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|  | Timespan | Content | Speaker |
| 1 | 0:00.0 - 3:32.6 | [introduction to the project]... I would like to know something about your general experience about design for additive, roughly how many products and components have you designed for additive? | Interviewer A |
| 2 | 3:32.6 - 3:34.4 | Specifically for additive? | ID09 |
| 3 | 3:34.3 - 3:34.9 | Yeah | Interviewer A |
| 4 | 3:34.9 - 3:37.2 | None | ID09 |
| 5 | 3:37.2 - 4:01.0 | So it never happened that you had to design a product for additive even that you only considered additive as a possible production technology? | Interviewer A |
| 6 | 4:00.9 - 6:45.8 | Yeah. In the majority of cases the client does know how their product life cycle is going to pan out, so a lot of people who we develop products for, they come to us with a rough idea of how many units they might be selling per annum. But they aren't one hundred percent confident in their projections or they don't know how the product is going to perform. So we may in early stages have a figure in mind for how many items are going to be produced and will present the client with different options based on those figures. Some of which might be on the base of additive manufacturing or other low volume production techniques or we might be suggesting from the very beginning that you are gonna be looking at injection moulding or other manufacturing techniques like that, more for large volume runs. So in a lot of cases because our client does not know whether product is gonna go or how is gonna perform, we have to be prepared to produce in multiversity of different manufacturing techniques and knowing that, the more traditional manufacturing techniques dictate the form of the product. Because at any stage the client might turn around and say: "actually we’ve changed our mind, we wanna get it injection moulded"; and then the injection moulding process is like the overarching governing process which we follow. Because there are so many rules about injection moulding which we’ve got to be prepared for. So even though in early stages, the client might be saying we are going to stick with additive manufacturing, because of our volumes and price breaks and everything else; we have to be aware that at any point they could change their mind and say we are gonna go to injection moulding. So we have to make sure that the product or the component is going to comply with that. | ID09 |
| 7 | 6:45.8 - 7:01.8 | Has ever happened that you designed a product or a component and that product or component, because of the volumes, stick with additive? | Interviewer A |
| 8 | 7:01.6 - 7:02.8 | No. | ID09 |
| 9 | 7:02.8 - 7:08.1 | All the components you have designed have moved to traditional or conventional processes? | Interviewer A |
| 10 | 7:08.1 - 7:09.1 | Yes. | ID09 |
| 11 | 7:09.1 - 7:19.5 | And how many components that have you designed, have started with additive and then they moved onto traditional processes? | Interviewer A |
| 12 | 7:19.4 - 7:30.4 | Less than ten percent. | ID09 |
| 13 | 7:30.3 - 8:41.4 | And if you have to give a percentage to the components that you designed for additive and then they moved to a traditional manufacturing process, the components or products you designed they start directly with production with a traditional, conventional manufacturing process that go directly to injection moulding or any other process and the projects you did for tooling and projects in which you used additive manufacturing for prototypes or one-off. If one-hundred percent is the number of projects you have worked on, can you tell us how much is percentage of projects in which additive is used as a prototyping technique? | Interviewer A |
| 14 | 8:41.3 - 8:42.4 | All of them. | ID09 |
| 15 | 8:42.3 - 8:48.5 | What is the percentage in which additive is used as a tooling technique? | Interviewer A |
| 16 | 8:48.5 - 10:31.5 | Only in terms of pattern making not in terms of making components to produce tooling. No parts of a cavity or a core are made using additive technology. We have seen when we have been to TCT, we have seen people using or saying that they creating tools using additive technologies, but I have not seen it work. And we tried it here and we cannot get it to work. I know what saying that, for soft components like producing items in cold cure silicone, we have done that here, our SPD team who make the surgical prosthesis design, they will use, their Makertbots to produce client interfaces (socking liners) from artificial limps. So they will use additive technology for that point of view and then cast silicone in those type of tools. But in terms of making items in rigid resin, we tried it and we cannot get it to work. There is usually some kind of leaching between the resin and the tool components and they just bond together. | ID09 |
| 17 | 10:31.5 - 10:43.0 | And how much is the percentage of products that you designed and they started the production with additive and they moved to conventional? | Interviewer A |
| 18 | 10:43.0 - 10:47.5 | Everybody ends with moving to move to conventional at the moment. | ID09 |
| 19 | 10:47.5 - 10:49.1 | But Everybody starts with additive? | Interviewer A |
| 20 | 10:49.1 - 11:04.0 | We start the process, we prototype with additive and then we present different techniques, we may stick with additive or we may start with vac casting, so it’s an alternative low volume. | ID09 |
| 21 | 11:03.9 - 11:11.9 | And can you tell us a little bit what is the percentage of products that you stick with additive and the projects where you move additive…? | Interviewer A |
| 22 | 11:11.9 - 11:14.5 | It’s very, very low that we would stick with additive. | ID09 |
| 23 | 11:14.5 - 11:16.2 | Something like? | Interviewer A |
| 24 | 11:16.2 - 11:19.4 | Less than five percent. | ID09 |
| 25 | 11:19.4 - 11:27.4 | Do you think this percentage is going to change? | Interviewer A |
| 26 | 11:27.4 - 11:28.7 | No. | ID09 |
| 27 | 11:28.7 - 11:35.9 | And do you think additive may become a production technology? | Interviewer A |
| 28 | 11:35.8 - 11:41.0 | In certain materials, yes, not in plastics, no. | ID09 |
| 29 | 11:40.9 - 11:51.5 | Do you think it may become in the future some projects in which you will start producing in additive and then you will stick in additive? | Interviewer A |
| 30 | 11:51.5 - 13:27.1 | Yes there will be. Specifically in metals, it won’t happen in plastics, because additive technology with plastics at the moment from durability point of view, from accuracy point of view and from a product longevity point of view, just it isn’t anyway near, good enough and I don’t think it will ever get that good to be honest, but metals, it is a different kettle of fish because metals -- lots of things that you want to do in metals, within the UK the knowledge base of how to produce reasonable complex forms in metals is quite low; so is where we could traditionally get something die cast or investment cast, those kind of skills aren't particularly prevalent in the UK at the moment. And there are lots of opportunities for using SLM to produce components which will -- if I am in a situation now where I am looking at die casting especially in low volume, I probably wouldn’t -- I would just stick with SLM. | ID09 |
| 31 | 13:27.1 - 13:38.6 | For die casting, the size of the part is relatively (()) bigger than a SLM part. | Interviewer B |
| 32 | 13:38.6 - 13:41.3 | No, not necessarily no. | ID09 |
| 33 | 13:41.3 - 13:59.5 | In my email, I asked if you could identify some components or products that you have designed and then they have been produced in additive, can you show some of examples of products you have designed and they have started the production with additive? | Interviewer A |
| 34 | 13:59.5 - 14:02.0 | I am afraid I can't. | ID09 |
| 35 | 14:02.0 - 14:04.7 | Because they are protected by? | Interviewer A |
| 36 | 14:04.6 - 14:15.7 | The are not public yet. | ID09 |
| 37 | 14:15.7 - 14:26.7 | For these components or products how did you decide to start to produce them at the beginning in series using additive? | Interviewer A |
| 38 | 14:26.7 - 17:13.5 | It is a question of risk management and cost. A lot of our clients have only get the funds or the resources to make one choice in terms of tooling and even then, they might not have a large funding or pot of cash to spend on tooling. So in those kind of situations it might be a brand new product, new to the market, it could be something very innovative which we don't know how it’s going to go. That might be dependent on third party supply of components which they cannot guarantee for any length of time. So for example we have a company who uses the CCD charge coupled devices for image capture. Basically they break a part, an off-the-shelf camera, rob the components out of it and put it into a different housing to do a different job. So something like Nikon, Canon are not going to be responsible to their needs, a customer or whatever. So unlikely the supply of those products might change every nine months. So there will be slight detail changes like mounting hole positions, the component layout on a PCB, which it means that they got to re-jig their housing to suit the changes being made by another manufacturer. So in those kinds of situations if it is likely that the design of a component is going to change every six months, the client, there is no way they’re going to be able to commit to a tooling cycle every six months. So it uses additive manufacturing to produce their parts especially if they are in reasonably low volume. Use additive manufacturing to produce those parts and every six months the designer revised to make sure that the part will work with changes (that are gone is) the manufacturer. It is a very typical situation. | ID09 |
| 39 | 17:13.5 - 17:24.9 | And in these cases which additive manufacturing technology was used to make the components? | Interviewer A |
| 40 | 17:24.9 - 18:15.5 | We will use SLA a lot. We run several different types of resin. So we will run a resin which we call it Extreme, which is like a ABS mimic. We still have to surface finish it on the outside because the other issue with additive manufacturing is the build quality is pretty -- isn't cosmetically acceptable in the majority of cases. So with SLA, a part (an prepit) so we sand it and finish it with a paint coating or a plating, so just chrome. | ID09 |
| 41 | 18:15.5 - 18:25.0 | In the cases and examples you told us before, for example that one of the camera, which additive manufacturing process did you use? | Interviewer A |
| 42 | 18:25.0 - 18:30.0 | That was SLA and those are SLA still. | ID09 |
| 43 | 18:30.0 - 18:31.6 | Did you use only SLA? | Interviewer A |
| 44 | 18:31.6 - 18:43.6 | That's the most convenient thing that we’ve got, which is at a high enough definition to be finished to make it look it like a finished product. | ID09 |
| 45 | 18:43.5 - 18:46.3 | Do you have any other technologies in house? | Interviewer A |
| 46 | 18:46.3 - 19:11.6 | Yeah in house we’ve got SLA, we’ve got Projet which is a powder and wax depositing process and we’ve also got hundreds of Makerbots. I would never, ever design anything to be produced on a Makerbot, or that kind of filament deposited. | ID09 |
| 47 | 19:11.6 - 19:19.3 | And you use SLA to do the actual production of the components? | Interviewer A |
| 48 | 19:19.3 - 20:07.5 | And we do with the Projet. We have a customer who wants extremely finely detailed meshing and moving parts and so these are the kind of parts that... In an ideal world, there will be metal injection moulded probably, but it can just not afford the tools for it. So we produce these parts that are tiny and they want thousands of them; so we lay them on a bed and produce thousands of things in one hit. So that's been done on a Projet. | ID09 |
| 49 | 20:07.5 - 20:13.2 | And did you design those components? Or were you involved in the design process? | Interviewer A |
| 50 | 20:13.2 - 21:48.8 | We were involved in the design process. They came to us with a reasonably well finished design, but it wasn't -- we had to consider things how it lays on the bed, the grain, the accuracy, orientating a part from -- whether it is in line with the build layers or against the build layers. We got to consider that, tweak it, move it, how it’s supported as it is being built as an effect. So if somebody wants a really nice cosmetic surface, we have to orient it, so that the build structure is below, so the A surfaces is going be spot on. So we will get involved and say look, if you do it that way, that might be an inherit weakness, because things like Projet the items that come off have a grain to them and it would fracture along the grain, so if you can turn this, if you can change the orientation, do this or the other, then it’s more likely to be more robust. So we will have or a conversation with them and sometimes they will supply us with the native CAD. In the majority of the situations we get supplied with non-native CAD so rather than having a Solidworks file or an Inventor file, we have STEP file or STL or an IGES and we’ll work off that, probably re-CAD it. So we can modify more effectively and then. | ID09 |
| 51 | 21:48.8 - 22:00.2 | In that specific case, do you remember -- did you do any modification to the design, to the geometry itself of the component? | Interviewer A |
| 52 | 22:00.2 - 22:08.9 | Yeah we regularly change the geometry to ensure that things like build layers and the dimensional accuracy, is at its optimum. | ID09 |
| 53 | 22:08.9 - 22:14.5 | And what do you mean by making the dimensional accuracy at its optimum? | Interviewer A |
| 54 | 22:14.4 - 24:14.8 | The build accuracy in terms of layers. As a layer is applied, the thickness of those layers is pretty consistent. So the Z generally in a build is accurate but the X and Y, because it’s dependent on pulleys and mechanisms to move the head around of the laser moving and tracking and registering and going back to its original starting point and that kind of thing. The X and Y accuracy is not as effective as the Z accuracy. So we might need to change orientation. If we got something which needs a lot of structure to support itself as it is being built then we got to make sure -- if we are building a cylinder, we want the cylinder to be built, so that the round dimension is in its Z ideally, because there is less chance of that cylinder deforming. If you build it on that way on its own weight, it might start to collapse. So we need to orient it according to the bed, according to the build. If we can, to give you the better accuracy and then the actual size of the bed might say, the item could be a hundred and seventy-eight millimetres long, the cylinder on that way but really you want to build it that way. So it might be too tall for the tank so we might have to say look, to get the right accuracy, it’ll need to be built in this way, but unfortunately it is three millimetres, too high, can we shorten it? So all those kind of things in your head as you are working through the CAD. Size of the build bed, orientation of the layers. | ID09 |
| 55 | 24:14.8 - 24:30.5 | Can you show any examples of that kind of process of products or components -- how they arrive to you and how you tweak them in order to make them feasible for SLA? | Interviewer A |
| 56 | 24:30.5 - 27:07.0 | Yeah I’ve got one part. You cannot photographs but I can show you. It is an early example but it is an example.  This is the lead of a box. It is been primed since but you can still see some of the -- especially on the other side you can see the build layers. When this CAD came to us -- this came to us as an STL file. The person who had designed this, had been making these on a Makerbot. Too slow, a lot of issues, so we have been making these, this is SLA. So we had to change the rib details on this basically to make sure that A surface is dead flat and there are no cosmetic interruptions or build lines or anything to that. It is as good as it can be. So re-orientation of that in the tank -- it had to be built the way up obviously and then to make sure that there is no kind of dishing or dimpling which could occur afterwards. Or the blending details between the ribs have been made, so that you would not get like a registration of that shape on the outside. | ID09 |
| 57 | 27:07.0 - 27:09.6 | Can I sketch it? | Interviewer A |
| 58 | 27:09.6 - 27:48.8 | Yeah just don't put the text on it. So it’s that the rib detail which is the critical thing I would have to change. | ID09 |
| 59 | 27:48.8 - 27:57.8 | You mean because of the steps? | Interviewer A |
| 60 | 27:57.7 - 28:19.6 | It is the thickness of the steps -- the way that you blend one step into the other, so it does not start to pull or deform or register on the top or start to ball. So we put a very fine chamfer on there, so the steps building gradually. | ID09 |
| 61 | 28:19.6 - 28:28.7 | Because otherwise you will have that kind of deformation you may have with injection moulding? | Interviewer A |
| 62 | 28:28.7 - 28:36.0 | Yeah. it is gonna be fifty of these made. | ID09 |
| 63 | 28:36.0 - 28:41.8 | Can I ask you the same questions using this case as an example? | Interviewer A |
| 64 | 28:41.8 - 28:43.1 | Yeah. | ID09 |
| 65 | 28:43.1 - 28:47.3 | Why they decided to make this in additive? | Interviewer A |
| 66 | 28:47.3 - 28:50.1 | Because they don't know if the product is going to sell or not. | ID09 |
| 67 | 28:50.1 - 28:54.7 | So it is what you tell us before about risk management and cost? | Interviewer A |
| 68 | 28:54.6 - 30:32.5 | Yeah. This is a device which is based on modifying somebody else’s technology. This is the lead of a box, everything that is in the box, the manufacturer of those components might turn around tomorrow and say I don't make those anymore. The project could finish immediately. They are not sure whether there is a market for it. They think there is a market for it because of their particular situation. They are producing a product which is essentially for themselves and they think it’s great. Whether they are going to be able to sell it, it is a different matter. They are producing fifty as Kickstarter organization. They are gonna produce fifty, see if they sell, then next a hundred they might still keep on producing the same way, because they are not a big enough client for the electronics company who is making all the (cobings) which goes inside the box. They don’t have any clout or any yeah clout. Do you understand a clout is going to be any like, in terms of impact with the electronics company? | ID09 |
| 69 | 30:32.4 - 30:35.3 | Yeah they don't have any leverage. | Interviewer A |
| 70 | 30:32.5 - 30:46.6 | Exactly leverage. They got no leverage at all so until they start to get leverage to commit to injection moulding tooling is too risky. | ID09 |
| 71 | 30:46.6 - 30:56.6 | And that's why they did not consider any other conventional process? | Interviewer A |
| 72 | 30:56.6 - 30:57.4 | Correct. | ID09 |
| 73 | 30:57.4 - 31:02.6 | And was this made in SLA? | Interviewer A |
| 74 | 31:02.6 - 31:03.3 | Yeah. | ID09 |
| 75 | 31:03.2 - 31:04.3 | And the material is EXTREME | Interviewer A |
| 76 | 31:04.2 - 31:07.0 | Yeah. | ID09 |
| 77 | 31:07.0 - 31:20.7 | And that's why they chose that process because -- what are the main considerations of choosing SLA and that material for that specific component? | Interviewer A |
| 78 | 31:20.6 - 32:38.9 | Eh well for us, those are the machines that we’ve got in house; so to a large extend, we are tight to the technologies that we have. You know, we’ve got three basic technologies in terms of RP: Makerbot absolutely no way; Projet you’ll get a better finish, but is not as durable; SLA we’ve got three different resins. The Extreme, it handles like ABS, more or less; so we are happy to use that. It is good, it’s reasonable, reasonably quick. We can layer -- we are not layering the lids, but we are layering the boxes on the other side -- we can layer the boxes because is less cosmetically critical parts to those boxes. So we can run, we can run four in a tank, in a build; so we can leave them overnight and clean them in the morning . | ID09 |
| 79 | 32:40.3 - 32:53.9 | Did the design change after you decided to make it with SLA? | Interviewer A |
| 80 | 32:53.9 - 33:52.7 | Yeah we had to tweak the CAD which we were given to make it more appropriate. So again in terms of risk management, being confident in your build, we were aware of the parameters and the constraints of the technology so we make allowances, we change the tolerances to make sure that, you know, the parts -- This is very simple job, it’s only two parts fitting together. It has to be a reasonably nice fit. So we changed our tolerances according to the SLA, according to how it is oriented in the tank. So whereas the tolerances for the Z axis usually point one of the mil [i.e. 0.1mm]. Tolerances on the X and Y axis, we’ve got a loud about point three. | ID09 |
| 81 | 33:52.7 - 34:36.5 | Sorry if I ask you this (()) If you come back to the example of the cylinder, it means that if your cylinder is like vertical on the building plat, the shape of each layer of the circle of each layer would be worse if you tolerances is bad on the X and Y instead the dimension of the overall cylinder would be much more precise. | Interviewer A |
| 82 | 34:36.5 - 35:21.2 | Correct yeah.  Because sometimes we are doing some stuff which needs a high level of accuracy. The same kind of accuracy you get of injection moulding. So we had to spend a long time just thinking about how things would build and we might actually build things in parts. Put like a jigs saw and joint in it so it can be built accurately and then assembled rather than being in a solid. Just to get around dimensionally inaccuracies. |  |
| 83 | 35:21.2 - 36:00.2 | Now I am going to use a metaphor ... [introduction to question] ... How did you come about with that specific shape? | Interviewer A |
| 84 | 36:00.2 - 37:12.1 | In this particular case, it was driven by the client. The client said I want a square box; but in other situations form, from an industrial design -- from a new product development point of view, the form, the overall form, the general form, is always driven by the industrial designer. So the guy who has the appreciation of the look and feel of the device will dictate to a large degree the form of that device than it’s due to job of the mechanical designer, the product designer to make that work. If our industrial designer said I wanna to be this shape, I can't turn around and say: "well you can't do it, you can't produce that" I have got to make it work. So they dictate the form and we make it work. | ID09 |
| 85 | 37:12.1 - 37:15.6 | And how do you make it work for SLA? | Interviewer A |
| 86 | 37:15.6 - 41:18.9 | It is all a question of head scratching, isn't it? You know, you just go through the hops. We all work -- create shapes, create the form, talk to the people who run the machines, who have got a better idea of how the machines perform and give them -- get them into look at the CAD and go through all the detail, is that going to build right? Which way should we orient it in the build? Can we cope with that overhang? Can we get any kind of -- if we have got to create a support structure, can we get that support structure out?  Now we had a situation a couple of weeks ago where we wanted to create a living hinge. Right, what we were trying to do, 'casue initially we thought this was gonna be SLMed, and it still potentially could be SLMed, so what we were doing is creating a very, very small barrel hinge. You know you have a door, put a pin in the barrel hinge is just under millimetre diameter. So we've got a millimetre diameter pin and then, one component [ID09 is drawing a sketch] looks like that, so you've got, effectively, two of the barrels and we've got another component [ID09 is drawing a sketch] looks like that. Now what we want, what we're doing on SLM, is that we are building, instead of building three parts like that, on the machine because we know we can generate, I think they could guarantee a point one millimetre gap between parts, between moving parts. I could build that pin between mils two and that in-situ with point one millimetre gap between that diameter and the diameter of the pin and that space all the way around. So that was being constructed, as a hinge on the SLM, and we just get it out, knock the dust down and expect it works. So that's the situation where we were designing that specifically for SLM but the client wanted to see it in a prototype in SLA quickly and SLA is no way, is gonna do that. And on anything which is plastic, you can't build in a fine gap around the parts, even on a Projet. You know, it'll put in a tiny layer of wax, which you won't be able to get out. So we had to design it in a more traditional way, put the pin in and glue it afterwards [background noise too strong, cannot hear what ID09’s voice]. So there's a lot kinds of situations that come up all the time and we tend not to think about them () [background noise too strong]. | ID09 |
| 87 | 41:18.9 - 41:34.3 | And, so, now maybe we are interrupting you, (and you are not involved), but do you think what were considerations at the concept stage? | Interviewer A |
| 88 | 41:34.7 - 42:07.3 | No, no, industrial designer does not consider manufacturing process at the top. If he did, he'd end up with the tail wagging the dog. Industrial designers gotta be completely free to say just make it happen. Alright. Mechanical designers' job is to deliver his or her vision. | ID09 |
| 89 | 42:07.3 - 42:18.9 | So, you were working more on embodiment and detail design, right? So, what were the considerations at embodiment and detail design, in that specific example? | Interviewer A |
| 90 | 42:18.9 - 43:24.5 | In this specific example, we got to consider that we can deliver something which is strong enough for the job and this is the main. The two main whole (boxes or bugs) for additive technologies at the moment is strength and accuracy. So we know, with something like this, you know, 3 millimetre wall, it's gonna be plenty strong enough, it's no way gonna break. So we are happy to use those processes for that kind of situation. I think, to customer, there is no way [ID09 restarts a sentence], once that's out in the field, nobody is gonna think, oh, that was a box manufactured by additive manufacturing. There is no way you'd be able to tell. So we are happy to work on that basis. | ID09 |
| 91 | 43:24.5 - 43:28.1 | What do you mean when it goes to the field? | Interviewer A |
| 92 | 43:28.1 - 45:22.3 | You know, a lot of what people seeing since additive technology at the moment [does not make too much sense], all these multi-layer builds, we see all the, it looks, it's being true to itself, but it's not necessarily in appealing aesthetic because it looks grainy. And at the moment, you don't associate a plastic item with a grainy feel. So we have to make the item look more like an injection moulded item, a finished item, because at the moment, I don't think the quality of an additive manufactured part straight off the machine, I don't think the visual quality inspires confidence in the end user. So you know, all our sections of quality about uniform surface, uniform feel with wood, it's slightly different, because we appreciate the novelty of the grain and it's the lustre of the grain which gives the product its appeal. But with a surface which is regularly (straited), it doesn't at the moment, say quality, strength, durability to the end user. | ID09 |
| 93 | 45:22.3 - 45:35.2 | There were any other considerations when the product was going towards production? You started to produce it, like, did you notice something that you decided to change? | Interviewer A |
| 94 | 45:35.1 - 48:40.7 | There is much more fine tuning as there is in any other processes. So you go to the process of T1, T2, T3s. Usually mechanical details which need further resolution. So if you've got a latching mechanism, so part are clipping together, you have to spend a lot of time analysing the performance of those clips, because what we've found with a lot of additive manufacturing parts at the moment, is that they are not dimensionally stable long term. So if you've got anything which's got any kind of tension on it, there is a tendency for small details (dis-stretch), especially if you (are) sub one millimetre wall thicknesses or cross sections. So we tend to push things as much as possible, in terms of refining the design to minimise materials. You know all usual processes you'll go to. So there are times, I've been working on a project where, we know that the product's got limited life span, it's only been on the market for a few weeks but within those weeks, it's got to perform well. So we thought we'd get away with quite a small clip detail to join two parts together. What they were doing was, they were sandwiching a silicon gasket. So the silicon gasket is obviously trying to push the parts apart. What we were finding was all the clips stretching. So when we first put the items together, it bombed, you know, it's like clogged, fitted together, solid, great. Leave it overnight, come back in the morning and its movement, because the clip details are stretched against the force (of the elastomeric). So then, it's, ok, T1 is failed. Go back to the CAD, add material, beef it up, SLA again. Actually that's Projet again. And as you would, with injection moulding, you adding material, taking material off, to get the performance you require. So, as with any other design process, it's very rare that you have first design, produce it and it works and brilliant. You know, there is always process verification and validation and adaptation to go to suit. | ID09 |
| 95 | 48:40.7 - 48:53.7 | Did you follow any design rules? Any specific design guidelines, design rules when you designed this component for SLS [I think it's 'SLA'] and Projet? | Interviewer A |
| 96 | 48:53.7 - 48:55.7 | No. | ID09 |
| 97 | 48:55.7 - 49:01.4 | But you did tell us that you considered the orientation, that sort of thing. | Interviewer B |
| 98 | 49:01.3 - 49:16.6 | Yeah, yeah, it's, I suppose nobody's, I haven't got a like an A4 sheet saying do this, do this, do this and do this. It's just experience. | ID09 |
| 99 | 49:16.6 - 49:25.7 | How many components have you designed for SLA? The day and then produce, at least at the beginning with SLA. | Interviewer A |
| 100 | 49:25.7 - 49:42.7 | In the past three years, [ID09 is thinking]. Individual components or products? | ID09 |
| 101 | 49:42.7 - 49:48.0 | Both. Either individual components. | Interviewer A |
| 102 | 49:48.0 - 50:01.1 | 8 or 9 products, so about 20 components. | ID09 |
| 103 | 50:01.1 - 50:10.3 | And how often did they come up? | Interviewer A |
| 104 | 50:10.3 - 50:19.5 | We start a new project about every 6 to 7 weeks. | ID09 |
| 105 | 50:19.4 - 50:28.4 | Any of the projects involves the production of that component or product with SLA first? | Interviewer A |
| 106 | 50:28.4 - 50:44.5 | Yes. About 80% of the time. Some parts, something just too big. | ID09 |
| 107 | 50:44.5 - 51:02.2 | Ok, so, you are telling us that you don't have any, you don't follow any specific design guidelines and design rules, which are hidden somewhere, right? They are all stored in your experience in designing and doing this. | Interviewer A |
| 108 | 51:02.1 - 52:39.6 | Yeah, also what you tend to do is that, if it is a specific element of a design, you'd research that element. So for example, we've just been looking at living hinges on nylon SLS. You (are familiar with) living hinge, so you know, usually you'd do that on (polypro) [I think it's 'polypropylene'] injection mould. Got a small project, it's a medical project. There is only gonna be 50 or 60 of these items ever gonna be made in the whole world ever, but it needs a living hinge. So we spoke with prototype manufacturer who does an awful lot of S L S. It's a lot here. We only need to produce a living hinge. Can machine it in polypro, I mean, couldn't machined it in polypro. But I can equally SLS it in nylon, and it will work just as well. So we asked him for details and he's just sent us a little guideline of dimensional requirements to generate a living hinge in nylon using SLS. So, orientation and appropriate dimensions. | ID09 |
| 109 | 52:39.5 - 52:42.7 | Then you would use it in Polyjet? | Interviewer A |
| 110 | 52:42.6 - 52:43.9 | Yeah. | ID09 |
| 111 | 52:43.9 - 52:50.5 | You would try the same dimension with the Polyjet and you would do test and iterations? | Interviewer A |
| 112 | 52:50.5 - 54:23.7 | Yeah, and that works first time. It's really good. We've actually taken our polypro shape and supply it to him right in the beginning and he said alright, ok, I can see this's been designed for polypro. If you modify with a living hinge, you have a curve side and a flat side, depending on which way it's gonna flex. So the shaping is like that [ID09 is drawing a sketch]. So you have a radius which is a critical feature. That thickness which is critical. And then that gap across that is critical. The thickness of that eventually doesn't really matter. There is no bending on that. It turns out with SLS nylon, you've got a limit of 0.4 mil there before that starts to fatigue and crack. So we had to build that feature. It's the item we were making. So wasn't the whole thing, it's just that one detail. It happens to a lot of things. Whenever you've got a, you can't have everything in your head. You don't want piles of books and pamphlets () everywhere, 'cause you don't want to () [ID09's voice too weak, cannot hear clearly]. So you just tend to do it detail by detail. | ID09 |
| 113 | 54:23.7 - 54:29.7 | So when did it take comes about [not make too much sense] solve that detail, then you will ask someone? | Interviewer A |
| 114 | 54:29.7 - 54:38.6 | Yeah. Usually the person who's running the machine is the best person to ask. | ID09 |
| 115 | 54:38.5 - 55:00.4 | I might have misunderstood about what you said, 'cause Interviewer A asked, you said a friend of yours some rules about, well something like that [Interviewer B is pointing the drawing ID09 drew], on SLS nylon, and you tried on Projet? | Interviewer B |
| 116 | 55:00.4 - 55:03.4 | No, you said Polyjet? | ID09 |
| 117 | 55:03.4 - 55:05.0 | Yeah, Polyjet. | Interviewer A, Interviewer B |
| 118 | 55:05.0 - 55:13.1 | On whatever the machine was, it's probably not Projet 5 run in nylon. | ID09 |
| 119 | 55:13.1 - 55:16.3 | Ok, so, you took the rules from SLS? | Interviewer A |
| 120 | 55:16.2 - 55:39.7 | We started off the rules for Polypro as it was gonna be injection moulded. And then spoke to the guy who's got a SLS machine. You tell us what you need to do or what we need to do to get that to work in nylon and he sent through some guidelines. | ID09 |
| 121 | 55:39.7 - 55:43.5 | What is the final production process you are going to make that component? | Interviewer A |
| 122 | 55:43.5 - 55:51.7 | That's gonna say in SLS. It's only gonna be 15. It's never gonna go to injection moulding. | ID09 |
| 123 | 55:51.7 - 55:58.1 | But it's never gonna go neither to SLA or? | Interviewer A |
| 124 | 55:58.1 - 56:12.1 | No. My only concern now is humidity on that, 'cause nylon SLS tends to. | ID09 |
| 125 | 56:12.1 - 56:14.2 | Nylon tends to keep the water. | Interviewer A |
| 126 | 56:14.2 - 56:23.2 | Yeah. SLS micro-pores. In my side, we don't know. | ID09 |
| 127 | 56:23.2 - 56:44.9 | Ok, so, in that specific case, did the introduction of or the use of additive manufacturing change the design of other components? | Interviewer A |
| 128 | 56:42.2 - 57:27.4 | No. The reason why using additive manufacturing is that everything else tends to be fixed and or in flexible. So the additive manufacturing is the most flexible part of the design process. So you've got so many other things that you cannot change. I can't change the PCB going in there, can't change the connectors that go in there. The only thing I can change is the box. So that's why we would use S L S for that, or use additive manufacturing for that. | ID09 |
| 129 | 57:27.4 - 57:35.4 | For that component, are there any drawbacks or limitations as a result of being made with additive? | Interviewer A |
| 130 | 57:35.3 - 57:51.0 | Only speed of production and cost. | ID09 |
| 131 | 57:51.0 - 57:56.4 | Does the use of additive manufacturing change your design process or practice? | Interviewer A |
| 132 | 57:56.4 - 58:02.6 | No, no. | ID09 |
| 133 | 58:02.6 - 58:22.9 | Ok, so, now, we are going to ask you some general reflections on additive as a production process for design. What are your views on additive manufacturing as a production process for end user products or components? | Interviewer A |
| 134 | 58:22.9 - 58:34.9 | I think it's pretty limited at the moment, especially in plastics. In metals, it's a different situation. | ID09 |
| 135 | 58:34.9 - 58:40.6 | Can you tell us what these limitations for plastics are? | Interviewer A |
| 136 | 58:40.6 - 58:53.2 | Quality of finish, strength and cost of production. | ID09 |
| 137 | 58:53.2 - 59:02.2 | In general, what do you think designers need to know for designing effective parts for additive? | Interviewer A |
| 138 | 59:02.2 - 59:15.1 | It's just understanding the limitations. | ID09 |
| 139 | 59:15.1 - 59:19.2 | What do you mean by 'understanding the limitations'? | Interviewer A |
| 140 | 59:19.2 - 1:00:10.9 | Well, we know, it's not an ideal process, because the layer generation. There is inherent weaknesses. Specially in plastic, it adds a consideration to material which you don't get in traditional plastic materials manufacture. So adding this element with grain which is critical, which generally don't have in other plastics manufacturing techniques. That's what you need to be aware of. | ID09 |
| 141 | 1:00:10.9 - 1:00:13.1 | Of the grain? | Interviewer A |
| 142 | 1:00:13.0 - 1:00:26.6 | Of the grain, yes, as an effect on strength, as an effect on accuracy. | ID09 |
| 143 | 1:00:26.6 - 1:00:28.9 | How did you learn how to design for additive? | Interviewer A |
| 144 | 1:00:28.9 - 1:00:40.8 | Talking to people who run the machines. | ID09 |
| 145 | 1:00:40.8 - 1:00:44.6 | Did you come up with your own rules? | Interviewer A |
| 146 | 1:00:44.6 - 1:02:56.7 | I learnt to dismiss some of the claims made for the process. It's not worth taking it, you know, if somebody, you know, manufacturers of the machines come in every four months trying to sell us new ones. And they'll say now you can get a build layer 0.07 millimetres. I'd say that's great but what does it mean to me as a designer? Doesn't mean that much because I cannot rely on, if I had a feature, which depended on a 0.07 millimetre gap for it to work, that'd be a crazy shit. You cannot rely on that level of accuracy and you cannot trust it and you cannot exploit that level of accuracy. You accept that it's there and as an effect on our ability to get a nice quality finish on the items, but you are not gonna design something thinking, I can get away with, you know, if I had two cylinders rotating on one inside each other and I put a 0.07 millimetre gap between them and SLA them or whatever machine is on that and expected that'd work, it's not gonna work. Because the build layer might be 0.07 but any slight deviation on the laser or the depositing head, if the cylinders gonna slightly bolt to it or the layer is building 0.07 that way, every build layer might be, and it's slightly moving over to one side, so there is a link to the device, there is no way it could work on that. [Note: there are a few incomplete sentences in this conversation] | ID09 |
| 147 | 1:02:56.6 - 1:03:03.9 | How do you prove your design rules? I mean, your knowledge of additive. | Interviewer A |
| 148 | 1:03:03.9 - 1:04:46.3 | With ISO 9000 quality assurance, so whenever we do a project, we try to do a lessons-learnt exercise. So we have a design team, a design office and we have a workshop team who owns the machine and anything else. So it tends not to happen if things are working well. But if there are, if we have had a significant problem with the project, then we will have a meeting, we will go through all the details of where it went wrong and why it went wrong, try to find out why it went wrong. And then that becomes the general knowledge within the department of what to avoid and try to avoid replicating that, that kind of activity happen again. We are regularly doing things like recalibrating machines, wouldn't recalibrate the whole machine to produce something like this. It's got 0.3 millimetre accuracy on it, it doesn't make any difference. If we go fine tuning and something very accurate we want to achieve before we do the build, can we calibrate the machine please? So we know that is working, (smack on), for that work. So things like that, we try and bring in our quality process as procedures. | ID09 |
| 149 | 1:04:46.3 - 1:04:48.2 | Do you document? | Interviewer A |
| 150 | 1:04:48.2 - 1:04:52.2 | Yeah, it's all documented. | ID09 |
| 151 | 1:04:52.5 - 1:04:59.7 | Ok, in the next 5 to 10 years, how do you think additive manufacturing as a production process will influence design? | Interviewer A |
| 152 | 1:04:59.7 - 1:05:14.1 | In plastic, it won't. In metals, I think it will. | ID09 |
| 153 | 1:05:14.0 - 1:05:21.9 | Can you explain a little bit more why do you think it will not influence plastic but it will influence metals? | Interviewer A |
| 154 | 1:05:21.9 - 1:06:43.7 | The cost of injection moulding in plastics at the moment is ridiculously cheap. You know, for that client [ID09 is pointing at a part], it is probably a little bit on the, well, I can get injection moulding to produce something 15 [or 50?] centimetres cube for 3000 US dollars. So you are paying, the client wants 50 of those, so for 3000 dollars, yes, 60 pounds [should it be 'dollars'?]. If you are paying 60 pounds for each of those S L A, and they want 50, it's 3 grands. So, (broad line), well I just flip files over to a mate in Hong Kong, and get it injection moulded. And then, if I never use the tool again, who cares. | ID09, |
| 155 | 1:06:43.7 - 1:06:49.4 | If for low production volume, injection moulding. | Interviewer B |
| 156 | 1:06:49.4 - 1:07:09.7 | If you wanted more than 50 units off, you might have to go to injection moulding at the moment. Well, depending on size. Injection moulding () coming various sizes for different sizes of press. So the cheapest till at the moment, 3000 US dollars. | ID09 |
| 157 | 1:07:09.7 - 1:07:31.7 | In academia, people look at the manufacturing paradigm. They think that there is a move, the paradigm shift, from mass production to mass customisation to personalisation. So, as a designer, do you think that this kind of shift is happening? | Interviewer B |
| 158 | 1:07:31.7 - 1:07:35.2 | No. | ID09 |
| 159 | 1:07:35.2 - 1:07:40.9 | If yes, that means additive manufacturing can be useful? | Interviewer B |
| 160 | 1:07:40.9 - 1:09:03.5 | Well, I think, where the main areas that additive manufacturing are gonna be used are going to be for things, for example, like the supply of replacement parts. So if I was a huge car manufacturer, whatever, I don't wanna be keeping massive stock of spare parts for ten years to service, the cars I've sold, so having the ability to fund every service station to have a 3D printer, so you know I need a new (cv gaiter) produced rather than having it on the shelf, print one. So I think that's where it's gonna go. The whole thing about customisation and anything else, how much spare time have you got in your life? Not much. So you've got time to design yourself a new cover for your iPhone? No. So, there you go. There is gonna be as good as something that you are gonna buy from Apple. | ID09 |
| 161 | 1:09:03.5 - 1:09:11.6 | For the spare parts, did you mean that's for both metals and plastics? | Interviewer B |
| 162 | 1:09:11.6 - 1:11:13.8 | Probably metals not because you need a secondary process. But anything plastics, that's what's happening, isn't it? Like BA systems are already looking at using additive manufacturing, and they've already used additive manufactured spare parts for components in planes. I don't know whether you've ever bought spare parts for car, but if you own either a Polo, (a Seat Ibiza) [ID09 is giving some brand names of the cars], initially, all those parts should be interchangeable because they are all part of VW AG group. So the components are supposedly interchangeable. But if you own a Vauxhall, or an Opel [a brand name of car], the same model, you might have 4 or 5 different variations of components depending on which plant your car was assembled in. So to be able to say, I need a distributed cover for a Vauxhall (Astra), you might think well, will it be the same distributed cover, for a (Opel Kadett) [a brand name of car] might be slightly different. So having all those kind of catalogues with all the 3D files available, so you can print, you know your car will have a serial number, you can have a complete initial build against that serial number. So if you do need any spare parts, you will know the exact replacement for using additive technologies for that part. That's how I see the future. | ID09 |
| 163 | 1:11:13.6 - 1:11:25.0 | Thank you very much for your time, it's been very helpful. Before we go, I would like to ask you some final question. What is your education background? | Interviewer A |
| 164 | 1:11:24.9 - 1:11:36.9 | I've got a Bachelor degree in product design from a college called (Ravensbourne College) [College name], is no longer exists. | ID09 |
| 165 | 1:11:36.9 - 1:11:46.5 | How long have you been working as professional designer? | Interviewer A |
| 166 | 1:11:46.5 - 1:11:51.9 | 22 years next week. | ID09 |
| 167 | 1:11:51.9 - 1:12:03.9 | Ok, so, can I confirm that it is ok for me now to take pictures and have copies? Can I have pictures of that drawing? | Interviewer A |
| 168 | 1:12:03.9 - 1:12:09.4 | Yeah, yeah. | ID09 |
| 169 | 1:12:09.3 - 1:12:30.1 | So, that project is not in the public domain? | Interviewer A |
| 170 | 1:12:30.1 - 1:12:35.2 | Not yet, no. I can send you photographs in a couple of weeks when it's out. | ID09 |
| 171 | 1:12:35.2 - 1:12:42.5 | That would be great. Can we use it as a case study? | Interviewer A |
| 172 | 1:12:42.5 - 1:12:56.0 | You can do. I'll try to find you something which is a better case study 'cause you know it's not a lot of (). So I will try to dig out a better case study for you. | ID09 |
| 173 | 1:12:56.0 - 1:12:57.1 | But eventually we can use it? | Interviewer A |
| 174 | 1:12:57.1 - 1:12:59.4 | Yeah. | ID09 |
| 175 | 1:12:59.4 - 1:13:30.7 | Ok, so, in the following weeks we will transcribe the interview and send you a copy to you in order to, so you can check what you've told us. If you want to change or modify it, adding or removing anything, you can do it at any time. Just one last question, would you prefer to be named or to be anonymised? In the future we are going to publish the study in a journal. | Interviewer A |
| 176 | 1:13:30.6 - 1:13:36.9 | Oh, you can name. | ID09 |
| 177 | 1:13:36.9 - 1:13:43.2 | Ok, that takes us to the end of the interview. | Interviewer A |
| 178 | 1:13:43.1 - 1:13:45.2 | I hope it was of use. | ID09 |
| 179 | 1:13:45.2 - 1:13:48.7 | I think it really was. | Interviewer A |
| 180 | 1:13:48.6 - 1:14:38.4 | [chatting] | Interviewer A |