Susan Carden

Craft Informed Digital Textile Printing

Abstract

Due in part to ongoing developments in pigment ink production, the quantity of pigment-based digital textile prints is predicted to rise significantly over the next few years. Current dye-based inkjet printing requires the substrate to be coated, with a chemical solution prior to printing, then fixed by steaming afterwards, meaning both processes have major environmental consequences. Although this forecast may reduce the impact of current dye-based textile inkjet printing (Fu 2006), the move towards more digitally printed textiles will affect the character of fabrics from the perspectives of both designers and clients. However, as Bradley Quinn points out, this digital expansion also risks the loss of individuality, and challenges the nature and infrastructure of tomorrow's textile industry on a global scale (Quinn 2009).

Against this backdrop of change, my practice-led research describes the output from a new process that has been developed at the Centre for Advanced Textiles (CAT), at the Glasgow School of Art. The technique enables designers to apply dye-based, rather than pigment-formed, digital images onto textiles without the need for preparing the fabric beforehand or fixing thereafter.

Combining craft techniques with advanced technology from non-textile specific areas has enabled a process to be produced that allows traditional practices to be used as interventions in the digital printing of textiles in order to provide practitioners with new opportunities. By comparing the technique with existing digital textile printing processes, early tests have identified a number of benefits, including: reduced capital outlay per print; lower energy consumption; and, less chemical waste. As the designer or maker is able to physically engage with the process, a new aesthetic is produced that reflects the originality of the hand-skilled element of each print.

While this new technique does not attempt to replace existing digital textile printing systems (for example that of the Mimaki TX2), it introduces an innovative alternative method for printing digital images onto fabrics. Due to the discrete nature of the system, this process has the potential to encourage the establishment of micro-businesses in outlying locations. With energy costs continuing to rise, it also offers a novel aesthetic at a low cost. This paper will explain how the new process differs from existing techniques used to manufacture digital textile prints, and outlines where the process may be used as a viable craft-based alternative for artists, designers and craftspeople in the face of an impending worldwide increase in the production of digitally printed textiles.

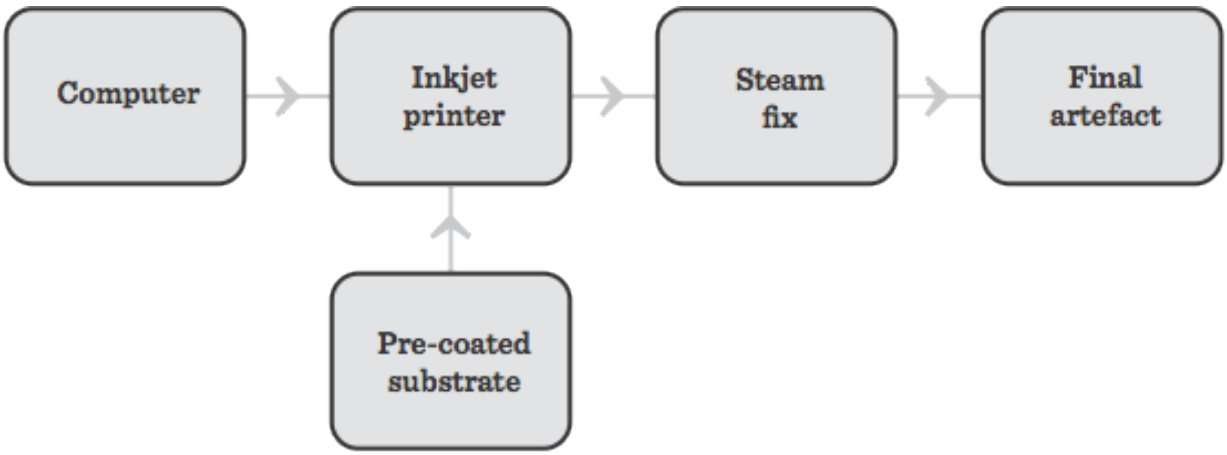
Introduction

In 1968, woodworker and master craftsman David Pye's book *The Nature and Art of Workmanship* was published. Four decades later this work is still described as 'a marvel of erudition, intellectual rigor and economy' (Clark 2008, p.41), and includes issues that are pertinent to my research. For example, one point that is discussed through a letters' correspondence between Pye and critic Michael Nevelson (Leonardo 1972): 'There is not and never has been (in most trades) any possibility of working either *by hand* or *by machine'* writes Pye (1972, p.94). Nevelson replies that this comment is the only one upon which he 'can not agree' (1972, p.95). However, Pye has already addressed this point, at length, in 1968, when he acknowledges that few crafts, such as basketry and coiled pottery, can be created solely by hand. Almost everything else, he concedes, requires at least a tool of some kind. Pye proposes that exceptions be made allowing *done by hand-tools* to be included within the same category as the *handmade*. It is this made-by-hand, but incorporating advanced technology, that is central to my research.

As skill is mastered, and the design process becomes increasingly intuitive, this also poses problems for researchers. How do we as practitioners extract knowledge, and explain skills, that are well embedded? While final artefacts can share many different meanings, this knowledge can only begin to be revealed once the viewer engages directly with the object. Until this point, the knowledge contained in artefacts is tacit, not yet made explicit (Friedman 2008; Niedderer 2009b; Büchler 2006). It is worth bearing in mind that although tacit knowledge may be made explicit, underlying embedded knowledge cannot (Barfield & Quinn 2004). In an attempt to address the unseen, or hidden aspects of practice, a dialogue needs to be entered into that works backwards from the artefact to the numerous ideas from which it is formed. According to Donald Schön, reflective practitioners reflect on their practice, it then responds, and subsequently the practitioner reacts to this 'back talk' (1983, p.79). In this way a research-practitioner is able to share and communicate experiences through action research, diaries and a subsequent report (Frayling 1993).

Martin Heidegger acknowledges the human influence over outcomes of technology, while at the same time, both he and Soetsu Yanagi point out that the more complex technology becomes, the greater our need to control it (1977; 1974). When the execution of a task is taken out of our hands, technology is more likely to be seen as an instrument. As Umberto Eco explains, when we create machines they immediately oppress us; he says the non-human relationship we have with technology is so unpleasant that we instinctively attempt to merge beautiful features with the functional aspects of machines to forget we are governed by them (Eco 1989). If we accept this position, then, until we are comfortable entering into a dialogue with advanced technology, such as the large format inkjet printer, we are unlikely to produce artefacts that contain the maximum creativity.

Digital Printing and a New Process



A digital image located on a computer is relayed to, and subsequently printed by, an inkjet printer onto a chemically pre-coated substrate. The printed substrate is then steamed, and the dyes fixed. The computer and the inkjet printer are still two separate units, although the latter requires the former, and each possesses its own unique set of

resources. One aim of this practice-led research is to observe and identify processes used within neighbouring disciplines, for example, glass, ceramics and letterpress, which may potentially be transferred to digitally printed textiles.

There are a number of ways in which a new process can be used to create artefacts, and if these are communicable, then they may be suitable for research purposes. A new process or technique can be used to generate a research problem, such as: *Can mastered skills, which have been used to create an existing object, be made explicit by repeating the making process and using alternative materials to form new versions of the artefact?*

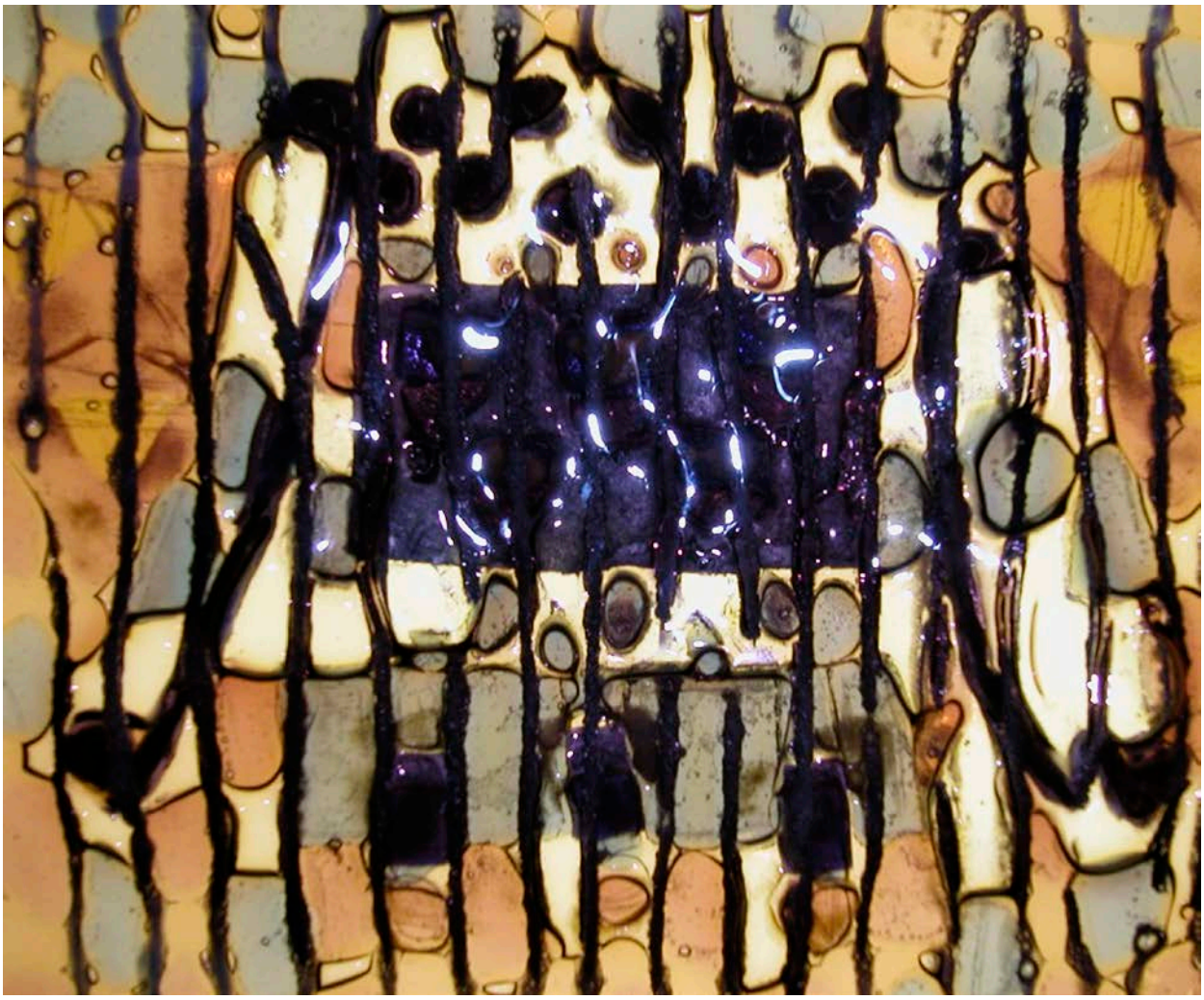
For this project I have taken one existing object, a glass artefact, made earlier in the studio. Then, by using reflective practice, I documented the forming of a second artefact. The act of making the latter was recorded in a reflective journal, observational sketches and photographs. In this way the data generated during the creative making process, a result of repeatedly moving backwards and forwards between the first object and the emerging artefact, is recorded and made explicit. As Kristina Niedderer writes, artefacts do not in themselves contain knowledge (2009a), but this new artefact, along with the documentation of its creation, now embodies an element of tacit knowledge made available through both visual and textual forms. It also reveals the embedded skills of the existing object (the glass piece) made apparent through the forming of the latter (silk artefact). Further, these skills are subsequently developed and understood using the act of forming involving alternative materials, such as dye, liquid and silk, rather than glass, glue and heat, which were employed in the original object. This allows the techniques to be experienced in relation to the object for the first time.

The original glass object could be read in a number of ways:

1. The vertical lines of copper oxide, saturated in cotton thread, and imported into the glass in order to draw distinct dark blue lines, have created a non-geometric framework for the piece;
2. The chemical reaction that subsequently took place around the oxide, formed small pockets of gas that migrated outwards to the sides, but these have been encased in the molten glass as the temperature dropped;
3. The central purple area has dissolved into a series of vertical wavy lines with sufficient texture remaining on the surface to reflect the light in a rhythmic pattern, contrasting with the two dimensional aspect of the outer areas;
4. The mosaic type glass pieces, set between the vertical oxide lines, melted within the confines of these stripes, and slightly spread towards the edges, migrating a short distance along the verticals, resulting in a visual that is similar to a highly magnified cross-section of a segment of wood.

To produce a similar aesthetic for digitally printed textiles, I tested a method to mobilise colour in a way that echoes the glass in a kiln. The dye is soluble, so instead of heat, I saturated the fabric with a prepared solution at room temperature, then removed the silk and dried the surface quickly to stop colour migration.

A series of fused glass samples were tested, and their construction methods noted. Large coloured glass sheets were broken down into the three different sizes: smaller cut sheets, mosaic-type jagged slivers, and finely ground frits. Using the glass sheet as a base, the other pieces of glass were arranged into a composition and lightly held together with glue, so as to stop the tiny glass shards from moving around. The glass sketch was left until the adhesive dried, then placed horizontally in a kiln and fired to 900 degrees C. This melted the glass sufficiently for the individual fragments to fuse together, and the sharp edges became smooth and rounded. The heat, while being sufficiently high to soften and merge all the glass pieces, was not so great as to over-blend the colours and lose the compositional form of the piece.



Glass sample, Susan Carden 2011

After slowly annealing, over two days, the cooled final glass piece was observed and the details, both visual and text-based, were analysed. Through exposure to extreme heat, the assemblage had been transformed from a solid state (comprising multiple glass pieces), to a liquid as it heated (with the edges of each segment bonding together), and back to a solid as it cooled (as one artefact).

In order to begin to achieve a similar effect from digital textile printing, it was first necessary to separate the technique into two parts: the physical component, and the process.

Substituting ink for the glass: dye-based inks were used to replace the coloured glass. Regardless of the base material, a method was sought that would allow the colouring agent to migrate freely, for example, by heat or through a carrier, such as a liquid.

Paper was investigated as a substitute for the glass sheet: this formed the base upon which the image was placed. The liquid in the ink held it to the paper, while similarly, glue adhered the glass fragments to the glass sheet.

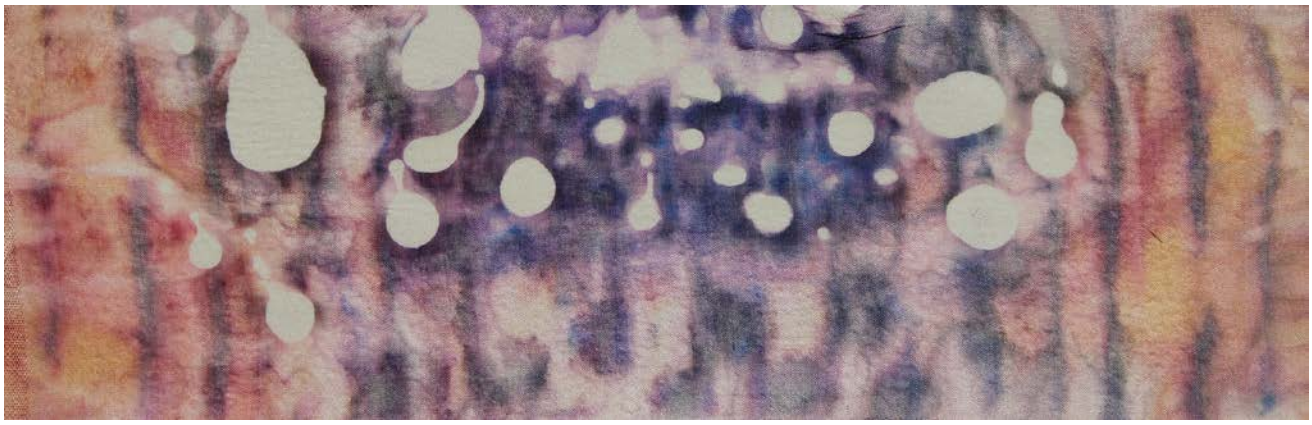
Ink was left to dry, in the same manner as the glue and glass.
Digitally printed paper covered with silk and saturated: the silk was coated with a specially prepared solution of food-grade ingredients to mobilise the dye particles; similarly, the glass composition was placed in the kiln and heated to mobilise the glass pieces.

Ink molecules were drawn towards the silk: the ink permeated the silk fibres. Likewise, the edges of the glass pieces merged together, forming a single unit.

The silk revealed a unique aesthetic: the solution was rinsed off, and the silk displayed a novel characteristic. The cooled, annealed glass also portrayed a new version of the original image.

The silk artefact showed a different version of the image: the resulting textile consisted of an alternative inkjet printed image. Similarly, the glass outcome had been regenerated.
The textile, like the glass artefact, had undergone a metamorphosis. The process offered a number of additional design opportunities:

1) During the stage in which the solution is applied, the length of time in which it remains in contact with the substrate alters the final aesthetic;
2) Agitating the surface of the saturated substrate also results in different visual effects;
3) Varying the quantity of liquid used similarly produces alternative outcomes;
4) Further crafts-based techniques, such as batik, can also be applied during this stage of the process. Thus, different printed textiles can be created, each one unique; but also, similar batch prints can be produced by maintaining a degree of consistency throughout the making process.



Untitled silk sample, Susan Carden 2011

Differences and Potential Advantages

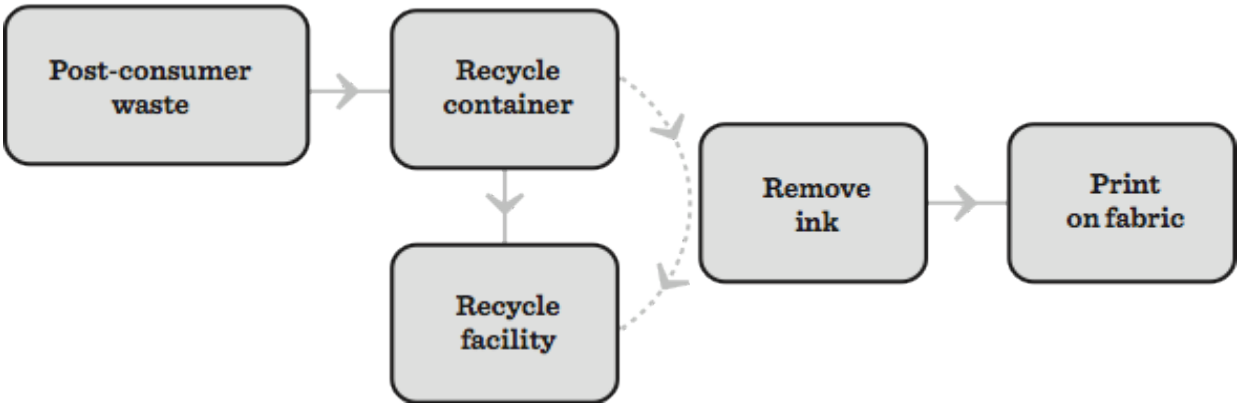
The final silk object could be read in a number of ways:
1) The dye had penetrated the silk fibres to such an extent that the back was virtually the same as the front; this was unusual, because, if the image had been printed directly onto the silk by a large format inkjet printer, the dye would have appeared to be sitting on the surface more than penetrating through to the other side;
2) To achieve variation in colour and texture, a series of tests had been worked to assess the batik, or blocking potential, that wax could produce within this process; three different waxes were tested: paraffin, soya and beeswax. As the process was new, the way in which each wax might behave, and therefore be incorporated, was unknown. The paraffin wax melted easily, but was less easily controlled than the others and randomly migrated during cooling; the soya wax behaved in a similar fashion, however the dye was less well defined at the edges of the waxed areas of the fabric; but, the beeswax performed best of all, with a good batik aesthetic, and ease of application in terms of contrast of colour between the dyed and blocked areas;
3) The final silk was found to have a soft, flexible handle after colouring; it had not stiffened, and no evidence was found of any surface irregularities that might have be

expected following the application and subsequent removal of so many foreign materials, for example, solution, dye and wax.

Untitled silk sample, Susan Carden 2011

One of the main benefits of this new technique is the elimination of the pre-coating and steaming stages that are normally associated with digital textile printing. The early samples were conducted with discarded paper printouts from desktop printers, such as the Canon 190 and the HP Designjet 10ps, a form of post-consumer waste, and were a combination of text-heavy and primarily image-based visuals. Later sampling involved images that were specifically printed for a predetermined final aesthetic. This provides the the designer with the option of intertwining random waste images with ones specifically printed for this purpose, extending the creative options of the process, while still providing an alternative low cost design system.

By reclaiming ink from paper printouts that had already been sent for recycling, dye is made available for textile printing that would otherwise be lost during the paper recycling process. The ink is thus accessible to individual practitioners, or small groups, at an extremely low cost. Also, large format textile inkjet printers are not readily transportable, and normally the fabric is brought to the inkjet printer to be printed; however, this new process enables the fabric to be printed almost anywhere, and the print-facility is thus brought to the fabric, instead of the other way round. An additional advantage of the new process is that it enables digital printing to be stored, as a file, for as long as is necessary, therefore eliminating the need for additional physical storage facilities. The textile can be held and transported as data, and the image to be printed is sent out over the internet to anywhere in the world; it can then be output onto paper, and applied to a fabric substrate as and when required.



With reference to Wiliam McDonough and Michael Braungart's manifesto (2002), initial results indicate that the value of the new process can be understood as possessing ecological, social and economic benefits. At the moment the process is only suitable for silk fabrics, with different weights of substrates producing contrasting outcomes. The author argues that the technique is best approached as a sustainable design tool, one that provides novel opportunities for the creation of printed textiles from images that are at first stored as data, transported electronically via the internet, and then digitally printed onto paper and fabric. The liquid used is of food-grade, and readily available as a staple in most countries, and further crafts-based interventions, such as batik, are also possible within the parameters of the process.

However, it is not an aim of this project to develop a substitute for conventional digital textile printing; but, the controlled use of reclaimed and recycled ink from discarded digitally printed images, when used for producing textiles with a sustainable footprint, may help to offer alternative design opportunities in the future.

Conclusion

This practical demonstration has shown one method for making advanced technology accessible to designers and makers in a novel manner. In this way technology, such as the large format inkjet printer, or the desktop printer, is incorporated into the practitioner's toolbox or palette alongside paintbrushes, glue, glass, dye and silk. The function of technology is embraced, and included within the handmade element of the studio enquiry. Thus, the technology can be, I would argue, described as being *humanised*, because its primary purpose is to act as a necessary component in the creative process, and its contribution is both challenged and built upon through the relationship it has build up with the designer.

Untitled silk sample, Susan Carden 2011

The new process was developed as a reflective exploration within the author's practice in response to the aim of reinterpreting a fused glass object for digitally printed textiles. By observing, documenting and reflecting on key stages of the making process, and involving a certain degree of trial and error, a parallel approach was ultimately devised (Schön 1984; Polanyi 1972). It was also a deliberate aim of the project, wherever possible, to try to make technology act in a way that was not originally intended (Frayling 2011:137). The data gathered during the studio practice, which was experienced through both the glass fusing and the digital printing experiments, demonstrate that the use of the hand and machine can result in a novel process that still conforms to predetermined guidelines (Yanagi 1972, p.108). These include, confronting advanced technology with craft-based skills, adhering to sustainable principles of design, and relocating a creative technique from one discipline to another, while attempting to maintain the integrity of the practice-led research (Niedderer 2009b).

Untitled silk sample, Susan Carden 2011

As today's designers increasingly find inspiration from many different areas and perspectives (Weil 1999), the presented new process strives to place additional value on the handmade from the points of view of the maker and client; to design with an awareness of the consequences of making using individual technologies, consumables, materials, and the ethical considerations of the workforce; to address how and where a product will be recycled or otherwise disposed of at the end of its lifespan; and, ultimately, to create digitally printed textiles from the perspective of the ecological aims of the designer, rather than the object, in a manner that begins to address the definitions of slow design (Fuad-Luke 2002). Additionally, the process has now been tested on a number of samples from food and clothes' packaging, all of which are routinely sent for recycling, and these samples have shown that it is possible to remove and reclaim ink from a wide variety of digitally printed substrates, most of which end up as post-consumer waste. Again, none of this dye is routinely recycled, and after the substrate is temporarily removed from the recycling process, and the ink subsequently removed, the packaging can then be returned to the recycling system. Preliminary results indicate that the outcomes of the new process demonstrate textiles with a unique aesthetic, at a very low cost in economic and environmental terms, thereby providing a creative technique
for designers and makers to use reclaimed inks from post-consumer waste within their ecologically considered design practice.

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