

Drawing with Fire: The Art of Laser Cutting Paper

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Abstract

This paper explores some of the laser cutting methods used by artists, in particular from an Arts and Humanities Research Council funded project (Paper Models: investigating laser-cutting technology to develop new artists' books and paper-based creative practice for arts, crafts and design, March 2010 – October 2010). The project explored and demonstrated the potential of the laser cutter as a creative tool in terms of design, structure and construction for the production of artists' books and paper-based works.

As the technology has become more affordable, laser cutters are now a regular feature within education establishments in the Western world and becoming readily available to artists wishing to explore the subject further. One major potential of the laser cutter as a tool for artists working with the book form and paper-based artworks, is that it can replace the need for labour intensive manipulation of paper and card by hand. Artists have throughout history adapted industrial and/or digital technologies to work with creatively, as evidenced by the relatively recent use of digital printing to create artists' books and prints, but can they see the longer-term potential of laser cutting as part of their armoury?

As will be explained, the possibility of using the laser as a tool for cutting, scoring, perforating and engraving paper is as yet under-utilised by many book and paper artists. Many of these artists use hand cutting and scoring in their work unaware that laser cutters can assist; not that the laser need replace the handcrafted element, but rather run alongside it. The laser burns or melts its way through materials, so leaves evidence of its involvement often through a scorch mark and this is not always to everyone's taste. The project's aim was to show artists and designers how the laser can be used as a creative tool.

So what is laser cutting?

The laser cutters that I use on a regular basis are carbon dioxide lasers. There are two other gases used, neodymium (Nd) and neodymium yttrium-aluminium-garnet (Nd-YAG), but these are primarily used for the cutting of heavier, more industrial materials. Within the laser cutter, the gas is stimulated in a chamber until it achieves sufficient energy and escapes as monochromatic coherent light. This light is then directed via a series of mirrors to a lens, which will focus the light down to a beam on the surface of the material to be cut that is approximately 0.2mm in diameter. As it comes into contact with the material it vaporises it, some of these burn (typically those made from natural fibres) and some melt (typically man-made materials).

All the laser cutters I use are flat bed lasers in which any material has to be flat to be cut, and the nozzle from which the laser comes moves over the material on an x and y axis, much like a plotter. Although the lasers can use photographic files such as jpegs for engraving images, vector based files are what are normally used for cutting. I use Adobe Illustrator to create the vector files and the laser cutter will follow any lines that are drawn in Illustrator.

Although I feel that laser cutters are often under-used by book and paper artists, there is some fantastic work that has been produced, and this paper will explore some examples of how a laser cutter has been used creatively in the production of these works.

Olafur Eliasson's book *Your House* was produced in 2006, commissioned by the Library Council of The Museum of Modern Art in New York. The book presents a negative impression of Eliasson's house in Copenhagen, Denmark, with each of the 454 pages individually laser cut and corresponding to 2.2 cm of the actual house. As a reader leafing through the pages, you slowly make your way through the rooms of the house from front to back, thus constructing a mental and physical narrative of the actual house (<http://www.olafureliasson.net>).

Scott Campbell is an American tattoo artist who has recently been developing a series over 2009 in Miami with the imagery used in this work very closely related to his tattoo work. The images are cut and built up in layers that, much like Eliasson's work, give the work a sculptural quality and help to create a body to the images. I particularly like the fact that Campbell has embraced the burning quality that the laser cutter gives. The work retains that sooty, burnt feeling that I feel complements the grimy nature of the imagery used by Campbell in his cut dollar bills (<http://www.scottcampbelltattoo.com>).

A British artist who is best known for producing hand cut work, but has also editioned his work by using the laser cutter, is Rob Ryan (<http://www.misterrob.co.uk>). Ryan has achieved considerable fame for his work over recent years and it is clear to see why the laser has helped in the mass production of his work. The transition from hand cut to laser is no effort at all for him, as the structures he uses in hand cutting translate so perfectly into those that are needed for the laser. The paper needs to be held together so that sections are not lost or it collapses in on itself. The hand cut work can be scanned and a direct digital copy used to produce an edition. The laser also offers Ryan the opportunity to retain the hand made look that wouldn't be achievable by using die cutting as some of the small cuts are just too complex for a die.

Some of the work that has been produced by Brooklyn based artist Michael Mandiberg (<http://www.mandiberg.com>), shows how the laser can be used to burn images into a substrate, rather than just for cutting. Mandiberg is an artist who has experimented with a laser cutter in a variety of ways across many works. His work *FDIC Insured* shown in April and May 2010 as part of his 'Great Recession' exhibition at PNCA's Feldman Gallery, presented row upon row of 'get rich quick' books, each laser engraved with the logo of banks that have failed since the beginning of the recession. The books were picked up in bargain bins for a dollar each and "Mandiberg continues to add to *FDIC Insured* weekly, making it not a dead monument but a living marker of an unfolding disaster."¹ The book 'The Total Money Makeover' is literally branded with the Merrill Lynch logo, 'Success is a Choice' with Main Street Bank, and so on.

Ingrid Siliakus (<http://ingrid-siliakus.exto.org>) is a Netherlands-based artist who produces paper architecture using a laser cutter. Paper architecture is the art of creating a three dimensional object from a single sheet of paper. Siliakus discovered paper architecture after seeing the work of Professor Masahiro Chatani, a Japanese architect who is the champion of this artform (<http://www.japandesign.ne.jp/IAA/chatani/index.html>). As there were no classes or books on paper architecture at the time, Siliakus taught herself using Japanese pattern books, and has been perfecting her technique over the last 16 years. Siliakus specialises in reproducing the buildings of master architects and intricate abstract sculptures. She now uses the computer to design the work and the laser cutter to cut them, sometimes making up to forty adjustments and alterations until the design is right. The speed with which a laser cuts allows this to process to be quick, and affords Siliakus the space and freedom to absolutely perfect the design.

Laser cutting residency artists

As part of my research project, I hosted two residencies for invited artists and wrote these up as case studies, as well as using my own practice developed on the laser cutter as a third case study. In selecting the artists to come to the University of the West of England to use the laser cutters - and in line with my early intentions to demonstrate the use of the laser cutter - I wanted to invite artists whose work contained hand cut elements, but had not fully explored laser cutting. Each artist was invited to stay and work intensively on the laser cutters for four days in order to develop new work. There were no conditions on what was produced; the invitations were purposely kept as open as possible so that the laser could really be explored for its creative potential. The aim of the residency case study write-ups was to show how particular pieces of work were produced:

The first artist I invited was Su Blackwell: a very well established, London-based artist who is developing a prestigious career, and who is perhaps best known for her hand cut book sculptures (www.sublackwell.co.uk). Fashioned from existing and predominantly old books, Blackwell cuts and works the pages into three-dimensional dioramas that often recreate scenes and characters from fairy tales and folklore. I wanted to work with Blackwell because I greatly admired her intricately hand cut work and was interested to see how she would utilise a laser cutter, and what the challenge for the laser cutter would be.

When Blackwell arrived in June 2010, she was hoping to produce work for two upcoming shows. An exhibition *Remnants* at the Brontë Parsonage Museum in the UK, and a solo show called *Happily Ever After* at the gallery that represents her, Long & Ryle, UK. For the Brontë exhibition Blackwell wanted to utilise the lasers for cutting a nightdress that would be laser cut with moth shapes, a dress cut with images of heather, and two copies of the book *Arabian Nights* that were to be cut with silhouettes of various soldiers for the Brontë show. For her show at Long & Ryle, Blackwell also had a wedding dress that she was keen to laser cut with images of weeds that would appear to be almost growing up around the train and base of the dress.

As much of Blackwell's work had previously been produced by hand, she was not used to preparing for cutting using the computer. After previous conversations she arrived with a series of clear black and white line drawings of the designs she wished to cut into her materials, which had been scanned and saved as jpegs. After using the 'Live Trace' function of Adobe Illustrator we converted each of these drawings to vector files ready for laser cutting.

Using the vector files, we then opened up the relevant designs in the laser cutting software, APS Ethos, and began to arrange the different designs so that they could be cut in the correct places on the dresses and books. Starting with the nightdress to be cut with moths, we prepared a template of the area of the dress to be cut and then placed the moth designs in the correct places. As this was to cut right through the front and back of the nightdress, once we had cut the template into a paper mask, the dress could be placed flat and the moths cut into both layers of the fabric.

A similar process was also used for cutting the heather into a cotton dress and the weeds into the wedding dress, except these were only to be cut into one layer of fabric, so the dress had to be carefully arranged and cut in sections. With all of the dresses Blackwell could only achieve so much using the computer and we had to keep removing the dresses and checking that the designs were working well when the dresses were hung up, as they were to be exhibited. Much like she works when hand cutting, Blackwell was responding to the cuts that the laser was making and adapting and adjusting the overall design as necessary.

The last things that were cut during the residency were the soldiers cut from two copies of *Arabian Nights*. Referencing some of the early writings of the Brontës' in which they imagined a world, based on Branwell Brontë's toy soldiers, where there is a battle between some of the key military figures throughout history. Blackwell's plan was to construct a large battle of figures and forts. With the laser cutter we cut directly into the pages of the bound books (the books needed to remain whole as they were to be used as well). As so many soldiers were needed, we decided to cut through six pages at a time. It is not always advisable to do this as the power needed to cut through multiple sheets is not consistent all the way through, so each page will not cut evenly. It is also possible that the small pockets of air trapped between pages can ignite with the laser and scorch the edges of the paper more than usual. This was not so much of a concern for Blackwell - it was the quantity that was important to build the armies. Unlike Blackwell's book sculptures which are usually one-off, larger scale, three-dimensional figures, the soldiers for the exhibition at the Brontë Parsonage Museum were cut flat and propped up on armatures. The full case study report for Su Blackwell can be downloaded from the project's website (<http://www.bookarts.uwe.ac.uk/papermods11.htm>).

The other artist invited for a residency was Mette-Sofie D. Ambeck, a Danish artist who hand cuts most of her work and had never used a laser cutter before (www.ambeckdesign.blogspot.com). Much of Ambeck's cutting is in the book form, where she utilises apertures to work an image through several pages at once and also uses paper engineering and pop-up techniques to bring a three dimensionality to the work. I was also a great admirer of Ambeck's work and was really keen to see if the laser cutter could benefit her in any way. My thinking was that if nothing else, with the laser cutter Ambeck would be able to edition work in larger numbers and more quickly.

Ambeck completed her residency in the week after Blackwell in July 2010. Being very computer literate and knowing the formats required for laser cutting (she has an MSc in Information Technology in Digital Design and Communication, from IT-University in Copenhagen), Ambeck came to the residency very well prepared. She planned to produce two new artists' books during the 4 days, a re-working of a unique book she had made for her MA degree show in 2000 called *Steam, Salt, Milk*, and a new book called *Day Return*, based on a return train journey to London.

The original *Steam, Salt, Milk* book was an English translation of the Nordic creation myth, with hand cut and burnt pages. The book seemed ideal to be produced on a laser cutter. Very intricate cut details running through the pages and intentional scorching - what was usually considered as a problem when laser cutting paper could actually be turned into an advantage. During the residency we both printed and cut the book pages, 144 in each book of *Steam, Salt, Milk*, and made a very similar reproduction of her original book from 10 years previously, but this time in an edition of 10.

Ambeck's approach to the residency was very different to Blackwell's in that much of the alterations and tweaking to the files was done on the computer, rather than reacting to what came out of the laser cutter. Almost all the files needed had already been prepared and to begin with it was just a case of printing and cutting some test sheets to make sure that everything lined up as it should. Thankfully because of Ambeck's meticulous preparation and reference back to the original book, only a few minor adjustments were needed before the hotbed of production could take place.

In making this new digital version of *Steam, Salt, Milk*, Ambeck wanted to use a paper that would scorch with a minimum of intrusion onto the pages, could be inkjet printed and would be light enough to work well in the book format. Earlier in my project I had tested many papers to see how they reacted when cut and engraved by the laser cutter, and suggested that she use a 135gsm cartridge paper from Devon Supply Zone as this met the criteria and did cut particularly well, scorching lightly on the edges of the paper, but without this intruding onto the surface as can sometimes happen.

Once production was underway on *Steam, Salt, Milk*, we turned our attention to the other book that Ambeck wanted to produce, *Day Return*. Much simpler in its construction, this was a double-sided concertina book that was engraved with an image on both sides rather than being cut. I recommended that this book was engraved into black Somerset Velvet paper as I knew from past experience this engraved beautifully. Rather than scorching brown as many papers do, black Somerset engraves with a deeper and richer black than the original paper. An effect that Ambeck was keen to embrace.

Using the laser for construction, we first cut the pages down to size and lightly scored the surface with the laser to create the fold lines that pages would be folded on. Then there were two photographic jpegs, abstracted images of lights through rainy windows taken when passing through towns, to be engraved on the front pages and one for the back pages. After testing the engraving of the images, we found that the jpegs engraved with a beautiful variation that really helped to enhance the image. The very light tones in the image translated to a very light grey engrave on the paper (lighter than the natural paper colour) - which contrasted nicely with the deep, rich, velvety black of the dark tones. Once set up this could be left to run, as engraving images takes a very long time with the laser working steadily and slowly over the surface of the paper, pulsing with the tones of the original jpeg images.

At the London Art Book Fair at Whitechapel Gallery in September 2010, Mette-Sofie D. Ambeck was presented with the Birgit Skiöld Memorial Award for *Steam, Salt, Milk*. Fantastic recognition for a beautiful and excellently conceived book that really explored the laser cutter as a creative tool.

The final case study for the project was myself. One of my roles at the University of the West of England is as an instructor in laser cutting for research, and the main responsibility of the role is to run a bureau service in which I facilitate external artists and designers' use of the laser cutters. That said, until starting this project I had produced very little personal artwork on the laser cutters, so to start making work in this way was a little bit of a struggle. From my previous experiments in producing specialist materials for designers, I knew that the laser cutters could work well as a tool for not only cutting the nets and creating perforations, but also for creating score and fold lines by only just cutting into the surface of a material. So using this as a starting point I thought about pop-up books as a way of creatively utilising the laser cutter.

After some failed attempts at using the laser cutters to produce pop-up (I am no paper engineer) I reassessed the aspects of the laser cutter that interested me and thought about how I could take these forward in my own artwork. The three particular aspects of the laser that I wanted to investigate further are: its ability to mechanically reproduce a cut many times over, its futuristic connotations thanks to science fiction novels and James Bond, and also the fact that it burns

through natural materials. With these as the driving force behind my process of working, I got to work.

The first piece I produced was the video and book, *Goldfinger*. Taking the iconic scene from the James Bond film 'Goldfinger' where Bond is strapped to a laser bed and Goldfinger threatens a live demonstration of it. I sought to recreate this using a 1964 paperback copy of Ian Fleming's book as a stand-in for James Bond himself. Playing on the futuristic implications of a laser as depicted in the film, I wanted to ham this up with our 200-watt laser - which is a powerful laser that is capable of cutting through whole books. I also wanted to encourage the burning that is present in the film and a particular feature of cutting many pages of a book. Cutting through multiple layers can create a lot of flame as air trapped between the layers is ignited by the laser.

I was particularly pleased with the finished video once it had been edited and synced with the original soundtrack from the film. Unfortunately I don't have copyright clearance to exhibit this work, but even with a fixed camera and very little occurring on screen, I think I managed to keep the humour I wanted and the suspense of the original. The book itself is also very recognisable for those who know the film and is now in the library's collection of artists' books at the University of the West of England.

I was pleased with the burning effect on the book, but wanted to see if this could be controlled a little more. I had already done some tests using the inert gas nitrogen as the cutting catalyst (as opposed to the usual oxygen) to see if it reduced the scorching when cutting single sheets of paper, so I was curious to see if this would help when cutting another whole book. The next piece of work I produced was *Cor-blimey*, which was produced by cutting a car shape from an old Haynes car manual for a late 1970s Ford Cortina car. Cutting this with nitrogen really helped to suppress the flames that normally appear, but didn't reduce the amount of charring on the edges of the pages, which I wanted. By suppressing the flames this helped to cut down on damage to the covers of the book, which in this work I felt was important as I really wanted the original text and diagram to remain as visible as possible.

The other aspect that I wanted to explore was the mechanical nature of the laser cutter and how it could repeat itself over the bed of the laser cutter. To do this I started work on a series of prints with laser cuts in them that would come together to make an approximation of a large-scale tunnel book, where the viewer looks through each section to create a 3D effect. The imagery was predominantly a series of fire doors that had large panels of wire mesh safety glass in them. In Illustrator I created a cut file that would cut all the glass around the mesh to leave only the wire. When these doors were placed one in front of the other, they created two series, at the back of these was another image, on one series - a stormy sea; on the other series - a long corridor.

Each of the doors was cut with hundreds of tiny squares. It was my original intention to remove each of these squares so that only a mesh would be left, but after cutting the first door and removing this from the laser cutter, I was really taken with the fact that many of these small squares stayed in place, held only by virtue that they were nearly exactly the same size as the hole.

It created an image similar to a blocky pixelated image. Perhaps again another futuristic connotation, but what I really liked, was the fact that these fire doors had been created by burning.

When displayed in the project's exhibition, the doors (each approx. one metre high) were hung in two rows, each five deep, on a peg drying rack system as used in a print room. It became difficult to see all the way through, but this was what I was expecting and was pleased it happened. The back image could be seen only if the viewer really looked for it.

Drawing with Fire

My original intention when starting this short research project was to see if the laser cutter could be a useful creative tool for book and paper artists, particularly as a way to replace intensive hand cutting. As the project progressed I realised that this was the wrong approach to using the laser cutter. All of the best examples of work I see being produced that utilise a laser cutter are being produced in that way because of the qualities that the laser cutter can give, rather than as a replacement for hand cutting.

Scott Campbell's, *Make It Rain* collection of artworks made from laser-cut one-dollar bill stacks could not really have been produced any other way, and the evidence of the scorched laser mark is what enhances and makes the works so successful. Michael Mandiberg's branding of bank logos into the get-rich-quick books needed a laser to burn them in, driving home the force of his ideas. Su Blackwell's dresses could have been cut by hand, but the laser cutter allowed for the exact repeat of designs over the fabric, and the slight scorching on the cotton enhanced the historical appeal of the pieces.

Now that the project has ended, I have published the outcomes, case studies, papers presented, cutting guides and information downloads on the project's website (<http://www.bookarts.uwe.ac.uk/papermods11.htm>). I hope these will encourage more artists to use the laser cutter as a creative tool.

To try and eliminate the burning that a laser gives is to suppress the character of the machine and therefore ultimately doomed to fail. The laser has a place as a creative tool in the production of artworks by book and paper artists, as I think is evident, not just as an aid to artistic construction, but as a complete creative process with its own character in its own right, truly: drawing with fire.

Notes

1. Review: Michael Mandiberg, *The Great Recession*, Ultra Arts Portland, Saturday, April 3rd, 2010 at 3:16 pm. <http://www.ultrapdx.com/zero/2010/04/03/review-michael-mandiberg-the-great-recession/>