INTRODUCTION

In January 2002 eight jewellers from the Association of Contemporary Jewellery responded to a question posed by Dorothy Hogg and that appeared in the ACJ magazine Findings, a question that I believe originally derived from a conversation she had had with Gordon Burnett. “What do you seek to make perfect, and what are you happy to leave imperfect in your work?” A difficult question, but perhaps that to a certain extent may lie behind why would a craft maker chose to use computer aided design?

The overall conclusion expressed by the majority of jewellers was that no avoidable imperfections should be left on a piece of work, yet the quality of handcraft or the marks of the human hand, as Giovanni Corvaja phrased it, should be not be erased. The fear then is that working with tools capable of such precise repetition will lead to the creation of objects that are rendered sterile due to their unnatural perfection. It is a fine line that has to be walked between the aspect of our craft philosophy that strives for perfection and the side that celebrates occasional marks of intelligent intentional interaction. It seems the potential CAD/CAM provides to achieve perfection is not only a factor in the choice to use it - but also in the mistrust it engenders.

In the late 20th into the 21st Centuries the computer has provided the designer and maker with not only new ways of seeing the world but also with new ways of fashioning it. Digital tooling allows us to examine form and structure from the macro to micro, from impossible viewpoints and within weightless environments. As digital technology enabled the new fabrication of objects it challenged the values traditionally associated with craft -labour, material and intricacy. Rapid prototyping, (RP) turns intangible digital data into physical objects, a magical process and in hours rather than the weeks it would have traditionally take by hand techniques. The objects designed with these tools can be sent digitally over any distance to be manufactured in an ever-increasing range of materials in distant cities, or, re-worked between remote designers at conference. Ideas evolve from the conceptual to the virtual, then into the physical and the real.

In 1996 Malcolm McCullough asked another question in his seminal book ‘Abstracting Craft’ was “What are the implications for art and craft as atoms become replaced by digital signals and the
physicality of reproduction becomes a ‘virtual’ on screen experience? A slightly more complex question— but then Malcom was writing for MIT and it was expected. This question lay at the heart of the computer aided design / manufacture (CAD/CAM) versus craft debate. Pros and cons were debated; the lack of physicality, the loss of tactile contact, new freedoms of design methodology, versatility of material output and increased speed to manufacture. This formed the basis for two years of my research from 1999-2001 at the Royal College of Art; years that I like to reflect on as spanning the 20th and 21st Centuries and a new digital Post-Industrial revolution.

Here and now in 2004 any technological/craft debate is history. The technology is readily available and being used by an ever-growing numbers of designers and especially the new emerging makers. We are now in a more fortunate position of being able to examine more clearly how CAD/CAM is being used and reflect a little on the new hybrid practice.
Computer Aided Design and Manufacture (CAD/CAM) provided a radically different process for creating objects compared to the more traditional studio design processes that built on known hand skills. CAD/CAM offers far more interesting propositions to a designer and maker than simply increasing speed and reducing labour. It also offers the opportunity to thoroughly explore and manipulate form from all angles and viewpoints and the ability to make radical alterations to scale and shape.

These Orbit rings illustrate a body of work made in 2001 utilising the potential of this technology to rescale the digital designs in order to resize the rings to individual proportions. The digital design for these rings made with Form-Z can be re-scaled within this package or at the rapid prototyping machine itself within the machine’s own software to create any range of sizes as individual master wax models. With a closed ring this would normally necessitate a range of size rings being printed by the 3-D wax RP printer to suit all the rings sizes. What I chose to do with these rings was to build into the design the ability to adjust the rings size by hand as an option. So, the rings are spirals that are not closed and can be easily stretched open or closed a size or more. Hand skill and design can often be faster than involving a machine.

As Tanya Harrod has pointed out “objects, like certain examples of silversmithing by Michael Rowe, can look CAD designed when they are not. They simply have a CAD aura” 2. The ‘aura’
referred to is the geometric form, a structure shared with mathematics and three-dimensional CAD programmes. It is a precise form that has become synonymous with computer design, but as Michael Rowe has commented, is not its sole provenance.

Fig 4

The application of a computer’s control and aesthetic restraint is crucial to the work I transcribe from CAD design to low relief metalwork. The role of a computer is not vital to the generation of this work- but it is the appropriate device to achieve the aesthetic quality sought. While these pieces of work speak directly of directing CAD towards remote modelling by CAM the route that brought me into applying computer technology within my work had been centred preliminary on the application of image, texture and pattern.

Fig 5

Fig 6

These pieces of jewellery from 1998 explored the transformation that occurred not only to image, but it’s context, identity or meaning but the qualities of pattern that could be derived from that process on to the material through the transcription from digital image to metal surface.
The necessity for the computer can be overstated. These pieces were not dependent on CAD but that process enabled me to achieve it more effectively and was the most appropriate tool to use. As David Watkins has said “Computers have been from time to time important to my work. The challenge of their rationality and their capacity to carry out fascinating but in some respects tedious tasks has often made for a good ‘fit’ with my immediate aesthetic objectives. I am not however drawn to the use of computers for their own sake. If I don’t have the overriding need to get the work done that way, I don’t have the patience.”

I have designed work with purely the computer in mind. 2001 is a range of pieces in celebration of the present- the here and now. 2001 is also a date of special significance lying at the dawn of a new millennium and already synonymous with the famous Stanley Kubrick / Arthur C Clarke film, 2001 a space odyssey. The form is a classic möbius strip, a familiar mathematical conundrum, or space oddity. The shape is representative of the twisted concept of time and space. A straight strip can represent a journey with a definite end, but by twisting this strip and joining its ends together a journey along its edge will last for infinity. The form was digitally modelled using the design programme ‘FormZ’ and the text was wrapped around its surface thanks to the innovative reverse engineering software of Delcam CopyCAD.
The model was then rapid prototyped by 3D-Systems growing the model by stereo lithography in a vat of photo reactive resin, hardening the cut layers of the digital design by laser, layer on layer, in a SLA-35000 machine.

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A young contemporary designer who walks that line with style is David Goodwin.
I would not have been able to visualise my ideas as clearly as I have done if I was not working within a 3D environment. Designing on paper does not convey the quantity and clarity of information that working with 3D modelling could. I still sketch out initial ideas on paper but the final design decisions are made within the 3D world. The ability to see designs in their entirety allows for greater selective decision-making. I am influenced by structure in man-made and natural objects- from buildings to the geometrical helix structure of DNA. 3D design lends itself to this kind of work, straight lines and smooth curves.

Rendering a 3D model in a programme called Flamingo Raytrace produces a photo like image of a possible physical object. Producing a large quantity of designs quickly, I can lay the photo like images out separately and make the decision of which designs to manufacture.

I started working with CAD in the first year of the MA course. I studied the 3D CAD programme Rhinoceros on a weeklong course taught by Dr David Humphrey. The programme is ideally suited for the designer as it allows maximum freedom as an all-round programme; some 3D CAD programmes can restrict the user because they are aimed at a specialist market, e.g. vehicle design, Architecture. Rhino is very much a programme for anyone to use and it is quite simple to understand the basics. From the weeklong course I could instantly see the potential of 3D design, and in finding a way to manufacture the designs through rapid prototyping I could visualise my work in a physical context.

The design of my work is concerned with creating jewellery objects using new or current technologies that are not common practise within the craft of jewellery. I want to create jewellery that would not be possible by any other means. Many designers/ jewellers use CAD and RP technologies to create pieces that could be manufactured by traditional techniques, the advantages being time based. With RP technology I aim to push the boundaries of what is conceivable within jewellery manufacture and design, to consider the possibilities when designing.

This selection of dyed polymer resin rings were the first pieces that I designed within Rhinoceros 3D CAD and manufactured on the 3D systems viper SLA machine.
There are certain restrictions that are important to notice when designing within a 3D environment. All objects must be considered solid to work with the rapid prototyping process. The CAD programme Rhinoceros is predominately a surface programme, but ensuring that all surfaces are joined therefore creating a closed polysurface allowed all of Grid Ring series to be produced.

The material itself is not suitable for making finished pieces; the resin is a photo-sensitive material and will continually cure if an ultra-violet light source is present. This results in a continuing hardening of the material and eventually causes the material to become extremely brittle. The rapid prototyped model is a good reference to appreciate the design in a physical form. It helps recover the sense of scale, which I feel is lost when working within the CAD programme.

The challenge was to use the techniques discussed to create a piece to be fabricated in metal. Some of the functions were troublesome, for example the programme does not like to generate surfaces on harsh angles over 90 degrees when using the 'pipe command'. This led to the designing of more rounded objects which would work with the programme and its functions, hence the design of the ‘Ball Mesh Ring’. The designs have to be created within a set of
parameters or restrictions that are created by the limitations of the programme and the knowledge of the designer.

The following images run through a step-by-step sequence of how the 'Ball Mesh Ring' was created within the 3D environment.

I generated two spheres that I then cut with cutting planes to then use the blend surface command to create a surface between the two cut spheres.

[Images of two spheres being cut and blended]

Figs 19-24

The next stage is to contour the object; I used a spacing of 1.5mm between each contour line. The polysurface is then hidden to show the entirety of the curves, the curves are then piped. In this instance I have used a 0.3mm radius for each pipe. This can be varied on each pipe and the pipe can be given an end and start thickness if it is not a closed curve. The surface that is built upon the curve is uniform thickness throughout unless otherwise instructed.

[Images of curves being piped and the polysurface]

Fig 25

Fig 26

The pipes are mirrored using the mirror command then the original base polysurface is un-hidden. A cylinder is generated to bullion difference a hole through the model to create a finger hole. The cylinder is bullion differenced then the pipes are hidden to allow work on the original base polysurface.
Curves from the edge of the ring hole are extracted using the duplicate edge command and if they are extracted as broken curves they are then joined together. The polysurface is then deleted. These curves are then piped at a 0.6mm radius. Due to the angle that the mesh pipes were cut at in the bullion difference command they leave a large surface area visible that is covered by the ring pipes being of double thickness.

The pipes are then re-shown to reveal the ball mesh ring in its entirety as shown below in the shaded view port screenshot.

In the rendering I have tried to show how the ring would look in a physical sense if it were 18ct gold.
The ‘Ball ring’ rendered in Flamingo Raytrace and given a plain gold surface.

Weston Beamor were the company that succeeded where others shied away, many casting companies turned down the opportunity to attempt the casting of my designs as they said it would not be possible. Weston Beamor cast the ring at the first attempt using high-pressure vacuum casting equipment after printing the design in a special resin that burns out cleanly. Shown are images of the Ball Mesh Ring straight from the casting.

Since the success of the first ‘Ball Mesh Ring’ I went on to create a series of eight gold rings of varying design for my MA degree show, all but the ring shown were set with precious gems. Although the pieces are very fine in appearance, the strength is inherent in the skeletal structure, and it is in this strength that allows the stone setter to set the gemstones. It would be impossible for the precious gems to be set by any machine because of the complexity of the work. My work combines the high-tech technology of CAD and RP with the more traditional techniques of casting and stone setting. Without traditional and contemporary techniques combining, my designs would not have succeeded as actual finished jewellery objects.
JOE WOOD

Joe Wood began combining CAD in his working practice in 1988 as a sketchbook resource and it wasn’t until 1998/9 that he started to use the 3D modelling program Form-Z, to directly model objects for RP.

These set of five "Ball Rings" 1999 by Joe Wood were computer modelled, rapid prototyped then cast. Joe Wood states that much of his work stems from a continuing interest in the rich tradition of jewellery and object making in metal.

Based in Boston, as the jewellery course leader of Massachusetts College of Art, Wood dealt with a local RP company, Z-Corps, founded from research at neighbouring MIT into RP layer manufacture. The first pieces he made were in 1999 and illustrate a new direction for his work inspired directly from the combined qualities of the modelling capabilities of Form-Z with its strong Nurbs modelling capability and the material quality of the unique resins printed by the Z-corps Z402 3D printer. These coated and dyed compounds then have traditionally made silver components added to them. The titles of Woods work reflect the direct influences of the techniques he utilises as well as the materials he now works with, *Nurbring* and *Sphero* bracelet. "When material is integrated into an application", he explains, "It connects the object to the world. It becomes an object that is a material that is an object." 

Fig 36
Peter Musson

Peter Musson graduated the RCA in 2004. His silverware aims also to interweave new technologies with traditional craft working techniques. Through CNC machining he develops ideas rapidly that will lead to developing new forms which are not possible by only traditional techniques.

He uses the milling machine as an aid for applications such as model making, rapid tooling, for traditional raising stakes and press-forming tools. As in the piece ‘Water Pitcher’ he uses it to make production models for electroforming and casting.

Fig 39  

He states, “Within my design I use the language of mass production, at the same time I aim to give my objects a more human quality through imparting individual touches upon them. I use industrial methods of production yet distort the perfect form to give the objects individuality; I achieve this by using craftsmanship ideals which I believe create an emotional connection to the user through the object.”

Fig 40

Fig 41

Fig 42

Fig 43
Conclusion

The hybrid practice resulting from integrating computer aided design and/or manufacture with the traditional techniques of metalwork and jewellery reflects concerns that are founded in both traditional approaches to the craft as well as contemporary issues of the time. The gold and silversmith has been accustomed to holding a pivotal role bridging science, technology and art. The choice of many contemporary makers to work with new and emerging technologies is not specific to our time - but a tradition to our craft. It is not only a matter of choice - it is also a challenge, which proves impossible to resist.

The programme designers who streamline their software packages in order to present simpler systems for creating digital designs for jewellers to be outputted to the growing range of computer aided manufacture devices narrow the new vocabulary. The technological choice and variety offered by different modelling systems provides a range of important triggers to the designer. It is evident from the work we have seen that ideas have been developed by moving back and forth between a range of visual and tactile stimuli. Within the designing CAD stage Tanya Harrod has referred to this as “artist’s, applied or otherwise, wisely, wilfully, tend to do low-tech things with high technology. They operate as outsiders with something of a hacker mentality.” Thinking out of the packaging box, or ultimately the monitor, is as vital in the creative process when encountering new technology as it is to experimenting with the traditional techniques. The area where these technologies, traditional and contemporary cross over is fertile territory indeed - even if at first, as with David Goodwin’s vacuum cast gold Ball ring, they may seem impossible to integrate.

To return again to the question posed by the Association of Contemporary Jewellery I’ll share the shortest response with you, the pragmatic response by the Dutch director of Gallerie RA, Paul Derrez that he sent by text, “New technology can be used for new ideas and old technology can be used for new ideas. My experience as a gallery owner is that in general old technology is used for new ideas and that is fine to me”.

If indeed the digital revolution is over and the technology is no longer something new but now something old, this is a situation that is unlikely to change - indeed one day it may be considered a traditional craft in its own right.
Footnotes.


Captions

1) **Orbit Ring** CAD drawing *Form-z* 2001 – Stephen Bottomley

2) **Orbit Rings** Sterling silver 2001 - Stephen Bottomley

3) **Orbit Ring #5** Sterling silver 2001 - Stephen Bottomley

4) **Conditions for Ornament No.6**, 1988 - Michael Rowe

5) **Large Ruff** – Sterling silver 1998 – Stephen Bottomley

6) **Blown Grass pendant**, Sterling silver 1998 – Stephen Bottomley

7) **Frame Brooch** & 5 interchangeable panels 18 carat red gold and silver

8) **Two Frame Broches.** 18 carat red gold and silver 1998

9) **2001 Bangle. CopyCad digital rendering of model** - Stephen Bottomley

10) **2001 Bangles & medals.** Stephen Bottomley

11) **SLA Selective Laser Apparatus or Stereo-Lithography Apparatus**

12-17) **Grid Rings** 1-6

18) **Ball Mesh Ring - Polymer Resin** - David Goodwin. *Photo Nick Jell*

19) **Creating the base shape to work on** - CAD Drawing David Goodwin

20) **Cutting the spheres with cutting planes** - CAD Drawing David Goodwin

21) **The two spheres cut open** - CAD Drawing David Goodwin

22) **Blended surface between cut spheres** - CAD Drawing David Goodwin

23) **Contouring the base shape** - CAD Drawing David Goodwin

24) **Piping the contour curves** - CAD Drawing David Goodwin

25) **Mirroring the pipes** - CAD Drawing David Goodwin

26) **Cylinder to create finger hole** - CAD Drawing David Goodwin

27) **Cylinder bullion differenced** - CAD Drawing David Goodwin

28) **Working in base shape** - CAD Drawing David Goodwin

29) **Duplicating Edges on finger hole** - CAD Drawing David Goodwin

30) **Piping curves at 0.6mm radius** - CAD Drawing David Goodwin

31) **The finished ball ring shaded** - CAD Drawing David Goodwin

32) **Ball Mesh Ring** - CAD Drawing David Goodwin

33) **STL model, Ball Mesh Ring - 18 ct Gold** – Photo Nick Jell

34) **Ball Mesh Ring in 18ct gold (sprues attached)** - CAD Drawing David Goodwin

35) **Ball Mesh Ring in 18ct gold (sprues removed)** - CAD Drawing David Goodwin

36) **Ball Rings** 1999 silver and 18 karat gold, Joe Wood

37) **Nubring Bracelet, Red enamel powder & resin on Z-402 digital print, 1999**, Joe Wood

38) **Sphero Bracelet**, Enamel powder and resin with silver on Z-402 digital print, 1999

*Photo: Dean Powell*

39) **Water Pitcher**, CAD rendered drawing, Peter Musson

40) **Water Pitcher**, Silver, 2003, Peter Musson

41) **V&A Medal design-Rhino**, 2002, Peter Musson

42) **V&A Medal – Bronze (front face)** 2002, Peter Musson

43) **V&A Medal – Bronze (back face)** 2002, Peter Musson