Fashion Design Using Laser Engraving Technology

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Abstract

Novel fashion design mainly depends on the integration of design method and technique. With development of technology, the laser technology is being applied for decorative purposes and to produce unusual looks in fashion design. It can engrave simple or complex patterns and designs through laser beam scanning on the surface of fabric. This study explores the application of laser engraving technology on assembled garments for diverse pattern effects. To improve the visual appearance, different design methods such as the graphic design method and the resist design method were applied for the CO₂ laser engraving onto garments made from rayon/polyester blended fabric with ideal laser engraving parameters including the resolution (dpi) and the pixel time (μs). The results of the laser engraved fashion designs indicate: (i) the appearances of the fashion designs depend on the material and laser engraving technology; (ii) the color appearances could be managed by controlling treatment parameters, such as the resolution and pixel time; (iii) unique design effects could be created by using different design methods; and (iv) computerized design processes could increase design efficiency and permit quick changes to ideas and designs. This study also reveals the future potential of feasible fashion designs through the use of laser engraving technology. The computer-aided design method could open up new possibilities for green fashion design with diverse patterns and textures which could cater to the demands for fashion industries.

1. Introduction

Laser engraving subsequently also referred to as a computer-aided design process, has been applied in textile industry (Ozguney, 2007; Steen & Mazumder, 1998; Zhou & Mahdavian, 2004). The application of this technique can create unique appearances of textiles without chemical applications and is environmentally friendly (Spalding, 1987). Different types of laser treatments can be achieved by using different machines such as: carbon dioxide laser (CO₂ laser), neodymium-doped yttrium aluminium garnet laser (Nd: YAG) and diodes lasers (Brichtová, 2007; Roux, 1989). Laser engraving is a subtractive method and can engrave simple or complex patterns and designs through laser beam scanning. CO₂ laser is the most efficient and suitable for engraving materials that are not good conductors of heat and electricity because its wavelength can easily be absorbed by textiles (Rajagopal, 2008; Ready, 1997; Ortiz-Morales, Poterasu, Acosta-Ortiz, Compean, & Hernandez-Alvarado, 2003). Although some researchers have applied laser treatment onto textiles, most of the studies have focused on the laser cutting method (Ghorannevissa et al., 2007). Furthermore, despite the fact that some studies have been conducted on laser engraving for the de-coloration of indigo-dye on fabrics, they have only focused on denim or cotton fabric (Kan, Yuen, & Cheng, 2010; Ondogan, Pamuk, Ondogan, & Ozguney, 2005; Štěpánková, Wiener, & Dembický, 2010). Hence, laser engraving is suitable for textile creation as it has practical value based on its various merits, such as: (i) flexibility; (ii) better quality; (iii) production efficiency; (iv) accuracy; (v) more perfection in the finishing of the final products; and (vi) environmental friendliness (Pundir, 2007).

In this study, the combining of technique and pattern design is conducted to create decorative fashion designs. Different engraved patterns are carried out based on the experimental design practices and methods. All the results demonstrate that the integration of the technique and material is an effective way to create innovative and environmentally friendly fashion designs.

2. Experimental

2.1 Laser Engraving

The laser engraving is carried out by using a GFK Marcatex FLEXI-150, a commercially designed pulsed CO₂ laser machine (Eurotrend Group, Spain) coupled to an Easymark® 2009 laser system. The experimental parameters for the resolution - intensity of laser spot (20, 30 and 40 dpi) and the pixel time - the time of the laser head positioning on each image point (120 and 210 μs) were varied to investigate the laser engraving effects on rayon/polyester blended fabric.

2.2 Process

The process of laser engraving treatment on textile for fashion design is as follows: (i) creation of a design pattern for the laser engraving; (ii) development of the pattern by using Adobe Photoshop software; (iii) conversion of the pattern into gray scale; (iv) inputting the design file into the Easymark laser system; (v) setting the parameters for pixel time and resolution; (vi) placing the garments on a honeycomb cutting table in a cabinet; (vii) location identification of the laser engraving area; and (viii) conducting laser engraving onto the garments.

2.3 Sample

45% rayon and 55% polyester blended plain weave fabric (density: 80 ends/inch & 88 picks/inch) with the fabric weight of 68.3 g/m² and the thickness of 0.65 mm under 5 g/cm² pressure was applied for laser engraving treatment. The fabric was conditioned at 21±1°C and 65±5% relative humidity for 24 h before experiments.

3. Design Methods

In the project, two major types of design methods are taken into consideration, namely: the graphic design method and the resist method. The six laser engraving parameters including 20 dpi/120 μs, 20 dpi/210 μs, 30 dpi/120 μs, 30 dpi/210 μs, 40 dpi/120 μs and 40 dpi/210 μs are applied in the laser engraving treatment of the garments.

2.1 Graphic method

2.1.1 Pattern creation method

This method involves the use of a personal computer with Adobe Photoshop software to design, edit and process images which make the design process faster and permit ideas and designs to be easily changed. Figure 1 illustrates a designed pattern and its corresponding details from laser engraving onto garment.
As evident from the results, the sophisticated pattern can be directly designed by using Photoshop. The pattern is engraved onto garment and exhibits different shapes and grey colors with different grades.

2.1.2 Pattern reconstruction method
In this method, preliminary images were directly captured by camera, and then edited and designed by using a computer with Adobe Photoshop software to reconstruct and process the images into new pattern designs in accordance with the different fashion design themes. After laser engraving, the colors of the reconstructed patterns were changed into gray scale as required. The new patterns were easily engraved onto the garments and evidently both novel and visually interesting. Some of the design results of the reconstructed patterns are shown as follows.

Figure 2 show that the reconstructed pattern create interesting design on garment made from rayon/polyester blended fabric. The result indicates that the different shapes of the pattern outline with some negative image effects after reconstruction could be engraved and show unique design effects.

2.2 Resist method
This design method permits the visualization of diverse forms of design inspirations in fashion design, resulting in new ways to design patterns and three dimensional visual effects similar to the tie-dye effect without the use of chemicals or dyeing. The garments are arranged into different shapes using the resist methods such as crumpling, pleating and tying for laser engraving. After treatment, the original and engraved areas showed uneven engraving effects amidst the folds, creating various photo-realistic three dimensional patterns for fashion garments.

2.2.1 Crumpling
Crumpling results in spiral effects on laser engraved garments. The designed garments were first laid on a laser engraving table and twisted to achieve a crumpled shape. After laser engraving, the garments were flattened and crumpled design effects could be seen. Figure 3 shows the result of the engraving process by using this method with different parameters.
This figure shows the results of laser engraving on garments by using the crumpling method. Spiral and floral patterns appear on the garment surface. During laser engraving, the laser beams engraved the surface of the crumpled garments, and the colors of the treated areas changed and showed diverse gradient effects.

### 2.2.2 Pleating

With the pleating method, the garments were laid onto an laser treatment table and pinched to raise folds until the pleats met the requirements of the design, and then engraved by laser beams with different treatment parameters. As illustrated in Figure 4, some vividly pleated engraving patterns are achieved.

The results show some indistinct as well as clear pattern edges are engraved onto the rayon/polyester blended fabric with correspondingly different shade change effects.

### 2.2.3 Tying

This method utilizes thread to wrap and tie garments for laser engraving. It is similar to tie-dyeing, but the wrapping is done relatively loosely, because the laser beams engrave the surfaces of the tied garment, and no chemicals are used, so there is no saturation of the dyestuff. After engraving, some vivid changes in the color shade and imaginative patterns are achieved. The fashion designs based on the tying method are shown in Figure 5.
As shown in Figure 5, the garments are tied by threads according to the requirement of design effect. The areas which were tied and folded by threads blocked the laser beams and preserved the original color of the fabric. The results indicate that this method could be used to make tie patterns more easily on garments which are similar to those with the chemical tie-dye method.

4. Design results
Some of the laser engraved garments are achieved and shown in Figure 6.

These designs shown in Figure 6 demonstrate the effects of laser engraving on garments by using different design methods for the diverse pattern designing. After laser treatment, the fibers on the garment fabric surfaces melted and vaporized, hence, the color changed to different paler shades of gray according to the parameters used while the untreated areas retained their original color. As a result of different design methods and laser engraving treatment parameters, these garments illustrate novel design effects.

5. Discussion
Diverse design effects have been studied in this paper to verify the relationship between design method and laser engraving for garments made from rayon/polyester blended fabric. Graphic design and resist methods are used with laser engraving so that different patterns could be created on garments. There are color changes that result from engraving onto tied and untied areas. Some lighter grayish colors are evident after engraving on the rayon/polyester blended fabric. These design methods applied in combination with laser engraving indicate great potential in fashion design depending on the treatment parameters and fabric selected.

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Characters of Techniques Represented by Fibers

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Abstract

The textile technology impacted human civilization, technology and fiber art characters in the early days. The technology is not only modifying surface appearance, shapes, and properties of textile materials, but also individualizes subjective sense of human. Assuredly, the technological feature is artistic taste of human nature. This paper would stress the specific significant of the technology and address a critical view that may distinct to the common misinterpretation in fiber art field. Additionally, it will further discuss the relationship between heritage of traditional culture and modern development. Highlighting the artistic creation in the importance of technical factors, the paper also concerns about the dynamic development of technology and with the corresponding steady flow of technical taste in the fruits created in past time. The technical contents in fiber material forms and its technical characters will be explored and analyzed.

Performance fiber materials are an important part of the shape of fibers, fiber materials fiber material itself or because of different characteristics and presents different representation, or as a fiber material with the composition presented in different ways and different performance results, or whether, after the former who are inseparable from the performance of fiber materials, the transformation of the role of technology, or some more or less, nothing more. The performance of fiber technology in the history of the development process and hand-woven textile technology textile industry, accompanied by the presentation of different technologies at different stages of development. In the era of manual techniques, the people directly involved in the fiber manufacturing process modeling, implementation of technology in the fiber material on the immediate shape forming process revealed, the final performance of the fiber forming, naturally reflect the implementation of the technical process different taste; textile industry and textile information age, mechanized operations, intelligent fuzzy processing, people do not shape forming fiber material is a direct participant in the performance of fiber materials, and technical course related, but the technology is only as performance fiber materials designed to implement the means, although modern technology has changed some of the fuzzy fibers form of machinery, cold and limited manifestations of the situation, given the performance of certain fiber taste, but still can not change the technology as a means of secondary meaning. No person directly involved in the performance of fiber technology in order to talk about taste I’m afraid it can only be empty talk.

1. Performance and technical fibers

Fiber material thin, flexible, but different types of fiber materials show different surface characteristics, smooth and rough, thick and fine, soft and stiff and so on. Fiber surface characteristics and performance of the fiber material is the most original, most essential form of expression. Nature of the banyan tree branches naturally drawn, woven palm bark appearance state, filament layers of bark, and withered to the water veins, performance fiber materials are characterized by their own example. Similarly, natural cotton, hemp, wool, silk itself has the characteristics and growth in the human form of existence, and in the technology through artificial extraction, thin material more obvious characteristics, modern synthetic fibers, synthetic fibers and minerals fiber, in addition to their functional characteristics, the fiber material of high elasticity, high gloss and high electrical conductivity, etc. caused by the visual power, has become an important part of fiber materials, fiber materials combined with modern materials in traditional fiber materials composed of a large family of fiber since become the basis for diversification of fiber materials.

After the material properties of knowledge and grasp of, the natural hair growth treatment process is the basic structure of the performance of the process, namely the technical process. As a wide range of fiber materials, fiber materials because of their different material characteristics, the use of technical means, the structure approach, the performance of different forms. Fiber morphology, determine the presence of fiber materials and forms, but also determines the existence of its technology, or process exists. Human society, there are completely natural performance of the fiber material does not exist, more or less transformed by the processing, structure and stability in the form of changing its characteristics. In nature, but added there are many fibers form a more stable, as previously mentioned the banyan tree, bark and roots have to wait. Fiber material manifestations of human understanding of fiber material in the process, the natural state of existence of the fiber material recognition, improvement and transformation of the technology presented.
To present the characteristics of fiber materials is characterized by its own fiber array technology. Through the finishing of fiber materials, layout, and a certain structure, showing the performance of parallel and orderly state. Such as flat embroidery, fibers were drawn to the ordering of technical devices; and the use of fiber small, slender features, and support the use of flat or three-dimensional molding process, showing the uniformity of the performance of state gathered disorder. Such as felt, arranged in a disorderly chaos embroidery techniques.

Technology is woven fiber material has continued since primitive times, the most practical, easiest and most varied material handling means. Today the surviving weaving mats, straw, bamboo, rattan technology. And the modern developed to strip materials (including bamboo, packing tape, plastic rattan, pink belt, pearls with other materials) base, compiled by successive weft interlaced to form a number of three-dimensional surface, with geometric composition, pattern income side of the modeling approach, the original baskets basket technology are further presented. Basket basket textile technology is the result of the development of technical refinement, and help solve the problem with mechanical force, intersecting warp and weft woven fabric, also known as woven fabric, such as jacquard, woven flowers. Knitting technology is based on fiber structure of technical performance characteristics of the other, circle each other by a string of yarn into a fabric cover made of molded articles of clothing and directly. Such as T-shirts, sweaters and so on.

The color of the fiber material to make technical changes that the staining techniques. People not only change the color of the fiber material desire, but also the resultant of the fiber material also has the desire, and this resulted in the introduction of numerous technologies. Dip, also known as exhaust dyeing, is made of fiber materials and dyeing of a whole class of materials technology, is to be dyed material impregnated with dye and the necessary auxiliaries in the dye bath, circulating through the dye bath or dye material movement, the dye gradually stained by contaminants on the way. Such as yarn dyeing, fabric dyeing. Staining pattern is dyed fiber material part of a class or in part, generated by the applied dye the fabric texture pattern techniques and methods are the most common printing technology, anti-pollution technology. Printing technologies such as screen printing, roller printing, hand-painted, etc.; anti-pollution technologies such as batik, tie-dye and so on.

Today’s fiber material and performance technology, already in the modern science and technology, driven by significantly across the fiber material generation technology, fiber nano-technology, post-processing technology, human imagination is sufficient to expand, in fact, is performance of fiber material provides unlimited possibilities.

2. The form of fiber materials

Fiber material fiber technology provides the performance and the performance of various materials, a rich and endless possibility. Since ancient times, mankind has no shortage of fun for the pursuit of performance fiber materials, fiber materials, regardless of the beginning of the baskets woven basket charm technology development, or age Silky cotton patterned textile technology development, or age Silky cotton patterned textile technology to pursue, as well as high-tech era of artificial fibers sheen and texture evaluation. Undeniable is that as technology continues to evolve and progress, fiber material increase in the base product constantly growing rich, fibrous material extend the performance range attendant, however, technology evolution led to the growth of things, but conceal the performance of individual mental disorders. When the hand-woven random diversity led to small changes loom planarity ﹑ shifted, until the looms of various types of medium-sized mechanical rigidity ﹑ dominant or ruling; machinery instead of hand, the program replaces the thinking, the whole process is not a sensual delight, purpose of the creation of human behavior into the behavior of mechanical production, purpose of the material form together overshadowed the main purpose of the taste. Material in the form of modern art to create almost all of artistic creation seen as, when the material presented ultimate pursuit of becoming the ultimate subject, ignoring the creation of the subject matter and its form of existence for the dominant technology.
In modern times, in the form of discussion and discovery, which greatly supported the creation of artistic impulse. Goethe said: "For everyone, material is placed in front, it seems that only some grasp of the content, we can grasp the content. For most people, the form of a mystery." 20th century, Clive Bell "significant form" to create, said Roger Fry "pure form" theory, and practice of modern art echoes the performance of the material in the form of taste substances into a climax. Form on the fiber material terms of performance, it is mainly in three aspects:

First, the performance of the material itself. Fiber material specific practice, a wealth of fiber material resources, combined with the different characteristics of fiber materials, in juxtaposition, arrangement, composition, resulting in contrast with the performance of the fiber material, showing the texture of fiber materials fiber material to their own "speak" of capacity.

Second, the process and structure performance. Proficient grasp of the material in the premise, the use of fiber material plasticity, is subject to different processes and structure methods produce different weave fabric, the fiber has a wealth of material is more expressive.

Third, the fiber forming performance. Whether flat or three-dimensional expression orientation of the fiber material dyed to give shape to the light irradiation, we can mix different colors of fibers to form fiber light reflection, refraction and other changes, clever interpretation of fiber material The new form of content. Three levels of fiber materials are interacting with each other's expression, not isolated, and their different combination, constitute a rich and varied forms of fiber materials.

Fiber in the form of the creation of fun, is a comprehensive form of fiber material, the depth of processing of the human consequences of the material, process, structure ensemble, with a clearer understanding of the fiber material and grasp, and the subjective performance of the fiber material characteristics of the desire to form a clear progressive levels of performance and deep technical mark.

3. The fibrous material of the human form of expression

Associated with the commencement of taste, technology, abstraction, symbolism, "symbol" theory has enriched the content of the form. Fiber is fiber material itself in the performance of many materials, especially the modern materials systems, independent of morphological features and performance qualities, which consists of two parts, one is the perception of physical form of thin, flexible; second is the psychological perception affinity form.

3.1. The delicate taste of the visual

Point, line, surface expression is the most pure form of the visual content. The performance of the visual beauty of the form should be filled with the simple static and dynamic rhythm changes with the rhythm and unity. The performance of the fiber material is to be the first to discover its own characteristics, and find that the most concise presentation of the natural ways and means. "Line" is a simple, direct fiber corresponds to the "line" form, corresponding to different fiber materials on the different "lines" different "lines" are corresponding to different human emotions. "Line" in the form of a natural extension to the ends of the characteristics, thus demonstrating the value of sport. Performance fiber materials fiber material found to be good at this feature, and make the best use processing complete, so that the extension of the material showing the rhythm of natural and free state, rather than the dramatic effect came to an end. Fiber, after all, is the "line"-like things, to constitute a multi-shape, multi shape, must depend on various combinations of materials, from the line to the surface, from face to body, is the fiber polymerization process. "Strand of the plot in the fiber, as if bent Lun" is to grasp the structure, indicating that fiber materials, especially to work hard in the structure, the structure is also designed to ensure uniform rational basis, looking for changes in the structure and rhythm of the performance of structures can be formed , rhythm.
the fear of human constant development, from voodoo rituals for the ancient rock paintings, to the caves, temples, churches, frescoes are giving courage, strength of the enlightenment way, people get from religion. Tapestry of medieval churches in Europe to become an important tool for enlightenment, through the walls hanging religious tapestry heighten the atmosphere. As the tapestry easy to carry and take the mobile structure, and even temporary religious tapestry has become the most important items, tens of thousands of people in the tapestry was made in an atmosphere of baptism. In the West, the building fabric as filler walls exist, which has a special significance. Performance fiber materials found to be good at traditional fabric patterns, images, and for creative expression, should be very valuable. In China, "farming men and women weave" the farming community of women created a special mode of founding the field of materials. Western feudal society did not exception to the modern society, women continued to enter the textile industry textile tradition. The textile sector as the most complete and comprehensive women’s development area, paid a genius to create the work. In the new background, women created by selecting the fabric and the performance of products and be able to demonstrate a more delicate feminine emotional content.

4. Performance fiber technology fun

Fiber material and technical achievements of taste fiber material performance, the performance of fiber material in the form of taste and cultural amenities, as technical performance fiber materials are in the process of development of modern technology, pointing away from the taste of the content lopsided.

The rapid development of today’s technology, textile technology, not only in cotton, hemp, silk, wool processing and production technologies extraordinary, since the beginning of the 20th century, with the emergence of cellulose fibers, synthetic fibers 1930s technology, fiber materials technology has also been an unprecedented development, with environmental consciousness since the 1980s, recycled fiber technology has been developed at the same time, because other technologies are also profoundly contributed to the development of the textile fiber materials include Manufacturing and printing of textile materials processing crafts technological progress, nanotechnology is changing the fabric fiber material function and other aspects such as a major breakthrough. Technology not only changed our daily lives, is also changing our environment, but also in the invisible world, bit by bit we improve our use of the function. As mentioned earlier, there is no direct human involvement, technology is always a means to the current era, showing significant high technology and low-level arrangement, is a sophisticated high-tech areas, relatively high barriers to entry, non- the expert can not grasp, intermediate technology also makes quite a lot of people stay away.

3.2. Flexible sense of taste

Sun, shade and soft match is often used to determine the strength of feeling, I do not know avoid masculine strong, fragile, feminine inability to be good at avoidance, easy storage. Tactile perception in the human activities, there is a certainty for the efforts to avoid, and rigid with only sustainable, flexible hand in hand in order to have degrees. Flexibility is a real sense of life, that is, the performance of flexible performance vitality. Is the modern face of fiber reinforced materials, cement and other hard objects to make the world posed by natural selection, the presence of soft materials is itself a performance, full of many wonderful imagination. Become "a treatment that we must live, functional, utilitarian buildings aversion excellent medicine. It embodies the profound emotions of human hand." Natural expansion of the elastic tension. Fiber material not only changed our living environment, the actual situation, but also provides a new public space to change, because in many of the public space environment, the actual tactile experience is limited, there are a lot of our visual experience, this is the sense of touch to feel the stretch in the fiber material, elastic force into a visual, the tactile feel for the fiber material into the visual texture of hard materials basis. In addition, the female image is a symbol of feminine beauty, the fiber material is a flexible material, through the hands of women in direct contact with the fiber material to form a perfect whole. Today, the performance of the process of fiber material not only women, the process of manual labor, but also includes human manual labor required to process sound, and the history of women in the performance of the fiber material is a symbol of the memory process. Fiber performance to be process-oriented performance, not only to feminine-oriented, but also rigid, that is the performance of the human hand plot.

3.3. The pro- life time of fun

The earliest human use of fiber materials, as a natural objects, it is not feelings, but as a human creation, through the last stages of the interaction, it embodies a lot of human emotions. At first, the human creature with the use of the fiber material creation is no exception, which, as the representative field of textile fiber material creation, a human cold wind, against the damage of membrane area, stretches for thousands of years, "clothing" is this effect of the show. Because of the existence of this man with a marriage, the performance of fiber materials can use the "finished" the performance of their own emotional world, where the information content infinitely rich. To overcome
Although the technology as a means to an end, we have long been known, but it is unclear how to achieve their goals, this is because we do not have full participation is still able to get the results of the Purpose. Part of the performance of fiber materials can not know how to change or deal with the so-called fiber material technologies designed to predict the shape of the final performance of the fiber material results; On the other hand, there is, after all, to master the technology, which in fact predict the performance of the fiber material in different ways with the former, they can directly participate in the performance of the whole process of fiber people.

Today's world, Material manifestation of the things I replaced one form of life, Form of artistic expression that is, technological innovation is equivalent to artistic innovation, performance fiber materials are the result of physical and chemical form of the times.

however, physical and chemical fiber material times to get out of the performance limitations of artistic expression, the need to pursue in the fiber material on the performance of the form to go beyond the scope of things. First of all, fun to work hard in technology, breakthroughs in technology areas of instrumental rationality, take advantage of substantial accumulation of various types of modern technology and cutting-edge technology, experience the process of using the technology experience. Secondly, we must change with the purpose of fibrous material forms of life created for the purpose of the form of non-extension of the fiber material in a variety of performance experience in the process of technological achievements, always found a new form of performance fiber materials - new forms. Third, we should gradually achieve the performance of the fiber material in the conscious application of new technologies and new technologies constantly and different experience, achievements fiber performance art.
Innovative design of Photonic Interior Textiles

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Abstract
Optical fibers have been widely utilized in communication and sensing technologies, but its ability to change colors also makes it a feasible material for interior textiles. In contrast to traditional textiles, the photonic fibres in the photonic textile can be connected to different Light Emitting Diodes (LEDs) sources to transform the textile color to adapt to the user’s preference. The technologies in fabricating photonic fabrics for interior textile are investigated in this study. The objective of this research is to examine the incorporation of optical fibers into fabric while maintaining positive tactility. For the purpose of this research paper, a piece of photonic fabric was created and the research rationale and process will be discussed. This research aims to integrate design and technology to create innovative interior textiles.

6. Introduction
Textiles form powerful interior components as they combine three strong design elements: the emotion of color, the impact of pattern and tactile qualities sensed through visual perception and physical touch. With the soft and comfortable tactility, textiles can offer physical advantages to interiors such as sound absorption, privacy, comfort, enhanced safety and aesthetics, and also can set a mood, establish a theme, and secure an ambience to create an enhanced interior environment.

Nowadays, as people are getting involved in more diverse activities within compact spaces, there is growing demand for interior environment to be flexible. Consumers demand for interior textiles which are multifunctional, reactive and interactive (Nielsen, 2007). Interactive interior textiles enable individual users to interact with the interiors and flexibly customize their fixed interior surroundings for different purposes. Interactive interior textiles are especially relevant to densely populated cities.

With the emergence of photonic fibers, textiles engineered with the ability of being interactive with the user as well as other surrounding technology are now possible. Photonic textiles with interactive function through the changeable and tuneable color can present a pleasing visual effect and customized interior environment to the user, and therefore greatly enhancing the interior environment. Nowadays, as our lives become more diverse and personalized, interactive interior textiles appealing to lifestyle enhancement and entertainment have the potential to be utilized in value-added products which can enhance quality of life.

Some fashion, design and architecture products employing luminous fabrics have been commercially available in the market, such as textile switches, textile keypads (Tao, 2005). Optical fiber displays and textile illumination devices have also been reported (Harlin, Makinen, & Vuorivirta, 2003; Koncar, 2005), and the technology is mostly based on woven photonic fibers having cladding imperfections (mechanical, thermal, chemical damage) and therefore light emitting sites. In most cases, a multiplicity of polymer optical fibers are integrated into textile structures connected to a light source at the fiber ends. Various light sources can be used to feed the optical fiber matrix.

This article mainly introduces an innovative photonic textile for interior purpose. The objective of the design is to develop a photonic fabric, which can be used for design of interior furnishings, including cushions, wall hangings, etc. With the illuminative effect, the furnishings can create two different interior environments during day and night as illustrated (Figure 1).

7. Methodology
7.1. Weaving
As one of the oldest way to make fabrics, weaving still remains one of the most widely used methods to produce photonic fabrics. The photonic fabric created for this study was woven with the photonic fibers introduced as weft yarns, and cotton yarns on the warp. The interlacing of cotton and photonic yarns will contribute to a positive hand feel for the photonic fabrics. As the warp yarns were threaded under tension through the loom, it was more feasible to introduce the cotton yarns on the warp as the photonic yarns are brittle and fragile and will easily snap during the weaving process.

By varying the weave structure and incorporating the photonic luminescence generated by the integrated photonic fibers, different surface pattern, texture, color and lustre can be created. The following weaving loom was adopted for production of optical fiber fabric (Figure 2). Figure 3 shows a photonic fabric swatch using plain weave.

Figure 1. Design Sketch- Photonic interior textiles
7.2. **Laser Engraving**

In the application of optical fibers, polymeric optical fibers are always used due to the fact that they are more resistant to textile manufacturing processes and have a higher flexibility and low stiffness, compared to glass fibers (Kuzyk, 2006). Therefore, PMMA based polymeric photonic fibers were used for this study. The fiber has three layers. The light is mainly guided through the core layer following the law of total reflection at the boundary between the core and the first sheath. The second sheath has functions of anti-bending and color modulation achieved by different reflective index and optic gain materials. In order to let the light emit not only from the photonic fibers ends but also from the lateral surface of fiber to produce different luminescent effects and design patterns, the fibers were engraved by laser, to allow side illumination (Figure 4).

7.3. **Integration of Electronics**

LEDs with green, blue and white colors were used as the light source in order to produce mixed color. Groups of photonic fibers were bundled together and then coupled with LEDs with predetermined sequences.

Ultraviolet bonding technique was adopted in coupling LEDs, which can maximize the lighting efficiency and reduce the coupling loss. All controlling electronics of LEDs were docked in a motherboard (Figure 5).

8. **Result**

A piece of photonic fabric named “Rhythm” was created (Figure 6). The normal cotton yarns and optical fiber were integrated into a fabric. More than 40 LEDs with blue, green and white color were used as light sources. The dimension of the fabric is 150 centimeters by 70 centimeters. With illumination, the fabric presented a dynamic and dramatic appearance. In contrast to the unchangeable nature of traditional interior textiles, the innovative photonic textiles can be adapted to suit different preferences and light conditions to create an enhanced ambience.
9. **Discussions and conclusion**

This research explores the development of innovative interior textiles with consideration of both aesthetics and technology. The researchers were successful in weaving the photonic fibers with cotton yarns to create positive hand feel and good flexibility as demonstrated by the draped shape of the artwork. The researchers were also successful in using laser engraving technology to cut the fiber surface to allow emission of light at the engraved areas along the length of the fiber. Traditional weaving technique has successfully enhanced the surface texture and design aesthetic without compromising on the technological functionality of the photonic textiles.

The engineered prototypes can be used in interior design, and can enhance the interior environment. The prototypes have the potential to be utilized in value-added products which can enhance the quality of life.

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**References**


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Dr. Jeanne Tan is currently an Assistant Professor at the Hong Kong Polytechnic University. She received her PhD from the prestigious Glasgow School of Art (University of Glasgow). Her research interests are in interactive textiles, fashion design and surface embellishments. Dr Tan has active roles as both researcher and practitioner. She is member of the editorial board for the International Journal of Costume and Fashion by the Korean Society of Costume and Praxes Journal by Shih Chien University, Taiwan. Her creative work had been exhibited in many internationally recognized venues like The Lighthouse, U.K. (Scotland's Centre for Architecture, Design and the City), Museum of Siam, Thailand, Chengdu Art Museum, China and Innocentre, H.K. Dr. Tan's creative fiber art work *Linear* had recently received an Excellence Award at the 1st Contemporary Chinese Fiber Art Exhibition organized by the China National Arts & Crafts Society.

Bai Ziqian is currently a PhD student under Dr Jeanne Tan’s supervision. Her research topic is *Innovative photonic textiles: The investigation and development of polymeric photonic fiber integrated textiles for interior furnishings.*
Shoe conceptual design using rapid prototyping machine

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Abstract

During the conceptual design phase, designers are not sure about the design. Depending upon their intended result, they might just design based on experience and gut feeling, or explore different design and choose the best design. During design exploration, designers are experimenting with materials, techniques, design parameters, colors, shapes and styling. In many cases, due to cost and time, designers are unable to explore all the design variables in a design space. Generally designers will make very few sketches. On the other hand, an artist is guided by his instinct, experience, and knowledge to create marvelous art piece.

With the increasing use of computer technology, designers are able to tap into 3D design software to enhance their design. Furthermore, 3D design software provides a cost effective method for design exploration. We can see the effect of different material, colors, and design parameters within few computer clicks. Once we have decided on the 3D shape, 3D printing machine enable generation of complex physical design. In this presentation, we discuss the steps in generation of an design using 3D software and 3D prototyping machine (Figure 1) from conceptual design.

1. Conceptual Design and Drawings

In this illustration, we get our inspiration from wires. Wires can be easily molded soldered to create complex shape, however not everyone has the necessary skill to convert wire strand to beautiful footwear. Also the concept is to make the footwear look fragile, but at the same time have the strength to support the wearer. Of course the prototype made using 3D printing machine, which uses Acrylonitrile butadiene styrene (ABS) plastic cannot be worn, but we are able to hold the design and appreciate the complexity of the design. Figure 2 shows different views of drawings. We also had several rough sketches to arrive at this design. The 2D drawing provides a good method to visualize the design however the design cannot be easily manufactured. Of course no shoe manufacturer will manufacture conceptual shoes with this level of complexity.

2. 3D Digital Design

Figure 3. 3D design based on digital shoe-last
Based on the drawing a 3D drawing is created. Many types of 3D software can be used such as Solidworks, CATIA, AutoCAD, ProEngineering, and ALIAS. The actual 3D design is based on a shoe last. A shoe-last is a 3D mold for making shoes. This ensures that the dimensions are correct. Figure 3 shows the 3D design based on a shoe-last. The 3D design involves points, curves and surfaces in 3D. Figure 4 represents the 3D designed shape. The 3D designed shape can be texture mapped to shoe metallic effect.

Figure 4. 3D shoe last design with metallic texture mapping

3. Physical design prototypes
The 3D digital design is then converted into STL format, a widely used 3D geometric format. Using the physical format, a physical prototype is generated using rapid prototyping machine. There are many commercial available rapid prototyping machine using different construction materials and different accuracy. They can also have different color. In our lab we have Dimension stratasys rapid prototyping machine. Figure 5 shows the printed 3D designed shoe. During printing support material is included to help build the prototype.

Figure 5. 3D printed conceptual shoe

For our current prototyping machine model, we need to break the support material (Figure 6). This is a rather tedious process. Newer version of prototyping machine enables washing away of support material.

Figure 6. Breaking away of support material

4. Final design
The final design can be glued, painted, machined, electroplated, or modified. Figure 7 shows an example of final product.

Figure 7. Final design that has been painted

5. Conclusion
This paper has described a step by step method to create a 3D shoe model. During the 3D design stage, different software will be able to provide different options to explore and modify the design. Some software also provides options for strength analysis before the product is designed. The developed prototype can be further modified to have different effect.
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