MODELS, MAQUETTES AND ART OBJECTS: MAKING DATA PHYSICAL

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When I am involved in interdisciplinary collaborations with mathematicians and scientists, physical models and objects have proved to be powerful counterpoints to virtual models and data sets. I will discuss my use of rapid prototyping to make such objects, and contrast that to my earlier screen-based and online artworks. The use of rapid prototyping reconfirms the importance of the material properties of objects in my art practice, but accessing rapid prototyping machines is not easy. I will highlight some of the limitations of the rapid prototyping process and suggest reasons why fine art objects made with these processes are relatively rare.

THE JOURNEY FROM LIVE ART

I did my BA at Sheffield Polytechnic in the 1980s in Fine Art, Communication Arts, where I used video, film, and sound. Through working with my tutor, Fran Hegarty [1], a performance artist who uses video, I became interested in, and attentive to, the body in space. She helped me to train my thinking, and to pay attention to every thing placed in an installation, to be rigorous about what happened across time during a performance. Attention to detail was paramount. In light of this formative mentoring, I would describe my practice as being one that scrutinises structure and space, and makes a response to it. Sometimes that is literal, exploring the physical structures of a building or anatomical structures, but it may also be a social or cultural exploration of meaning. There can be an interesting overlap, or a kind of slippage, between how we relate to a physical structure, such as the heart or the English oak tree, as ‘out there’ and simultaneously as an icon, whose meaning is contested.

While at art school, I did not make many objects or models, focusing instead on performance and video. The nearest I got was as a first year student in Hull where we were

expected to draw boats. Bored and bewildered by this assignment, I hung out in the local café with unemployed dockers who still went there every day because that was their routine, their structure. I got to know them a little and a couple of them guided me around huge, derelict, cut-up trawlers. During those walks I accumulated samples in plastic bags (flakes of rust, dried pigeon shit, dozens of discarded welders' gloves). For me, this was the true stuff of the docks, getting up close and personal in a way I could not do by sketching. I'd lay this accumulation of material out to make compositions, but it wasn't representational sketching. Now, when I work making art objects in my studio, I recognise a similarity to that gathering of impressions. I am not necessarily trying to represent something literally, I am trying to capture the essence of a structure, sometimes to allude to its ideal form (its 'model' version). The series of pieces that comprise *Model Landscapes* were made in this way. This is in contrast to the works I make with scientists, where the resulting object is in some way a literal representation of a data set (such as *Heart*).

Model Landscapes (2005). Two rapid prototyped tree forms generated from fractal data.
A video camera that sends the image to a small LCD screen.

GRAPPLING WITH DATA AND THE VIRTUAL

I did my Masters in Electronic Graphics in Coventry, an odd choice for a technophobe. I focused on making time-based work. It was incredibly frustrating, the relative fluency and sophistication of my live art seemed long gone, replaced by clunky, awful-looking animations. Like many of my cohorts I produced nothing in that 18 months that I liked. Subsequently, many of my so-called 'digital artworks' have a time-based element. In

TechnoSphere [2] the Alife creatures ‘perform’ their lives, in Cell [3] the simulation of time is essential to our modelling of stem cell behaviour. In that virtual space, the importance of every element we model cannot be underestimated because it impacts on the veracity of the stem cell simulation, and its resulting usefulness to our collaborator medical scientist. The concerns of much live art are still in the pieces, and ‘the devil is in the detail’.

During my MA I learnt, falteringly, to 3D model on a computer, which at that point meant typing in *x*, *y* and *z* coordinates, using DART™ software. I had a matchbox on my desk that I used to hold up as a stand-in for whatever I was modelling, as I struggled to visualise *z* space. It seems strange now, but screens really meant two dimensions to me then, and working with a third, virtual, dimension was hard. Nothing I modelled was of any interest, but visualising a 3D virtual space was pretty radical for me. The ‘*z*’ space was a non-space ‘in’ the computer. It was in data.

OBJECT FROM DATA WHICH WAS FROM A ‘REAL’ OBJECT

Years later I read about rapid prototyping in journals like *Scientific American*, and *New Scientist*. Most of the examples shown were three dimensional, but barely. It was rare to see any rapid prototyped object that looked organic or particularly irregular. I was intrigued, but struggled to relate fully to this process. My interest in rapid prototyping was not to make ‘the prototype for something’, but to make ‘the thing itself’ (what is now partly addressed through so-called rapid manufacturing). In essence, rapid prototyping makes real something that previously has been virtual, and that is what interested me. Previously the object has been in that ‘*z*’ space on the computer and I wondered ‘do you relate any differently to it, when you see it and can pick it up?’

Heart (2004) MRi data of healthy human heart reconstructed for rapid prototyping. Two angles of the resulting rapid prototype, silver plated.

I concentrated on ‘making real’ objects that had previously been virtual. The first object I made was from MRi data of the human heart. I worked as artist in residence with Francis Wells [4], a cardiothoracic surgeon. By working with him I became interested in the structure of the heart, especially how he saw a ‘model’ of a heart in his mind’s eye, alongside what he saw literally when he was operating. To operate, a surgeon accesses multiple simultaneous understandings, and three-dimensional ‘images’ of the heart structure. One understanding is based on what they see before their eyes and feel in their hands. Others are derived from conceptual models – the heart as a moving vascular structure. But the appearance of the complex vascular structure as shown in textbooks, is never seen in surgery (unless it is plastinated and preserved as a rigid immobile object). As soon as the chest cavity is opened and the heart lifted out, it is subject to gravity. The vascular structure, without the support of the surrounding tissues, collapses and hangs like a squid. The only time it is seen non-collapsed and ‘alive’, is mediated, in 3D MRi scans and echocardiograms. So, I made a heart on the rapid prototyping machine from MRi data as an experiment to see how the surgical team would react to it.

OBJECTS FROM DATA FROM VIRTUAL OBJECTS

After we made TechnoSphere, Gordon Selley and I wrote some plain English rules describing the way oak trees grow, and the way they look. We embedded these rules in algorithms, and used them to produce 2D images to make the digital photographic work, The Landscape Room, and the animation, Decoy. It was intriguing how many people suspended their disbelief and thought they were looking at ‘real’ trees when looking at The Landscape Room photographs, into which I had placed algorithmic trees. People believed they were seeing a real tree, even if it was a wire line (so largely transparent). Viewers said, “Oh! It can’t be real because that one is transparent. I don’t understand. Did you erase part of the photograph to make the lines?”

Decoy (2001). Still from one of the animated sequences.

For Model Landscapes some of these computer models were wrangled into a format that the rapid prototyping machine could use, to produce little 3D trees. Some of them were impossible trees (without collision detection some branches blended together). It was interesting watching people look at them. They looked at them from many angles, by moving their head around, in the same way the surgeons moved the heart or walked around the heart object. And the more angles they looked at the object from, the more they started to question whether it was real. Then they would have discussions amongst themselves about what ‘real’ meant. And that, for me, was really the whole point. What is it about a structure that makes us believe it is natural, organic, versus artificial, and does it matter? In relationship to model-making, how does the scale of an object or a model impact on our willingness to believe it is a real organic object?

MAQUETTES, RAPID PROTOTYPING AND SCALE

When I made Model Landscapes with the rapid prototyped trees, I never thought of them as a maquette. I thought of them as a model in the sense of being ‘smaller than’, and in the sense of them being an idealised tree. That was my motivation. I started to think about them as a maquette *after* I had made them. They came out of the machine and were exhibited almost immediately. When the work goes out into the world, my relationship to it changes. I am distanced from it. Seeing the trees as part of the Model Landscapes exhibition was like looking at those Gestalt images, when you see the wine glasses, and then suddenly you also see two profiled faces, and then you can only ever see both images of figure and ground, but beforehand you could have spent months only ever seeing one or the other. For months I had seen the rapid prototyped trees as an exploration of ideas about

idealised landscapes, and been engaged with their relationship to mathematics, rules and the modelling of tree growth. Once I saw them as objects ‘out there’, I suddenly saw them as maquettes, which was disturbing.

I went back to the engineers at Bath University and said “Why is rapid prototyping used to make small things?” And the more important question, “What would happen if we scaled up rapid prototyping?” That was an important collision point for me. We had talked about approximation, and rapid prototyping being about intricate detail. One of rapid prototyping’s selling points is that you can get within 0.1mm accuracy. But for me, what it does in terms of making virtual 3D data real is the cool thing. I asked Adrian Bowyer [5] at Bath University what would happen if you scaled up rapid prototyping, and he was willing to conduct a thought experiment with me. His first response was ‘But of course it probably won’t be very accurate.’ I said ‘No, okay, it won’t be accurate, but if we made something that would rapid prototype something 40 feet high, do you not think somebody would find a use for it? We dreamt up giant cake icing type machines - robots that would pipe out expanding foam (or concrete) to extrude huge rapid prototyped objects, big and messy, not very accurate in relation to the computer file. For me, the making physical of something that is virtual is what is most interesting, and seeing the rapid prototype as a maquette rather than a model, made me think about wanting to scale up rapid prototyping, and that triggered off a huge number of problems, questions and ideas. These ideas have not been made real. Yet. [6]

THE TURN-OFF

Having a sketchbook with lots of ideas for rapid prototyped objects, does not mean any will get made. I am a determined, some say stubborn, artist, and many of the pieces I have made have been produced in a context where a lot of ‘people who know’ have told me a work is technically impossible, too expensive, or too big to produce. But I’ve made it anyway, somehow. So, it’s notable that I’ve made so few rapid prototyped objects. The current lack of opportunity for artists to rapid prototype replicates the problems of early artist-adopters of other computing processes – ‘who’ makes and ‘what’ gets made is shaped by the context of the technology. A lot more designers use rapid prototyping than artists. Why is that? It uses a very uniform material, an ivory coloured plastic (a polymer) that is brittle, not that interesting. You can now rapid prototype with inkjet coloured plaster, but plaster is vulnerable. The inks are not archival inks. These are off-putting restrictions for sculptors, used to a range of materials that have a richness, different surface textures, strengths, durability. Currently, rapid prototyping materials do not have that variety. And it is also expensive. Every time I say that, industry people say ‘Oh but you can buy one for £1500.’ But unless you are going to use it a lot, £1500 is a lot of money for most artists to spend on trying something out. In summary, there is a dominant culture within which artists use this

technology. This, and the institutional context (the places that have the equipment) impacts on take-up, on who is using it, and how are they using it.

This is not the whole story, there are plenty of artists that want to use the technology, despite its material imitations, and having to access it through a University or business. However, most have not done so. Why? What are the most significant limiting factors? Firstly, you need a particular skill-set to use rapid prototyping machines, if you are not scanning an existing 3D object from the real-world in order to generate virtual 3D data, then you have to model the object in virtual space. 3D computer modelling is complicated, time-consuming, and can be very boring. You do not make the virtual model with your hands, and the irony is that the people who would probably make the most fantastic objects using the technology are traditional sculptors, but to generate the computer file you cannot use those techniques. Then there is dealing with the seemingly archaic STL file format. The file formats that can be used on these machines need to be expanded, radically. Even though I worked with programmers, the STL file format was a serious barrier to creativity, and the only way to find out if a dataset was going to work was to run it through another piece of software. In summary, for a broader take-up, the technology needs to expand out of the specialised engineering and university workshop environment.

This is anecdotal, but when a straw poll of where the RP machine is located in the university system, and which staff control access to the machine, shows it is predominantly in engineering with technicians controlling the machine, or it is in design (and there is still a split between art and design). So, if you find a rapid prototyping machine you need to ask 'who has got access to it?' Design departments, where prototyping of all sorts is an established part of the design process, of have queues of students waiting to use the kit, there is little spare time to offer artists and art students. Some art departments shy away from buying and running these technologies and say "we really want this department to stay very traditional, we don't want laser cutters and rapid prototypers, we want to stay etching and doing litho and whatever". It seems strange to assume one would replace the other as opposed to them sitting side by side. As long as you have that kind of Luddite resistance from fine art departments, there are all sorts of objects that will not get made.

WHOSE ART GANG?

Rapid prototyping depends on a skillset more common amongst artists who have been identified as working with 'new media'. Elsewhere, I have spoken about what I see as the delights and dangers of the 'new media art ghetto', one of which is that new media art remains predominantly screen-based, maybe because it came from independent film, guerrilla video, guerrilla television, independent video, video art, scratch video, performance. It didn't come out of object-making. One of my personal hobbyhorses is that

if you look at the new media art exhibition circuit, there is no place for ‘the object’ unless it is interactive. So, rapid prototyping is problematic for that art gang, because it is not seen as relevant due to the dominant ideology that privileges interactivity and autonomy. Objects that respond, especially robots, *are* considered relevant. What is often engaging about a rapid prototyped object is the ‘being of the object’, the way the object ‘is’. It doesn’t have to ‘do’ anything. Its form, and how that form came into being, is what is engaging about it. I think that is completely at odds with the new media art network. This matters because funding and commissioning is greatly influence by these arbiters of taste. I have a feeling that my sketchbook of unmade rapid prototyped works will continue to get fatter, but I am determined to make more of them real [6].

ACKNOWLEDGEMENTS

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References

- [1] HEGARTY, F: Emeritus Professor of Sheffield Hallam University. Her work as an artist spans three decades: at times concerned with received ideas of cultural and national identity, with emigration, with the female body and mortality. She works with video, audio, photographs, drawing and installation, exhibiting worldwide. <http://www.brighter.org/franceshegarty/index.html>
- [2] TECHNOSPHERE: An online digital environment launched on September 1, 1995. TechnoSphere, created by Jane Prophet and Gordon Selley, was a place where users from around the globe could create creatures and release them into the 3D environment, described by the creators as a “digital ecology.” <http://en.wikipedia.org/wiki/TechnoSphere>
- [3] CELL: A collaboration exploring the ways research into adult stem cells is having to re-address the complexity of human biology. As part of the collaboration, medical scientist Dr Neil Theise, a world leader into adult stem cell research, based in New York, worked with Jane Prophet, mathematician Mark d’Inverno, computer scientist Rob Saunders and curator Peter Ride, who instigated the project, from the University of Westminster. One aim was to find ways of visualising the new and contentious theories of stem cell behaviour, and to feed these visualisations back into the scientific research, as tools for use in the laboratory practice. Another has been to generate a range of artistic outcomes that are under-pinned by the emerging

- understanding of cellular activity. <http://www.janepropheet.com/cell.html>
- [4] FRANCIS WELLS, heart surgeon from Papworth Hospital, Cambridge and Leonardo da Vinci expert. <http://news.bbc.co.uk/1/hi/health/4289204.stm>
- [5] ADRIAN BOWYER, Senior lecturer in the Department of Mechanical Engineering at the University of Bath working in the Biomimetics Research Group on the RepRap Project and the Bioaffinity Applications Laboratory.
<http://people.bath.ac.uk/ensab/>
- [6] UNMADE ARTWORKS
Small But Perfectly Formed <http://www.janepropheet.com/small00.html>
Big Plastic Tree <http://www.janepropheet.com/plastic.html>
Self Portrait of the Artist Meditating on Death: A Vanitas
My aim is to make a contemporary Vanitas piece using medical imaging to recreate my skull, face and brain (preferably also using MRi to show which part of the brain is active when one thinks about death) and recreate the Vanitas using my data, like a self portrait. The form of the sculpture would be similar to the form of the Wellcome piece – namely a head which is dissected to reveal the skull, and again to reveal the brain. The work would be made as a physical object using rapid prototyping so that it can be reproduced life-size. This would result in an off-white coloured polymer form that would then be silver plated or coloured