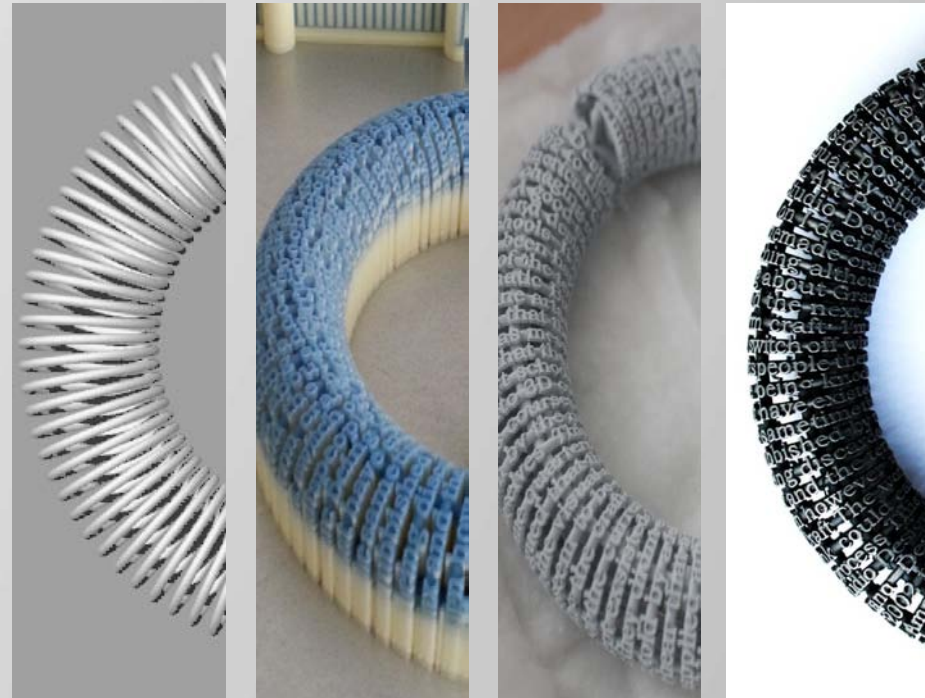


## Complex and experimental sculptural casting systems.

*Innovations including:  
'Complex Thousand Sprue' casting systems  
Material Investigations into fineness and  
surface pattern, The self supporting  
integrated spiral sprue..*

**Submitted by J.M.Boyd**  
Output No. 1





**Jonathan Boyd**

Silversmithing and Jewellery Department

Research Portfolio No.1

\*Some Artefacts in this research output appear in my other Research Portfolio No. 2: 'Exploring the relationships of language, text, body and object through the production of artifacts'.

These artifacts are created through **two separate research processes** Portfolio No.2 is devoted purely to the conceptual ideas behind the work and aesthetics. This Portfolio being dedicated purely to the craft and research in making these complex objects. The two strands of research are separated by theme, time, context and created in different environments.

## REF Output 1- Narrative

**Lost wax casting:** a method of casting metal, in which a mould is formed around a wax pattern, which is subsequently melted and drained away. The resulting void is filled with molten metal creating a cast

**Sprue:** a channel through which metal or plastic is poured into a mould.

Advances in technology in lost wax casting (especially vacuum casting) and rapid prototyping ([in jewellery] advances in ultra high definition wax rapid prototyping) means that objects can now be created that have never been possible to make. Through their delicacy, quality of finish and complexity this research portfolio looks to explore possibilities in vacuum casting by the creation of ever more complex ways of spruing wax and indeed exploring the breath of materials that can be cast.

Most jewellery will be sprued by one to multiple sprues (depending on size of work) the work created in this portfolio looks to create ever more finely detail objects by raising the complexity of the spruing systems involved in their casting. Several Jewellers have used multiple sprues and computer aided design to create fine detail objects, notably the jewellery of David Goodwin MA(RCA) and more recently the precious metal stationary of Jack Row.

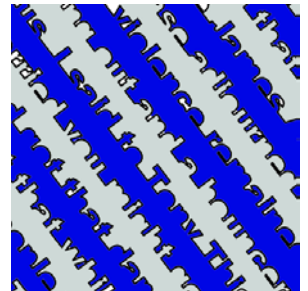
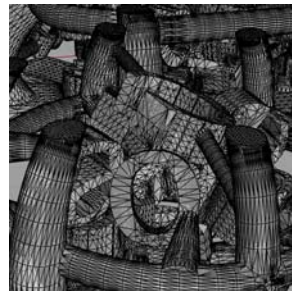
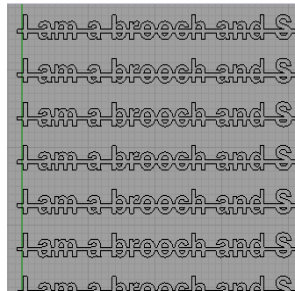
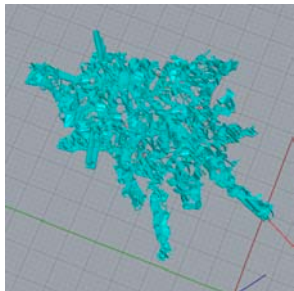
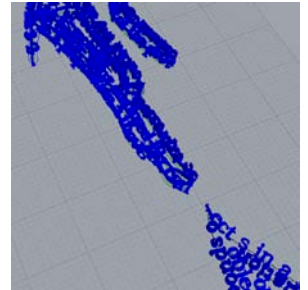
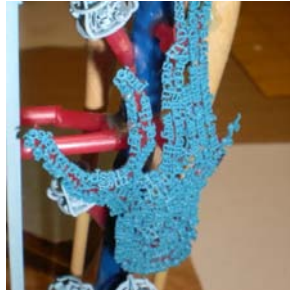
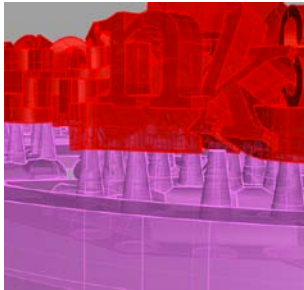
The technical innovations in this portfolio separates itself from these works or any others by several key innovations: by its sheer scale of miniature spruing systems (1-3 thousand sprue castings), the lack of symmetry and skill of placing each sprue separately on to the work, the invention of the unsupported/integrated spiral sprue (in one case over 4 meters long) and the breadth of materials used to create these highly detailed spruing systems.

The inspiration for the narratives for these works stems from research and design ideas mentioned in REF Output No.2 'Exploring the relationships of language, text, body and object through the production of artifacts', although the craft and research of creating these objects is a completely separate process from the ideas that generate them.

## Research Title, Outputs and Methods used.

Title:	Complex and experimental sculptural casting systems.
Outputs:	Artefacts and works of jewellery and objects for exhibiting.
Methods:	Rapid Prototyping, CAD design, Sound collage using editing Software, Lost wax casting, laser cutting, hand fabrication and Laser welding.
Reach:	Exhibitions, Catalogues, Lectures, Publications. Please see Slide 31 for full listing.
Date of Research:	2010 – ongoing.

# Artefacts produced by means of Research. Exhibited together 2010-2013



## Explanation and Context of research narrative

### Background:

Following on from work created during 2009 and from my MA at the RCA, I have researched complex ways of lost wax casting objects and jewellery. To create these complex structures I have been investigating ways an ongoing use of CAD design and ultrafine Rapid Prototyping techniques. Other ways of including Digital ways of manufacturing and process have also been investigated.

I have submitted two Research outputs as there are two strands of research that always combine in the creation of artifacts. These are (Research Portfolio 1) an investigation and research into 3D printing, complex spruing systems and digital technology in Jewellery and (Research Portfolio 2) an investigation and research into the relationship between language and object, conversational dialects, disfluencies and object and the creation of artefacts on this subject.

## Further Context

Using CAD, wax rapid-prototyping and multiple sprues to create jewellery has been used before examples can be seen on the right by pen fabricator Jack Row and Jeweller David Goodwin. In both instances the works were made with high levels of detail and several sprues dotted around the works to improve metal flow.

Where my work differs is in its sheer complexity and scale. With ideas imposed by concepts seen in my Output Folio No.2 a lack of symmetry and extreme levels of detail are required. This means that rather than using Cad functions such as Arraying tools or Grasshopper each Sprue system I create is unique both in its complexity and in its lack of uniformity.

Jewellery pieces such as Case Study No.1 (see page 15) can take up to a month to draw the main work however the sprue system which in this case included over three thousand sprues (an unprecedented achievement for an object which has a scale of 50mm x 40mm x 8mm) took doubly long at two months.

The work 'An extended rant on craft' (see page 21) uses my innovation of the integrated sprue, but the scale of the sprueing inside means that the work is a hollow form created by an unsupported four meter long sprue. My research indicates that no one within my field has ever created a castable work of such a scale, complexity and high definition before.

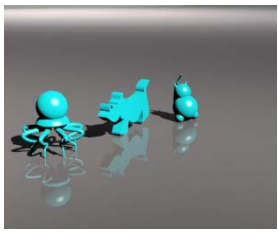
The works in this folio add a creativity, complexity and delicacy to CAD built sprueing systems that has never been witnessed before.



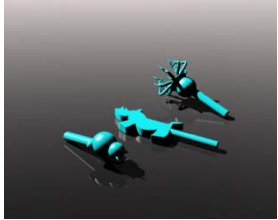


# Methodology

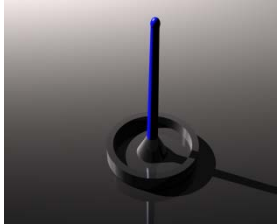
How the artefacts are produced through Practice based research



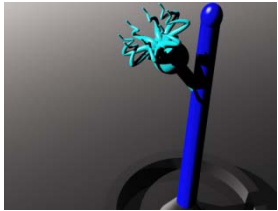
Waxes are produced



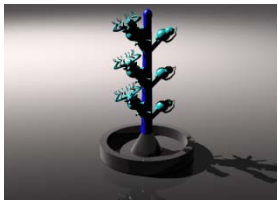
Wax legs (Sprues )are attached



A large central wax sprue and rubber base



Objects are attached to central sprue via smaller sprue



Until the central sprue is full



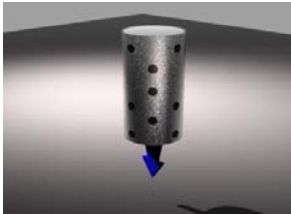
The whole sprue structure is place in a steel canister



And filled with plaster



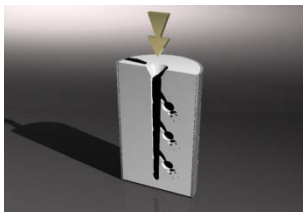
When the plaster is set, the canister is turned upside down and the rubber base removed. This reveals the bottom of the central wax sprue.



In a kiln the wax is melted out



A void is left



Molten metal is poured into the void



Filling all areas where wax masters sat



The plaster is washed away leaving you with a precious metal version of your original waxes

# Lost Wax Casting.

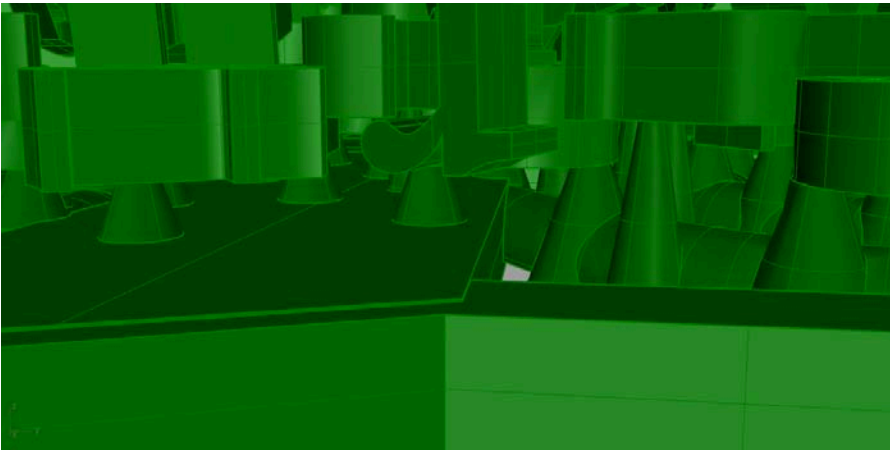
My research as described in this Portfolio is concerned mainly with ways of lost wax casting. For those unfamiliar with the process I have included a visual explanation (left). Waxes (or other materials that will burn out at a high temperature) are placed in a plaster mould and the contents burned out. Metal is then poured via vacuum into the areas where the wax was. The images work from top left down and have been created as an explanation to Silversmithing and Jewellery second years about Lost wax casting.



## Introduction into complex spruing systems.

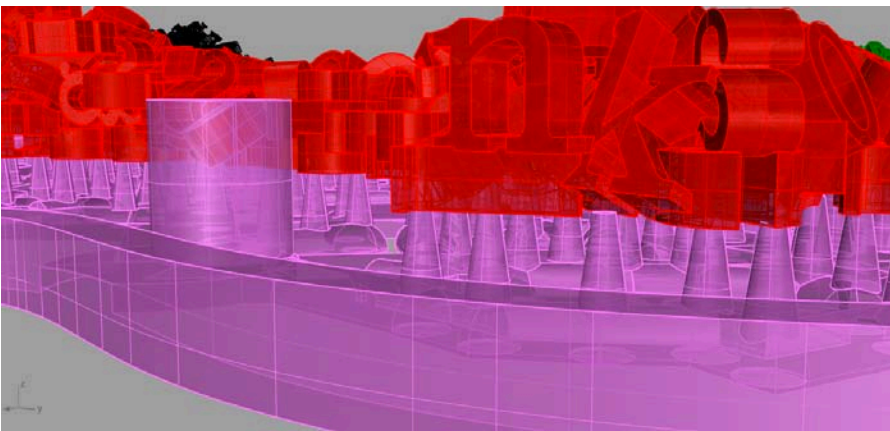
A sprue is a gateway for metal to enter into a plaster void so that it can be filled with molten metal. This process is called Lost Wax casting.

The lost wax casting system is used through out the jewellery and sculpture worlds.



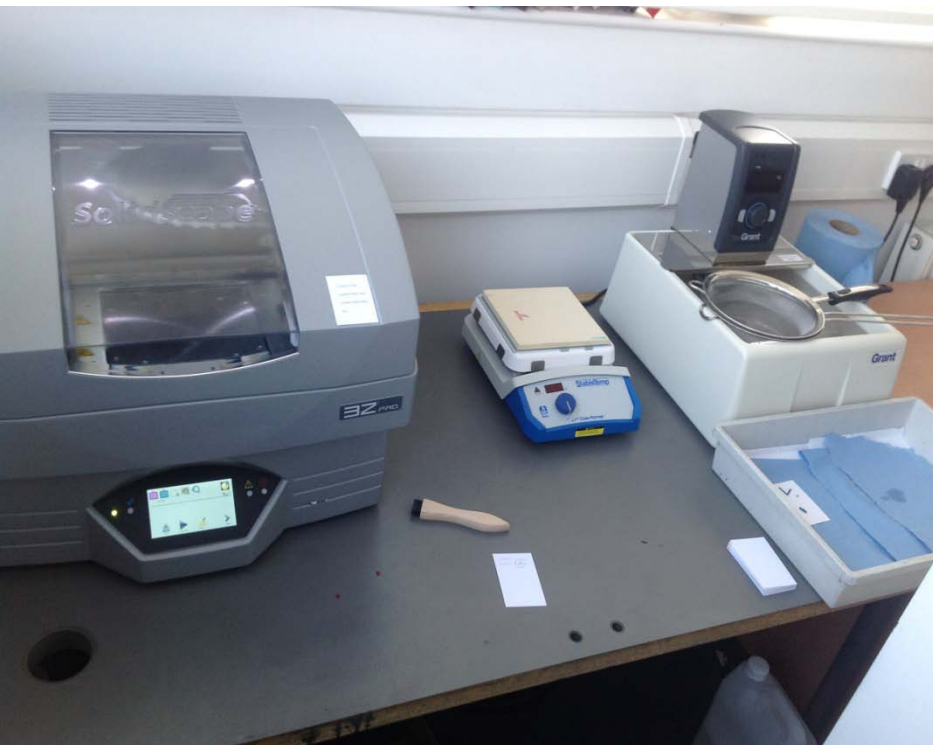
Several Jewellers before have employed CAD designing techniques to create complex objects for casting (such as Jeweller David Goodwin) Through wax rapid prototyping. Where my work differs from this is the sheer amount of the sprues, the complexity and the non-uniform way in which the way the sprues are placed.

The images of the left show how works made of scrambled text are held in place by tiny 'hair width' sprues. Some of the item had up to 3,000 tiny sprues (each one individually placed attaching top part of my work) acting as gateways for metal to enter the cast.



The works themselves are designed to be non uniform, this means that the sprueing systems must also be non uniform. Each model can take up to a month to draw.

*The letters shown in these models measure 2.3mm height.*



In 2012 a SolidScape 3zPro rapid prototyping machine was purchased in the capital bid. This enables the school to teach CAD design to students with possibilities of making 3D models and works in ultra fine detail. It also enables my research to create more complex and finely detailed work without prohibitive problems such as posting and casting fine detail models by outside contactors.

When rapid prototyping my I use SolidScape machines as they have an ability to print with a surface resolution of 197X197dots per mm. This level of finish means that build lines will not be visible to the naked eye.

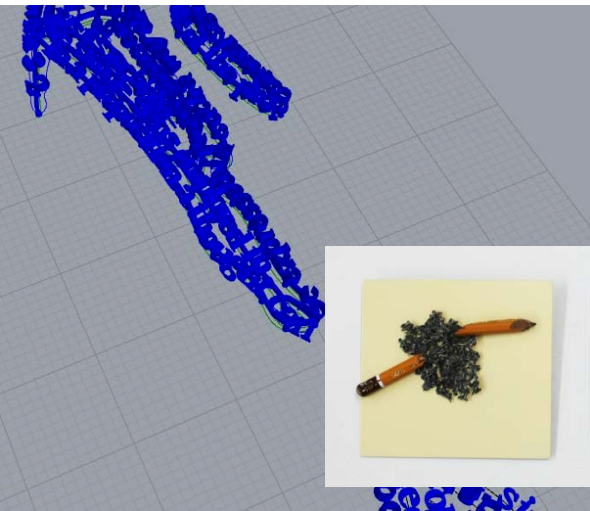
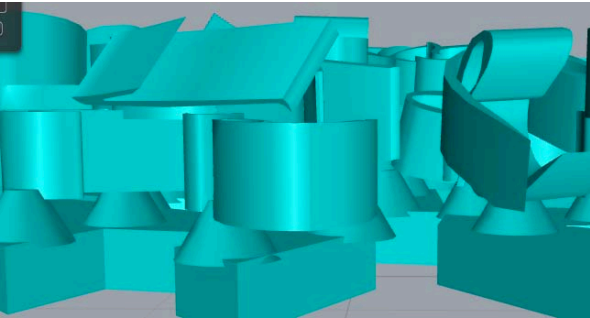
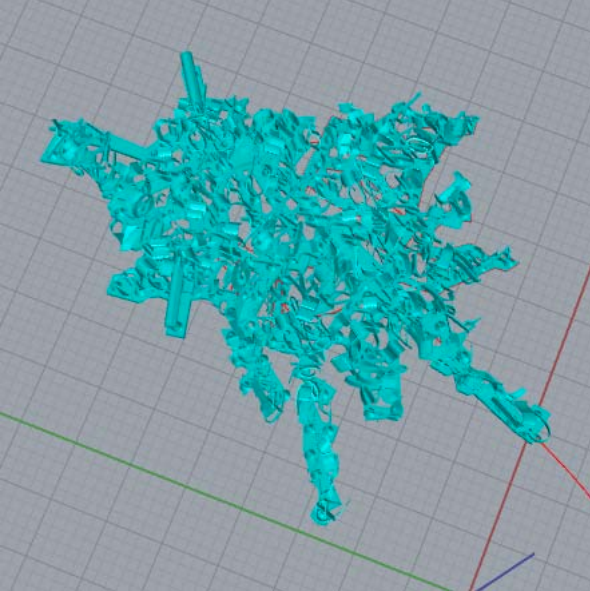
Also these machines print in two materials, a blue wax which is tough and fairly durable and a red wax which dissolves on the completion of a model. This means that nearly any idea can be created with out the worry of support structures for over-hangs etc and will produce a near perfect surface finish.

The work I create using these machines has been exhibited and published internationally.



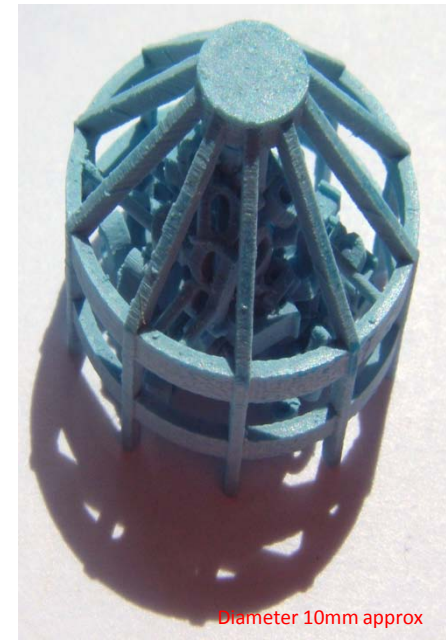
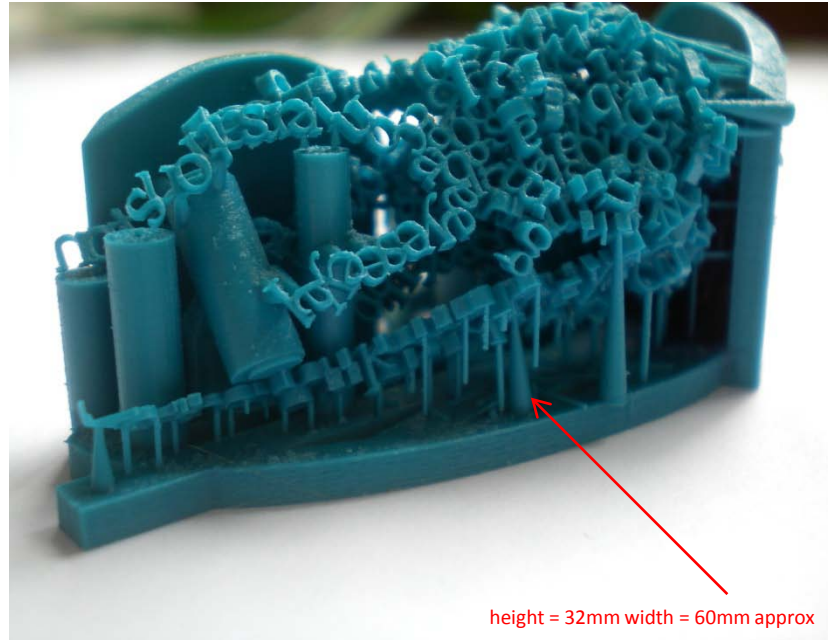
## Examples.

Examples of CAD designs with spues attached (left) and a finished work (right) once the piece has been cast, the sprue cage removed and finished to the required finish.



Examples of waxes rapid prototyped with the ultra fine 'hair width' sprues:

Note that they are often conical in shape this is to aid as much metal getting through the sprue as possible.





### Sprue shape

When closely inspecting the sprues on the previous pages it is clear to see that unlike a cylindrical shape which is far more common in jewellery spruing, I have used instead smaller conical shaped sprues. This means that there is minimal contact with the surface area of the final work (so less clean up involved when removing) yet there is still a larger channel for metal to flow through at its base. This helps improve flow of metal.



## Once Cast.

Once cast the pieces of work are still housed in their sprue cages. Each sprue then has to be removed by hand and cleaned. In the case of Case Study No1 (left) almost 3,000 sprues were removed.

The images on the right (top and bottom) show the work before it was cleaned and finished.







Rorshcach No.1 (brooch) above, is the only piece of work where I have not removed the sprue when finishing the work. Impressed with the visual appearance and beauty of the craft of the sprue structure, it was left on. The artery like system seen (right) has hundred of miniature sprues attaching the lettering to the larger sprue system.

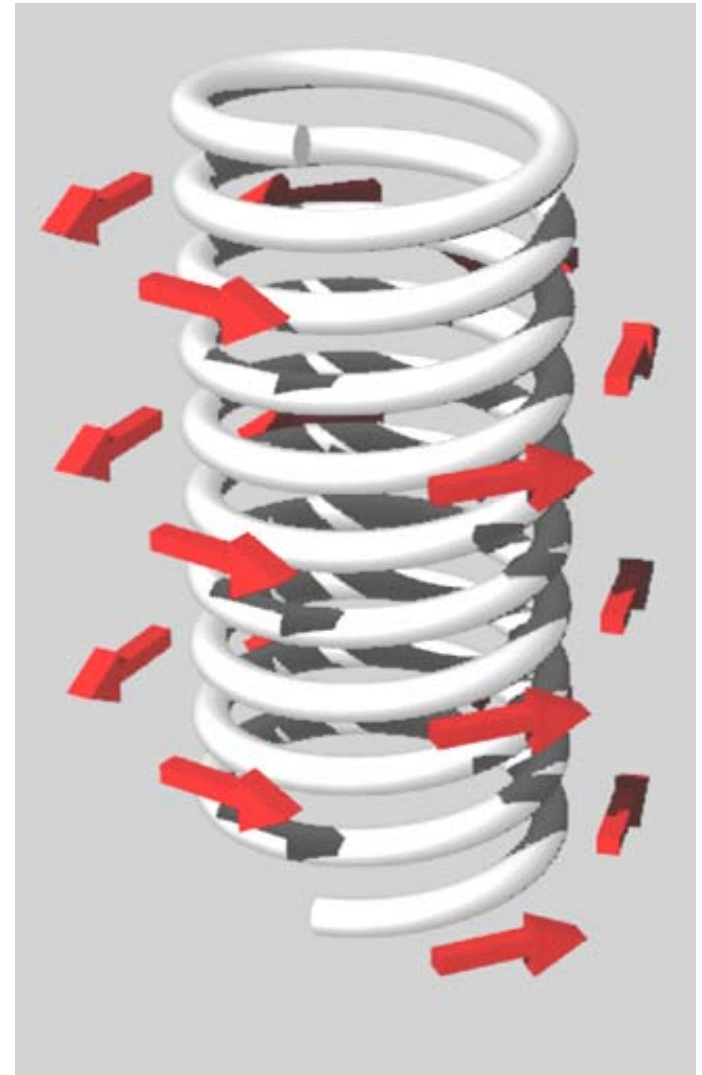
## Spiral Sprues:

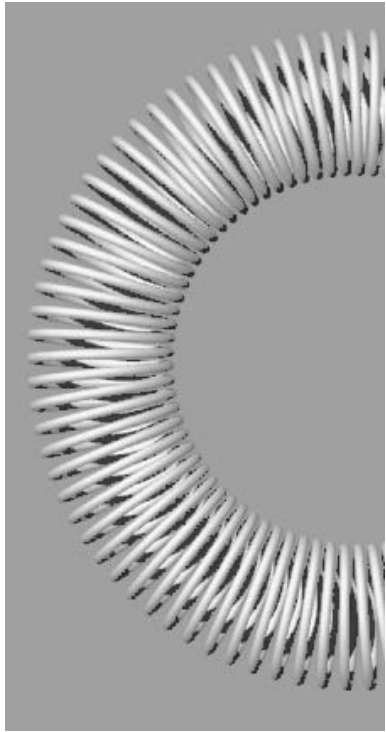
Integration of sprue system into works and spiraling structures.

As can be seen from previous slides my works used hundreds of tiny sprues that would then be removed when cast by hand. This is an effective way of creating extremely intricate artifacts with no visual explanation of their creation.

However it is also a very time consuming job removing each tiny sprue and this led to research into building sprues as part of the structure of the works.

Works were designed to have intricate spiraling sprues inside them. The structure of the spiral meant that metal would flow easily through the work. The diagram on the right shows how such a sprue would aid the flow of molten metal.





CAD spiral sprue



Wax Prototyped spiral sprue  
with narrative (with support)



Wax Prototyped spiral sprue  
with narrative (with support)



Finished Cast artefact (oxidised  
Silver)

Example of large spiral sprued work.

The piece is designed in two parts so that there is minimal points of connection making it harder to understand how the object was fabricated.



Three stages of spiralled spued Chain.

The Solidscape machine creating waxes of half links. The machine is printing with a fineness of 0.000254 mm.



The links after casting and joining. The material is Sterling Silver.



The finished Brooch with a oxidised surface.





Building on the success of the casting of An Endless Rant on Craft, I furthered the possibilities with the creation of 'An [Extended] Endless Rant on Craft). 5 times bigger than the former work it includes an internal sprue that would measure approximately 4 meters long if stretched out.

By increasing the size 5 times this pushed to the limit the capabilities of the processes involved.

Firstly of CAD: It took a year to draw and over 10 failed attempts at finishing the work ready for printing.

Printing: The job was so large and in such high definition that to use a Solidscape machine [the main printer used in this portfolio]) it would have taken 28 days to print in its entirety. Finding a company that used a faster printer for wax was needed. It still took 4 days to print with two failed attempts. Costing over £600 to print in wax.

Dewaxing: the process in which the support material is removed ready for casting took over 13 hours. **Support material took up approx 75% of the bulk of the work**

Spruing: to the casting tree: The weight of the wax and the length of time meant dewaxing meant that the finished wax could barely take it own weight and in one instance when **breathing too heavily** I put a small hole in the work. Spruing to the central tree too over 4 hours.

Casting: The largest piece I have ever created: myself and technician Nigel Munro thought that this time I had 'pushed my luck to far jonno'.

It cast perfectly, and is the greatest technical achievement within this portfolio.

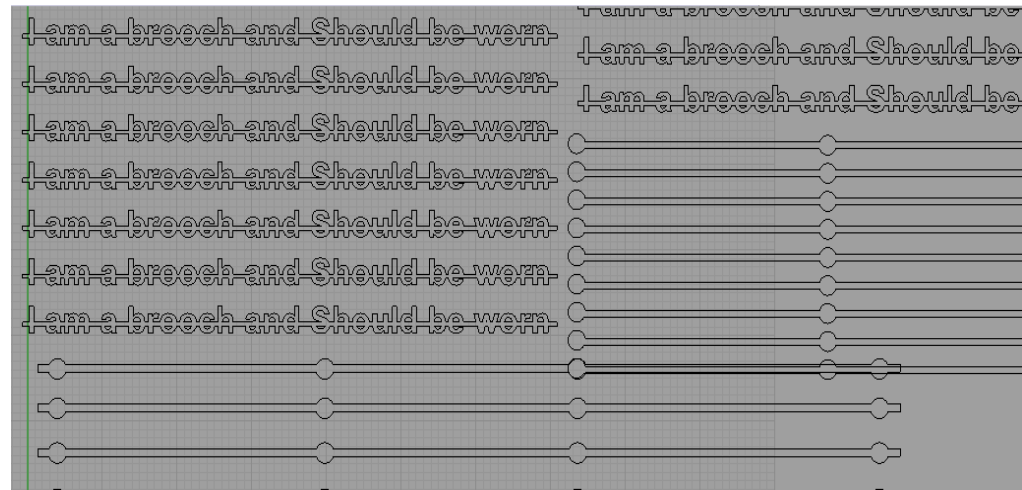
## Scale.

On the left is a piece of work ('speechbubbles' - brooch) that shows the experiments with scale that I have undertaken. The spiralling dome sentences are 9mm wide and the text becomes a pattern when seen with the human eye. Only on closer inspection does this delicate pattern reveal itself to be text.



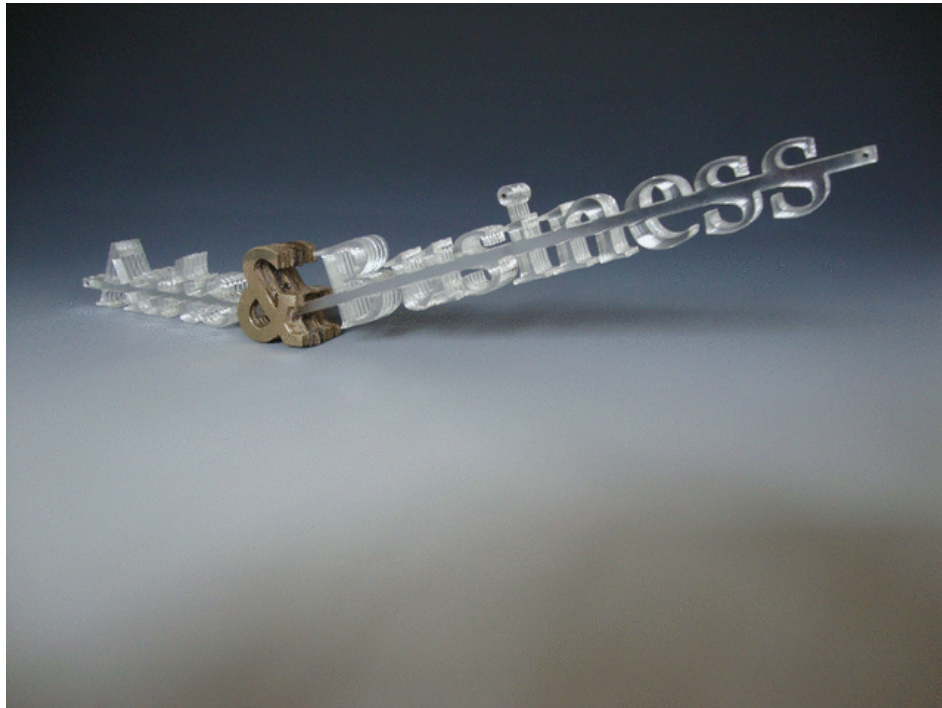
## Laser Cutting

Experiments into different effects created by using different materials, and laser cutting as an effective way of creating detail in cast objects.



A laser cut bangle in Perspex and 18ct Yellow Gold (left) and Cad drawing ready to cut sentences out of card for casting (right).





## Collaboration with Andrew Lamb

Collaboration with Andrew Lamb to create an award for the Arts and Business foundation. The work was created using laser cut Perspex and then layered using steel rivets. The '&' was also laser cut before being cast in bronze.

This work tied in with both mine and Andrews design interests as well as using my experimentation with casting laser cut materials.

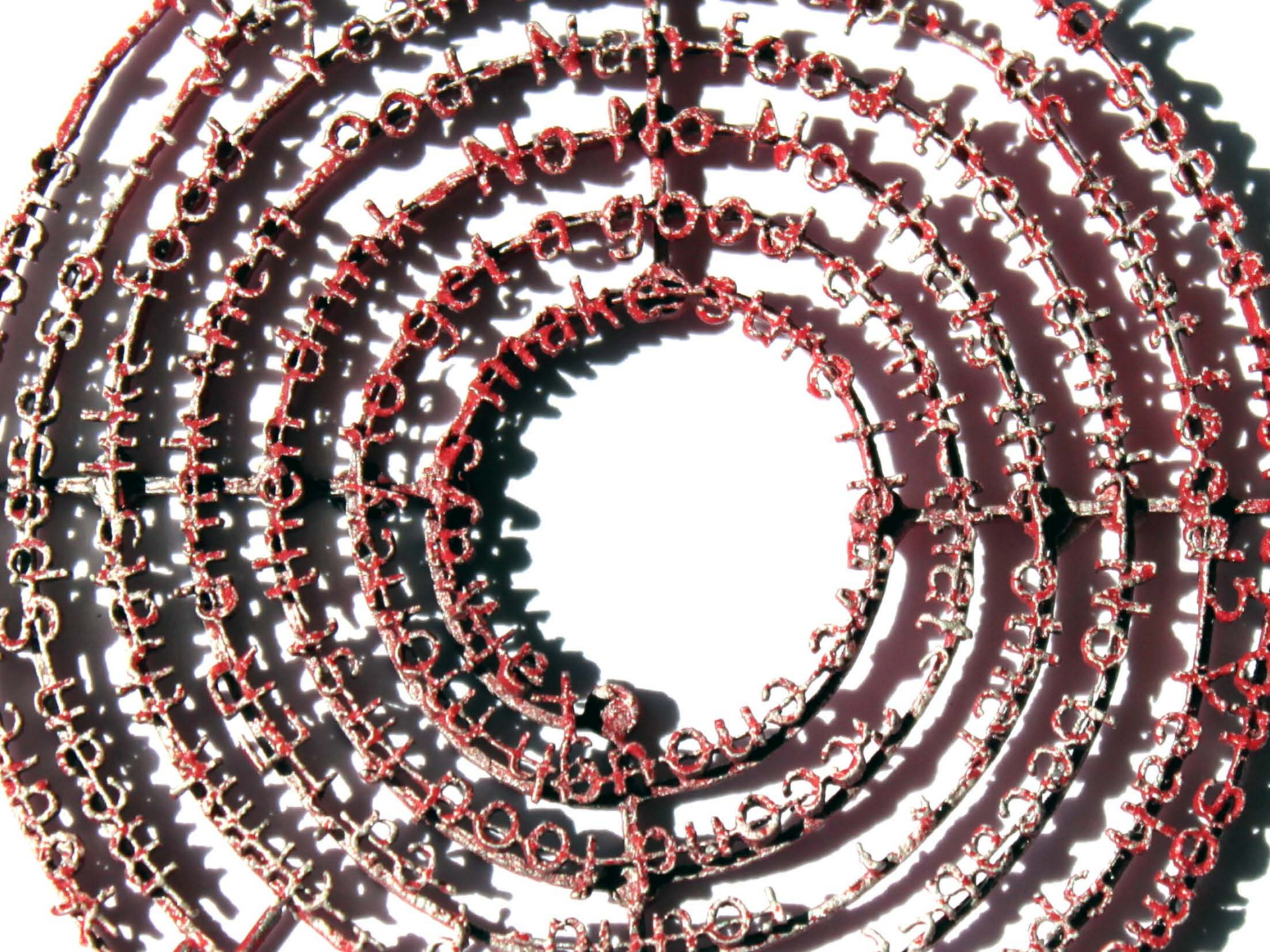


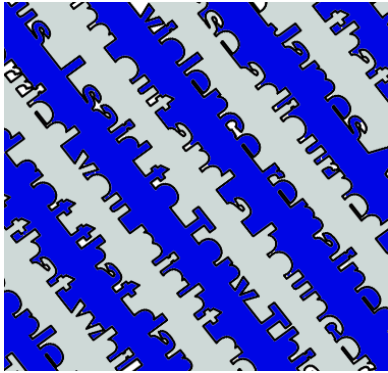
Using card to laser cut very fine text patterns means that unlike perspex the material won't melt beyond thickness of 0.5mm (the text shown on the left has thickness of (0.2mm in areas).

Two layers are of card are cut- The top text layer and the bottom layer a spiralling sprue. The two are carefully glued together then dipped in a natural resin. The resin has two functions, one to stop wet plaster leaking into the card and causing it to deform and two natural resins have a better burn out in the lost wax process.

Visually the process of using laser cut card rather than using Rapid Prototyped waxes creates several key differences. Scale can be considered at much less expense and the mottled effect created by the burn out of the card gives the work a more natural and less engineered finish.







Laser cut individual sentences (right ) and CAD drawing (left) for cutting two different materials to fit together.

## Sound

Experiments with integrating digital sound and sound Collage





## Digital Sound.

Both laser cut and Rapid Prototyped lost wax castings have been used in this work. The work also contains a digital recording that is held within the work. When worn the piece should also be listened to. The sound collage works alongside the works narrative.

Several experiments using digital (MP3) sound collages with worn objects have been undertaken with the 'I.P.A' (left) the most successful and only exhibited one so far.

# Reach

Exhibitions, Catalogues and Awards of artefacts created for Research topic since 2010.

## Selected Exhibitions

2013	Subversive Design, Brighton and Hove Museum, Brighton.
2013	Challenging Perceptions and Pushing Boundries, World of Art Museum, Beijing, China
2013	Forming Words, Flow Gallery London & Design Centre Manchester
2012	BKV Young Applied Artists of the Year (finalists), Munich & Schmuck International Jewellery Fair
2011	Collect with Marzee 2011 Saatchi Gallery, London
2011	Not Pretty (Glasgow, London, Sydney,)
2011	40 Years in the tower (Glasgow School of Art)
2011	In Tandem, London (Electrum, Collect/Flash)
2010	Jonathan Mathew Boyd – Solo Show (Au Studios Glasgow)
2010-13	Goldsmiths Fair 2010, 2011, 2012 & 2013

## Selected Awards

2012	BKV Young Applied Artist Finalist. Munich
2010	Best New Design Goldsmiths Hall
2010	Scottish Arts Council Development Grant
2010	Goldsmiths Fair Bursary 2010

## Publications

2010	Sloman, Paul (2010) <a href="#">Publication : Book Art by Paul Sloman</a> . In: Publication : Book Art by Paul Sloman. Publisher: Die Gestalten Verlag. ISBN 13: 9783899553666 ISBN 10: 3899553667
2012	(2012) <a href="#">Jewelbook</a> , International Annual of Contemporary Jewel Art 12/13, Oostkamp: Stichting Kunstboek, ISBN 978-90-5856-410-8
2013	La Trobe-Bateman, Mary (2013). <a href="#">Growing Talent</a> . The Worshipful Goldsmiths Company, ISBN 978-0-907814-32-0

## Lectures and talks

2013	<b><u>Asking questions.</u></b> Pushing Boundaries and Challenging Perceptions, World of Art Museum, Beijing
2013	<b><u>Jonathan Mathew Boyd.</u></b> Subversive Design. Brighton and Hove Museum.
2013	<b><u>Meet the Artist.</u></b> (January 2013) Jonathan Mathew Boyd in Interview with Author Jenni Fagan. Donald Dewar Fund. Edinburgh Botanic Gardens.
2011	<b><u>Studio Design: Design as fine art practice.</u></b> Jonathan Boyd. (2011) Glasgow School of Art. GFT.

## Acknowledgments:

All works in this portfolio are created by Jonathan Mathew Boyd.

An enormous thank you goes to **Nigel Munro** whose expertise in casting and jewellery making is invaluable and essential to all works created in this portfolio.