up -- as a product designer as mass consumer products and additive manufacturing is just not up to it yet. | ID11 |
| 11 | 4:38.3 - 4:42.2 | And do you think this is changing? | Interviewer A |
| 12 | 4:42.2 - 5:21.1 | I think it will change, but I don't it’s changing yet and I think it’s -- more and more companies assume additive manufacturing as a tool as a great prototyping tool, as a great function to actually help their product development. I think as an actual manufacturing process they are not yet there. I know there is a lot of companies working on the speed and how getting the things right, I think for the field that I work in it’s not there yet and it won’t be there for at least five years I think. | ID11 |
| 13 | 5:21.0 - 5:33.4 | So in my email... what products or components have you chosen? | Interviewer A |
| 14 | 5:33.3 - 10:40.7 | So I quickly picked a few which -- one of them is now in mass manufacturing with injection moulding techniques, while I helped quite a lot in the design process. One of them is a project for a workshop, two actually are for a workshop and one of them is actually a component we use to make tooling out of.  I will start with the (D-So), so (D-So) are both 3D printed, one of them is body shelf of a car and it was a car workshop so we gave participants a bunch of electronics, a couple of batteries, bits and bobs like that, motor, bits and bobs and we printed out a car body for them to work out of. So we gave them a sort of a shell to work around as a (work from). It is ideal for us, because it’s cheap for us to make and we only need about ten of them so that's two overnight print and we are done. And that's the kind of thing we use at the moment. We use 3D printing quite a lot, quite heavily in. There is also a second example which is a tree scan of myself based on a footballer's body, we use a lot of in a project, we have now which is a football table, where again combining these techniques of 3D scanning and 3D printing. 3D printing is an ideal then with one-offs because it is a face, you don’t want to make tools for that and turnaround time is quick enough for those kinds of things. The next example I’ve got is something we actually made this week which is quite a simple project, it is just proving a lot more difficult that we hoped. We are making nose cones for rockets, for solid fuel rockets and we were looking at a way of producing these nose quite quickly, quite efficiently out of foam and we tried CNC milling the shape, or we did now actually, we 3D printed the positive mould so we can cast the negative into it out of silicone, so for us that is twenty-four hour turn around, going from, let’s try this technique to that. And then 3D print is actually (then a waste as well) so you have to tear it apart to actually get the silicone out, unfortunately. We were hoping to keep them intact. And the last project I’ve got, that is actually now in mass manufacturing and we are quite involved in prototyping this. This is a sun cream applicator and actually it is in the shops in the UK now and they were on the American TV last week. You twist the top off, it is a blow moulded piece you fill it with sun cream, any brand you want to fill, and then the middle piece contains a deodorant roller or something similar like that screw back on top because the deodorant roller it spreads around an adequate amount of sun cream and with a sponge you can actually sponge it around. This has been a great project and this was one of the examples where -- because we always knew that this was going to mass manufacturing. To 3D print was a tricky one because this obviously is shape which is incredibly difficult to print because of the overhangs, the undercuts so we had to print several pieces and it is a different way of going to the manufacturing process. Yeah so there are the four pieces I chose today. It is called Solar Buddies if you need to find it. Solar Buddies. It is actually one of, I think it is one of my favourite projects because of the way that this came through the university. Basically what happened was two mums had an idea, because this is designed, because they are both mums and they said in the morning we put sun cream lotion on our children and by the time is eleven o'clock the sun cream lotion wear off and teachers are not allowed to put on sun creams on kids because you are not allowed to have skin to skin contact (give sum themselves) gets messy so they have found a solution. So what they did, they actually contacted the university, product design, and the first had a third year degree project, so a bachelor undergrad and then they brought it as a large project to a Masters degree, postgrad and then they actually took a graduate designer who had finished the design with us. Not have been involved in the whole process, past three years now. And now they are on the market, they are sold by a thousand. | ID11 |
| 15 | 10:40.6 - 10:51.0 | So none of these projects have been produced in additive? | Interviewer A |
| 16 | 10:51.0 - 10:53.7 | This is additive, this is additive, this is additive. | ID11 |
| 17 | 10:53.6 - 10:58.2 | This is additive for tooling right? | Interviewer A |
| 18 | 10:58.2 - 10:59.5 | Yes | ID11 |
| 19 | 10:59.4 - 11:03.2 | The first one, the Solar buddies is additive for prototyping | Interviewer A |
| 20 | 11:03.2 - 11:04.1 | For prototyping yeah | ID11 |
| 21 | 11:04.0 - 11:33.7 | But the other two, you are actually using additive as the final production process. So regarding the soccer table in particular, at the end of the project, since you are using scanning and some anthropometric data to add into the product, are you thinking to use additive as the final production process? | Interviewer A |
| 22 | 11:33.6 - 11:57.5 | With the man we are still developing it, I think at the moment the plan is to prototype the body 3D print and use a casting method again to give the strength it needs because it is one of the downs of the 3D print, but the heads would be removable, the heads would actually be 3D printed and the actual, final production process. | ID11 |
| 23 | 11:57.5 - 12:08.3 | So in the specific case of the Soccer Table, how did you decide to produce in series this product? | Interviewer A |
| 24 | 12:08.3 - 12:50.8 | It is the easiest way because it is a one-off thing, because it is such a unique 3D scan, you don't need many of it so 3D printing is the ideal solution for it. It sticks out overnight and next morning you come in and it is done. That's probably the only solution we’ve got as well. I can’t think of any other way of actually doing this at that rate and at that quality. If you think about CNC milling something like this, it is too much hassle, the details that you can get from a CNC mill on -- with us only limited as compared to what we can do with 3D printing. | ID11 |
| 25 | 12:50.7 - 13:02.6 | And Which additive manufacturing technology are you thinking you are going to use? | Interviewer A |
| 26 | 13:02.6 - 13:14.5 | FDM, because it is cheapest (shapes). We have lots of them around. It does exactly what it needs to do you don’t need much more on it. | ID11 |
| 27 | 13:14.5 - 13:22.5 | The same thing for the car, even though it was not an end user product? | Interviewer A |
| 28 | 13:22.4 - 13:41.8 | It was actually an end user product. So this was part of the workshop. So we showed them that for a car workshop so a small race car basically. A 3D printing was a viable option actually to prototype the body or make the body so we had a base to work of. This was actually all the things bolted to it. | ID11 |
| 29 | 13:41.8 - 13:43.7 | How did you choose 3D printing? | Interviewer A |
| 30 | 13:43.7 - 14:17.9 | Again it is the amount of parts we needed, compared to the turnover time. We needed a couple in a week and just stick them over night and next morning, they are all done. We can print different colours, we can have a little play with that and it is just getting those pieces out as quickly as possible, as cheap as possible as well because we have quite cheap FDM printers. We have the high end consumer models, we have the Ultimakers and we -- a cheap shape (()) | ID11 |
| 31 | 14:17.9 - 14:22.6 | In both cases did you consider any conventional process? | Interviewer A |
| 32 | 14:22.6 - 14:25.5 | A conventional process as in? | ID11 |
| 33 | 14:25.5 - 14:27.6 | As alternative | Interviewer A |
| 34 | 14:27.5 - 14:50.5 | In the car no, because we needed ten pieces and we left at that. We did shelve the workshop. But the advantage of shelving is that if we need another, just hit ‘print’ again. There is no stock, there is no need for any tools, you don’t need mould, there is no -- finding commercial companies for 3D printing for us, do you mean that? | ID11 |
| 35 | 14:50.4 - 14:59.7 | No I mean if you considered to make them, the car in vacuum forming or in milling or | Interviewer A |
| 36 | 14:59.7 - 16:08.9 | Okay yes we did actually, vacuum forming would have been actually a good option as well but it had features we could not include in that, undercuts and some of the screw (mountings) and things like that, which you cannot include in vacuum forming. CNC milling goes the same thing; I think it is the amount of detail, the strength of the materials have. One of the advantages for us, for additive manufacturing is the amount of waste, so with this we know exactly the amount of plastic we are using, we don’t have any waste or hardly any waste, but if you use it, for example CNC milling it is -- you straight have to go to either quite a big chuck of plastic considering the size, the amount of stuff you wanna take away which us would have cost. It always kind of affects to each other. I always find it one of the -- after the one-off prototyping, 3D printing I think the best thing is the waste. I think I don't like what CNC milling, is just, you spend so much time cleaning up and binning expensive materials. | ID11 |
| 37 | 16:08.9 - 16:17.0 | So do you remember what are the main considerations for using additive manufacturing in these two products? | Interviewer A |
| 38 | 16:16.9 - 17:29.6 | So in these two products. For us it is turnaround time. It is time, how long it takes to get things out. It is quantities as well. So anything under -- because we have a range of 3D printers we sort of -- like if you need like five, next tomorrow is fine, if you need hundred that's different -- we always -- every company we have that turn out cross over. Sort of the one off thing, the time and cost as well, it is cost and often 3D printing is good enough. One of the things you see in the car is that it’s not a good print, it is actually a really low quality print, but it does its form and function. We don't need a super high gloss finishing, we don't need to spend loads of time painting it and sanding it and then making a cast and a mould, it’s total hassle. Just get it out, and that is for us -- especially in workshops and in what we do is what we need. We need someone to show what the process does, show what AM does and then, fine, this is what we made before, they are doing the cooking shows as well. | ID11 |
| 39 | 17:29.5 - 17:35.9 | What do you mean when you say that you don’t need a very high finishing quality? | Interviewer A |
| 40 | 17:35.8 - 18:02.8 | It really depends on -- because we do a lot of -- what we do most is teaching people how AM works and teach people how to (make things) works, how to make things and for a lot of people, it is more the process behind it then actually getting or look at a 3D printed amazing part, it is like design something and printing. So it does not have to be a perfect mirror shine finish. | ID11 |
| 41 | 18:02.8 - 18:13.2 | And that the same for the soccer table. Are you thinking to commercialize that project? | Interviewer A |
| 42 | 18:13.2 - 18:23.6 | We are actually going to commercialize the project. We are going to commercialize this exact workshop because we have all the kits to do it, it is a good day out and it is… | ID11 |
| 43 | 18:23.6 - 18:33.3 | That, as far as I understood is, despite the Solar Buddies, that one is, as far as I understood, the project that is going to be a product? | Interviewer A |
| 44 | 18:33.2 - 18:40.5 | Yes we are going to try to market it as a workshop, as a product life workshop and it kind of depends how far it takes us. | ID11 |
| 45 | 18:40.5 - 18:43.4 | And also in that case the quality would be good enough | Interviewer A |
| 46 | 18:43.3 - 19:42.9 | Yes it is. I think so. We might have to reconsider at the time as soon as we have more feedback from our clients. I think at the moment we are doing quite well. I think one of the advantages is that -- this is FDM so it is not the best quality. We have the option of actually doing it in SLA so a resin-based 3D printer, which is an option, so that is nice for us. This is fine that's all keep it to. If you want to go to SLS we can do SLS but it adds so much more to the cost. 3D printing for us is 4p per gram and SLS goes to 25p per gram so it’s about five times as much which is significantly, if you think of using it quite a lot of material and the material is a hassle to work with. SLS is -- I don’t like it -- is too much mess. | ID11 |
| 47 | 19:42.9 - 19:46.0 | What do you mean by too much mess? | Interviewer A |
| 48 | 19:46.0 - 20:09.4 | Oh everything is gluey and you have to top of resin, you have to clean it in a few times, you need to wear gloves, glasses, you need to use a lot of alcohol to rinse everything it just makes everything a little bit messy but high quality, so it is a trade-off. | ID11 |
| 49 | 20:09.4 - 20:21.4 | How did the design of the product or the component change after it was decided that additive manufacturing was going to be the process? | Interviewer A |
| 50 | 20:21.4 - 21:42.4 | I think with the football object is that you have a lot more freedom in undercuts in holes, in features, in those kind of things which make it easier to actually design in that kind of way. One of the key things with this is that if we considering casting the bike, casting the bike is going to be pain because there is a hole in the middle, that's not going to be an easy mould for us to make in our workshop although for mass manufacturing this is relatively doable. So that's one of the advantages of 3D printing is those kind of features which are in other ways more difficult to make. To add those. That is the main key with that one. Also the fact of just using unique items like -- because 3D scan person, there is a 3D scan head that kind of unique features something you are not doing other than additive manufacturing. For the race car it is actually, again it is the features we can add, it is the wall thickness you can use, it’s features of the plastic you can take as (you come or bread the pure materials) we have. That's an option. | ID11 |
| 51 | 21:42.4 - 21:49.5 | Do you have an example of that products or components made with another process? | Interviewer A |
| 52 | 21:49.5 - 22:58.9 | Yeah this is injection moulded so this is an example; this is blow moulded if I remember correctly, I am pretty sure actually blow moulded, this is injection moulded. I am not sure how the ball is made. This is definitely injection moulded and I remember when we designed as a first time especially this middle piece which is relatively thin as a screw thread built into it. One we designed it for a prototype, you get the sizes right. There are features you cannot do in injection mould which you can do in 3D printing and other way around as well. So this is a relatively thin piece, this is, with we our technique almost impossible to do a decent quality in 3D printing so actually I had to make this into a solid, make it a little bit more strong and to make sure the features we are using to transfer -- so there was a different design, a final different prototype compared to a final different design for mass manufacturing. | ID11 |
| 53 | 22:58.9 - 23:12.4 | Can you talk a little bit more about this. I mean you said there are features that are impossible to make with injection moulding but they are possible to make with 3D printing. Can you talk a little bit of these features? | Interviewer A |
| 54 | 23:12.4 - 25:26.6 | I find that with 3D printing is, overhangs are a little bit easier, undercuts are a little bit easier, hole features are a little easier as well with 3D printing. Especially with 3D printing, it’s the undercuts which in injection moulding are expensive to do, they are often doable but often very expensive and with 3D printing it makes the life so much easier, you don’t have to worry about those things, it’s done layer by layer. I think the disadvantage of 3D printing is that it has a minimum thickness while injection moulding you can quickly go to half a mil thick or a mil thick, with 3D printing we normally don’t go under one point six five mil for the resolution the printer can handle and we can still get the strong part. That's only thing 3D print can't do and same goes for, if you at your iPhone or the battery cover of your battery charger, those has small little lip features which are fine in an injection moulded part but in 3D print they won’t work because they are not adhering correctly which is the layer based system or just too short of an overhang it does not print well, there are some many factors to take into account. What we often say to students is that eventually you have to make 3D models for you final design, you need to make one which is for your model, 3D printed model which kind have all, as much as the features as you can but taking those limitations into account. You gonna have a final mass manufacturing model which you are gonna send off and have a tooling for, as much as possible and you gonna have a rendering model which you will use for renderings, so that is (not) too complicated. It really depends on what the project is. I think for 3D printing, size is often an issue as well, it is something that is just so much quicker to CNC mill. They are too big to 3D print, so you have to go to CNC milling, depends on what kind of accessibility you have as well. | ID11 |
| 55 | 25:26.6 - 26:00.0 | Okay now I am going to use a metaphor... How did that design come about the way it is? What did you do make that? | Interviewer A |
| 56 | 26:00.4 - 28:15.2 | I think both of them are made in 3D StudioMax which is not an engineering programme but more of a polygonal modeller, they are different modellers and with the soccer man we knew we wanted we needed the hole for the rods to go through. And the bolt on either side to make sure the person (()) on the same spot every time and we knew we needed roughly where the kicking area was and anything in between was flexible and we didn't have to worry about that because we knew that 3D print normally would take those into account. And when we printed this, we actually printed it up-right like this because we knew the flat surface, this was a flat, the bottom was a flat surface. So we knew we could get away with some overhangs, not too many though, so you see that it is as smooth as possible going up, so you don’t have too many overhangs, there are few overhangs on certain areas if you can see there is definitely deformation, it is one of the downs of FDM printing and the hole is not perfectly round but these are all things, aspects that we can go with and we can drill them out because it is only a prototype, it is only a one-off thing, we are not making hundreds. So that's how (ducking) about. It is taking the rules to account which you don’t have to worry too much about overhangs, we can support if you need to support, try and give a little bit smooth so you don’t have to get supports on. With the car, those only -- there is not that much thinking about it, we just knew we needed to have a body shell as any car has but we didn’t take into account like -- there is a lot of support structure underneath and it was part of the process for the participants, we showed them if you design something like this, you are going to cope with this and you have to cope with this, which makes the workshop more -- hitting more learning targets I think. | ID11 |
| 57 | 28:20.7 - 28:29.8 | What were the design considerations at the 'concept' stage during idea generation, especially I mean for the soccer table? | Interviewer A |
| 58 | 28:29.5 - 29:11.5 | There weren't that many design considerations. The prototype process was relatively straightforward. Because there are so many examples that already are out there for a football table (including) you knew what the man should look like. It's getting the proportions right, getting the head shape on their right, and the legs as well, they just (wear right shoes), (). This is how it all works. That would've () actually. It's that you've been given the freedom to not to think too much about design considerations. | ID11 |
| 59 | 29:11.5 - 29:14.2 | And at the embodiment and the detail stage? | Interviewer A |
| 60 | 29:14.5 - 30:12.9 | The detail stage, again, it's further refining it, the advantage of this is you have a quick turnaround. So it's the turnaround of designing and updating and printing and you coming back the next morning and see what's wrong and see what needs to change. At the detail stage, it was getting the sizes right. So one of the things specially with circulate and 3D printing, and it's printed, so it's certain of upright. Some of them shrink quite a bit on F D M printing, so it's getting those sizes right. Same goes for the hole in the soccer man, is make sure that fit is big enough. Do you need to change, maybe, the size on purpose, make it over a little bit more on purpose, so it'd be printed a little bit rounder eventually. Because the size of 3D print, all those things are taken into account to make sure you make the life as easy as possible, which you manna make quite a few () eventually. | ID11 |
| 61 | 30:12.7 - 30:25.7 | Ok, so, when you were designing this product or component for additive manufacturing, did you follow any specific design rules or guidelines? | Interviewer A |
| 62 | 30:25.7 - 31:05.6 | No. It's mainly based on experience. I sort of know that, I think, additive manufacturing gives you the possibility to not to worry too much on guidelines. As I said earlier, if you think you'd keep it to account and see, especially the wall thickness, for us, it's mainly because you should, but apart from that, luckily with support material and positioning with the right angle, you can be quite free in what you wanna make. You are not restricted to undercuts, overhangs and those kinds of things. | ID11 |
| 63 | 31:05.6 - 31:13.1 | So, you are not using any, like books, reference material? | Interviewer A |
| 64 | 31:13.1 - 32:03.7 | It's all like experience, and especially with FDM. We only have one material (). There is no point of trying to find anything else. There are options of course if you need to, but I absolutely don't need to. Science books, we've been working with the Ultimaker now for three years, yes, I can take a part. It's experience maybe. If you look at the guide books, and I think main magazines made a few, but I'll go through them because there are a few in the library, and I know this, I know this, I know this, it's just experience and experience and experience, I think, at this early stage. | ID11 |
| 65 | 32:03.7 - 32:16.0 | For instance, before you told us about the thing that I cannot design wall thickness less than 1.5 or 1.6, how did you learn that? | Interviewer A |
| 66 | 32:16.0 - 33:01.8 | So what we found that, in this () project, cannot show you because it's very NDA related, so I can't actually show you this. It's a medical device, and I found out that there was a thin wall surface and every time we printed it, it just wouldn't work. And you see that software that just refuses to print certain features, and you see the software that just doesn't wanna do it. Actually the minimum you can get away with is actually 0.8 if you push it, 0.8 of a mil because that's exactly two nozzle thickness, that's what the printer can break and do as well. Well, for strength, you need to add another one or other, it just won't work. | ID11 |
| 67 | 33:01.8 - 33:06.4 | So, one part is 1.6 because there are four nozzles? | Interviewer A |
| 68 | 33:06.4 - 34:02.1 | Four nozzle thicknesses, yeah. And normally 1.65 to make sure that in case you have a bend or something like that, it would be perfect. It's, that's the way it is. I've printed so many, like thin, hollow and empty things, my fans just don't work that fast [referring to the fan on the FDM machine?]. Again, this really depends on what kind of product you are working with. If you are looking at something cylindrical like this, it's, what I often see is that, like there are so many settings you should take into account like infill, it's the () pattern inside. You don't want that in there because it will make your surface not nice. You'll only want circles in there. And also keep to make sure the print is acceptable with all the moving about, knocking it over if it's tall, all those kind of aspect. | ID11 |
| 69 | 34:02.0 - 34:09.1 | For instance, you said, depends on what kind of product, what do you mean by that? | Interviewer A |
| 70 | 34:09.1 - 35:08.4 | It depends on what the product looks, it depends on how it shapes, how it works. You see, we actually had a project lately from quite a big aerospace and defence company. You see they add features they wanna have for injection moulding, like small recesses on the bottom. You print on the bottom, you want recess areas, it's gonna be one joint support material. It won't look nice, it'll look dark. And all those aspects that depend on form and shape of the product you wanna produce in 3D print. This comes with experience as well. This comes with doing it a hundred thousand times. I can, I'm best at this when you should me a product, I can tell you this is how to do, this is how to do. It's really difficult to explain it and I'm just trying to explain it. | ID11 |
| 71 | 35:08.4 - 35:36.1 | I think from most of who you've asked, who've used 3D printing a lot, they would say exactly the same. There is no book, there is no guideline on this. They would say watch out for this, watch out for this, there is a tip there but that's where it ends. It's () a print and coming back an hour later and see a ball of, a ball of blast, it's finding out what went wrong and seeing defects in your print. | ID11 |
| 72 | 35:36.1 - 35:47.5 | So you are saying that what you would do is just basically, you would take the part, print it and then you will see all the defects and then you will try to? | Interviewer A |
| 73 | 35:47.5 - 36:33.2 | Yeah, well, essentially yes, but normally it is like, let's, right, I'm gonna assume this, this, this are gonna go right; this, this, this are gonna go wrong. Let's try this first and then see how it goes from there. It's the experience which is the first half of that bit, which is actually the same one what mould maker has as well. So if you go to a company, P D R, where you've been with silicon mould making. Today they do additive manufacturing for a lot of things as well. I'm not sure who you spoke to, but and they say as well, the mould making is 100% experience. Where do I put my line, where do I put my channels, which is up to printing experience. There is a few bits and balls on guideline, but it's still (half-guidance) technique. | ID11 |
| 74 | 36:33.6 - 36:47.0 | So, in those cases that, in those examples you showed us, did the use of 3D printing change other components of the product? | Interviewer A |
| 75 | 36:46.9 - 37:18.1 | In the cases I showed you, no, there is no. No, because the projects I showed you, the restrictions for the design were the other components were () [voice too weak to hear]. So the example of the man is that this is an M3 bore, this is a certain size hole, I can't remember this [ID11 was pointing to a feature on the soccer man], to make sure the all other components around fit, because we can get them elsewhere. | ID11 |
| 76 | 37:18.0 - 37:26.7 | For the two examples, are there any drawbacks or limitations as a result of using 3D printing? | Interviewer A |
| 77 | 37:26.7 - 38:40.8 | Yes, definitely () was the limitations. Although I said that you don't need to worry too much about overhangs and undercuts, you still have to worry about, because you are taking away support material, which is very time consuming. So that goes for the direction you are printing as well. So the example of the soccer man, you can see there are a few defects around quite steep overhangs, which make it less glorious, and that's definitely a drawback. I think the biggest drawback for 3D printing is what I showed you the moulds there, is that 3D printing is extremely fragile along the lines. In this case, it was a good thing because actually they took apart quite easily, but you can see that sometimes we've 3D printed once, was a small little project, was a little replacement part for your shower where the direction we printed it originally was the low [doesn't make sense], which was wrong, so it just snapped into half every single time. So we had to 3D print it the other way around to get the leg in the right alignment. So it's the adhesion between layers, is one of the biggest issues and you can see weaknesses in your 3D print. | ID11 |
| 78 | 38:40.8 - 38:46.6 | Did the use of 3D printing change your design process or practice? | Interviewer A |
| 79 | 38:46.6 - 39:06.4 | Well, our whole practices are based around 3D printing so I can't say yes to that. So I think this is more a question better for manufacturers, mass manufacturers. Our whole system is based on 3D printing. We are Fablab and so that's what we do. | ID11 |
| 80 | 39:06.4 - 39:23.2 | Ok, so, now we will ask you some general reflections. What are your views on 3D printing, well, additive manufacturing, as a production process for end user components or products? | Interviewer A |
| 81 | 39:23.2 - 39:28.0 | As of today? | ID11 |
| 82 | 39:27.9 - 39:29.3 | As of today, tomorrow. | Interviewer A |
| 83 | 39:29.3 - 40:23.5 | Or in a couple of years? Ok, I think it's amazing. What I make sure is the wastes you don't make. It's the on-demand thing. I started before in a presentation is that if you now go to a company like () [a company name], where you have all the pipe bands, and all those kind of things. With additive manufacturing, you can make them on-the-fly. You can make them on the right size, the right direction, you would do stock, you would do transport issues, all those kind of things which are amazing for 3D printing in the future. As of today, I think hearing aids in 3D printing these days, because these are cheaper than to cast them individually and they get so good results. Individualisation, I think, which is, for me, the key in really high end products. | ID11 |
| 84 | 40:23.5 - 40:33.0 | In general, what do you think designers need to know for designing effective parts for additive? | Interviewer A |
| 85 | 40:32.9 - 41:24.6 | I think they would to learn the limitations of what 3D printing can and cannot do. If you think about completely designing for 3D printing, I mean the options are endless, but it's taking into account that it just takes time at this moment in time, a lot of things still take times. You're looking at really high end things like medical things of 3D printed, and at this stage, there is no point of doing this, I think, as mass manufacturing still, because it's just too expensive compared to having a tool made and making a hundred a thousand in a day, compared to making one every five hours. | ID11 |
| 86 | 41:24.6 - 41:29.1 | How did you learn how to design for additive? | Interviewer A |
| 87 | 41:29.0 - 42:20.4 | Experience. I'm a product designer by (). So I always thought what it was, how it worked and () it was alright. So can I use it? It's also making, looking back now, it's making things I should not have made in 3D printer. So largely what we do is advice people on what process, laser cut, CNC milling. There is often (way to better to make it). So it's experience again. It's doing it, doing it and doing it, and printing buckets, buckets of material. | ID11 |
| 88 | 42:20.4 - 42:23.5 | Did you come up with your own rules? | Interviewer A |
| 89 | 42:23.5 - 43:01.8 | Maybe a little bit. There is no very strict rules because I think 3D printing throws most of the rules out of window, () a few small ones. Again, that's just the experience on the machines we have and the machines we use daily a week. Maybe a little bit we come up with some rules. I think the biggest rule for, in the work we do is, are you sure you want to 3D print this? Because I don't think it's the best way of doing it. It's the rule based and saying, are you sure 3D printing is the best option? | ID11 |
| 90 | 43:01.8 - 43:06.3 | How does that rule work? | Interviewer A |
| 91 | 43:06.3 - 43:52.9 | So, it is, I think in these days in age because students have a 3D printer, they are being lazy with their designs because 3D printing allows you to be lazy with your designs, undercuts, consistent wall thicknesses, big blocks material, all those kind of things you can get away with 3D printing but not make them as much as attraction today. And it's taking those things into account; I think that's the biggest thing. Are you sure that it is the right process? You sure there is nothing else? I will doubt, which might do the job better. | ID11 |
| 92 | 43:52.9 - 44:05.0 | Have you written those rules somewhere? Did you document those rules? | Interviewer A |
| 93 | 44:05.0 - 44:11.1 | No, it's experience. It's no, we don't. | ID11 |
| 94 | 44:11.0 - 44:18.1 | How did you prove them? Have you ever tried to test your rules? | Interviewer A |
| 95 | 44:18.1 - 45:40.8 | Yeah, I mean, we do this every day and we often get students coming and saying I want this 3D printed. I said this is not possible, it's too thin, too thick, it's not gonna work, bla bla bla. So yeah, we tried, didn't we? It's again, because you start to do it anyway and then you end up with a ball of blast next day, which is a completely waste of time and material. Experience, just doing it, doing it, making, over and over again, dozen, dozen times. As I said, like 3D printing gives you so much flexibility, is that a lot of things do work, things shouldn't work in mass manufacturing methods. Big blocks, it's a really good example. I once had a student came to us, it was basically a solid cylinder with quarter cut out of it. So I looked at it and it's like how in the world are you gonna mass manufacture this, except you can 3D print it quite easily because it's a cylinder about that big, so it's about a CD disk with a quarter cut out of it over the wall length, back in the front face. | ID11 |
| 96 | 45:40.8 - 45:47.8 | I'm just making a sketch, try to understand if I understood. Something like that? | Interviewer A |
| 97 | 45:47.8 - 47:03.5 | No, I will show you. [ID11 was sketching]. So it was a () cylinder but in there, you cut this section out. I think it's a dog food dispenser, so the food can drop into that cut-out, and twist around and fall out to bottom. And this is what you can 3D print. It was an incredibly big, massive thing, which would've been fine to 3D print. But (), you are a product designer, you design for mass manufacturing, I assume you wanna do that in prototype, which I shouldn't do as a product designer. It's not mass manufacturable because it is too big of a block, there are too many differences between the thicknesses in the middle, thicknesses on the side. You get warpage; it won't come out nice, using tons of material, so go back and think about something else. It's those kind of things we deal with on a daily basis. | ID11 |
| 98 | 47:03.5 - 47:05.5 | So the student came back? | Interviewer A |
| 99 | 47:05.7 - 47:28.6 | No, I told them to find a different way to make it. If you decide to laser cut it, if you decide to make a cross by a laser cutter with two circles at the end, so you have four hoppers instead of one, and that's actually probably one of ways that would mass manufacture as well, which still treats. | ID11 |
| 100 | 47:28.5 - 47:36.3 | Ok, so, in the next 5 to 10 years, how do you think additive manufacturing as a production process will influence design? | Interviewer A |
| 101 | 47:36.3 - 49:56.4 | In the next 5 to 10 years, I think it's gonna be, I think in the short term, it's gonna be, they are already doing it actually, one of the things I saw that they are doing 3D printing bikes now which is actually they use carbon tubes, they are using a custom 3D printed at sections to connect them so you can get custom heights and directions. So, it's, I think it's gonna be, the next 5 years, it's gonna be the combination of traditional with the new being additive manufacturing using existing materials like tubes and then 3D printed, part of this case, it was a laser sintered metal, which define how the tubes come together and then form a bicycle frame. I think the best viable is what B M W and Mini have been doing for a couple of years now, it's, alright, I want my Mini but I want seat's this colour, I want the inside this colour, I want the wheel black colour, you can pick and choose basically because they, NIKIE do their shoes as well. I think that's kind of thing we are going to. We are going to traditional process with added features in the next 5 to 10 years. Kind of depends on which processes are. Maybe in 10, we might look at things being more common, and it might, you speculate there might be 3D printer in every house, maybe by then. I think what you see now is that specially younger makers out there, people who are under 15 now and they know how to use C A D, they know what to use to design, you can see them make their own products, you can see them make their own toys, make their own aspect in life. It's in the design process, you are the doctors or your are the inventors, they are fairly serious people who see something doesn't work, and want to change it, I think that's going more and more available to people or to everyone. | ID11 |
| 102 | 49:56.3 - 50:11.1 | Thank you very much. Before we go, I would like to ask you some details about your education background. So what is your education background? | Interviewer A |
| 103 | 50:11.1 - 51:05.1 | I studied product design in Netherlands. No, I actually started mechanical engineering for a year, then I swop to industrial design as an undergrad. I did my postgraduate as well in industrial design engineering and, I can't remember the full title anymore, product innovation and new forms of technology and I did a few streams in product surfaces and a few lectures and a few really interesting subjects as well. So that's my education background. That's now, I finished my degree two or three years ago now. | ID11 |
| 104 | 51:05.1 - 51:05.7 | Where did you study? | Interviewer A |
| 105 | 51:05.6 - 51:32.1 | I studied in University of Twente in Netherlands, which is, I only experience Company H so far, but it's a totally different university a () in the UK. It's, we are research based, we are report based, we are systems based, management based, and we do less and less and less in the design process. | ID11 |
| 106 | 51:32.1 - 51:33.2 | Here or in? | Interviewer A |
| 107 | 51:33.1 - 51:35.3 | In the Hollands, yeah. | ID11 |
| 108 | 51:35.3 - 51:36.7 | Less design process? | Interviewer A |
| 109 | 51:36.7 - 52:03.9 | Less design process but more, basically all the lectures that are set, you are going to be trained to be a project team, project design team leader. So you will be able to talk to the programmers, we have a lot of programming, electronics, electronics course, we have biomechanical engineering, so it's making sure you know enough all those topics so you can make sure they can talk to each other properly. | ID11 |
| 110 | 52:03.9 - 52:07.2 | How long have you been working as a professional designer? | Interviewer A |
| 111 | 52:07.2 - 52:11.8 | 5 years. | ID11 |
| 112 | 52:11.8 - 52:25.7 | Ok, so, can I confirm that it is ok for me to take some pictures and have copies of, well some pictures of the projects you showed us? | Interviewer A |
| 113 | 52:25.6 - 52:27.9 | Yeah, that's fine, that's fine. | ID11 |
| 114 | 52:27.9 - 52:29.8 | Are those projects in the public domain? | Interviewer A |
| 115 | 52:29.8 - 52:51.2 | Half. Yeah, I know a bit, some of them are, some of them are not. I mean, it's not rocket science, it's not like it's super innovative, it's somebody else doing it as well. | ID11 |
| 116 | 52:51.2 - 52:54.9 | Can we use that as a case study? | Interviewer A |
| 117 | 52:54.9 - 52:56.7 | Of course, sure. | ID11 |
| 118 | 52:56.7 - 53:26.2 | Ok, so, in the following weeks, we are going to transcribe this interview and will send a copy to you. And at that time, or at any time, you will be able to cancel, change what you said, add or remove any part of the interview as you please. Probably at the end of the project, so, in a year time, we are going to publish the results. At that time, do you prefer to be anonymised or named? | Interviewer A |
| 119 | 53:26.2 - 53:29.3 | I don't mind. | ID11 |
| 120 | 53:29.3 - 53:40.9 | So this moves us to the end of the interview and thank you very much. | Interviewer A |
| 121 | 53:40.9 - 54:11.7 | I just want to ask one last question. I mean, just a bit curious, you've made a point several times about the waste. So you said 3D printing does not generate too much waste, whereas CNC machining can have lots of waste like chips during machining. Are you only talking about FDM or SLA, because well, it seems to me EBM or SLM can have lots of waste as well, which we cannot reuse them? | Interviewer B |
| 122 | 54:11.7 - 54:37.8 | Mainly FDM has a little waste, I think SLA does not have that much waste, you can recycle most of the resin. I assume you didn't mess up with your print. I'm not sure how it is about SLS, the powder one. I don't have any first-hand experience on that, so I'm not sure how much the powder can recycle. | ID11 |
| 123 | 54:37.7 - 54:44.9 | So, when you were talking about waste, a lot of waste, you were talking about FDM and SLA? | Interviewer A |
| 124 | 54:45.3 - 55:03.8 | Yeah, I mean, I have first-hand experience with those. Especially you think about trying to make something out of CNC milling with this, it's quite a big block, you take quite a lot of material out. While you do it on FDM, you don't, you use exactly amount of material to use. Something as simple as that. | ID11 |
| 125 | 55:03.8 - 55:12.5 | So the waste is still one of the very important criteria for you to choose? | Interviewer B |
| 126 | 55:12.5 - 55:25.4 | Sometimes it is, yeah, sometimes it is. It really depends on what the shape of the (goal) is to make. | ID11 |