**The Application of Paper Modeling in the Design of Woolen Knitwear**

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**Abstract.** Paper modeling, as an important decorative means and formal language, has been widely applied to the knitting fashion design in recent years. This paper mainly offers an introduction to the current status of paper-cut and paper-folding, two Chinese traditional handcrafts, in the design of woolen knitwear as well as an analysis of its structure and process; on the basis of which, it comes to the conclusion that paper modeling art plays an irreplaceable role in the design of woolen knitwear. Considering its unique cultural connotation and modern processing methods, it also conducts research on the latest development and application of paper modeling method in the woolen knitwear, which is of possessed of broad application prospects and market values.

**General Introduction to Paper Art**

Paper is a raw material with multiple functions. Early in 105 A.D., the Chinese people began to make papers with discarded fishing net, barks, rags and fibers. After the invention of typography in the 15th century, the paper materials enjoyed increasingly wide application. Along with the constant increase of and in-depth research on the processing technology of paper materials, an artistic technique featuring paper as the design elements or style begins to take shape. It refers to a form of art that displays the beauty in form by folding, rolling up, shearing, pasting and inserting the papers of different textures and colors. Among these techniques, the most widely used are still paper-folding and paper-cut.

**Paper-Folding**

Paper-folding, or paper art, is an artistic activity by folding papers into different shapes. Paper-folding is said to stem from China, Japan and even Spain. However, its origin cannot be confirmed as no record has been found on the historical documents or archaeological discoveries. Despite this, it is still undeniable that China is the cradle of papermaking technology; on the basis of which, it gradually develops its own tradition of paper-folding and gains momentum through the folk sacrifice and religious activities. In the middle of the 7th century when the Great Tang Empire became the top-ranking country with open civilization, the paper-folding art, carrying the good wishes of the Chinese people, was disseminated to other countries. Despite its vividness and in exhaustive charm, this art also embodies rich scientific principles and methods. By the end of the 7th century, the Arabian applied the European geometric principles to the paper-folding, marking the beginning of the combination between art-folding and mathematics. However, since the 19th century, art-folding, integrated with natural sciences, became the teaching and scientific and research instrument in Europe. Laszlo Moholy-Nagy, a scholar from Bauhaus, put forward the method of designing architecture with paper-folding. Friedrich Froebel, the founder of preschool education, held the view that, paper-folding could enlighten people through its integration with art. In the late 19th century, the first International Academic Conference on Paper-Folding was held in Paris. Then, the 20th century has witnessed the rapid development of paper-folding art.
**Paper-Cut**

Paper-cut, which is also called paper carving or paper-cut for window decoration. The major difference lies in the fact that either scissors or graver is used. In civil society, the decorative patterns or style is usually called the paper-cutting art. The history of paper-cutting can date back to Han Dynasty; during this period of time, the invention of paper has advanced the emergence, development and dissemination of paper-cutting art. So far, the earliest paper-cutting artworks are the 5 pieces of flower mission found in the ancient ruins of Gaochang of the Northern Dynasties at the Turpan District of Xinjiang. As different historical period breeds different social background, the development of paper-cutting art will inevitably change along with the historical vicissitude and social transformation to keep abreast with the trend of times. Paper-cutting was intimately related to offering sacrifices to ancestors in Tang Dynasty and to the traditional opera art in Song Dynasty; however, in Ming Dynasty, the combination of plastic arts and the traditional thoughts of auspiciousness constitute the major products of paper-cutting art at that time; then in Qing Dynasty, this art has been well developed and reached its peak. Nowadays, it is a world-renowned art that has been widely used in all the industries, modern design in particular. The Poland Pavillion during the 2010 Shanghai World Expo, for example, has white exterior wall with hollow and asymmetric patterns covered, fascinate people as if it were a large paper-cutting with distinctive polish characteristics.

**The Application of Paper-Folding Elements in the Design of Woolen Knitwear**

Paper-folding is an important part of paper modeling. It aims at creating a three-dimensional form through turning over, rotating, folding, pulling, lifting, squeezing and inserting and adopting the methods of composite paper-folding and combination paper-folding without using the scissors or glues. The technique of folding and piling-up, once used in the design of knitwear, could change the soft features of knitted fabric and innovate the style and silhouette of the knitwear.

**The Modeling Features of Paper-Folding**

Paper-folding art, with its unique three-dimensional modeling, space sense and variety, has enriched the expressiveness of knitted fabrics. The modeling characteristics of knitwear design are demonstrated in the following 3 aspects: 1. Paper-folding art has been widely applied to different industries. The structural design of the woolen knitwear displays a strong visual impact for the feature of soft fabrics, obvious space sense and formative nature. 2. The variety and fitness of paper-folding art. The diverse weave of woolen knitwear echoes with the variety of paper-folding structural design. It could fit the body structure through the certain direction of folding. When human body naturally moves, the folding modeling opens, demonstrating its appropriate fitness. 3. Paper-folding art has distinctive ornamental features. The elements of paper-folding could be paralleled and crosswise arranged in the form of dots, lines and surfaces, thus enriching the style and structure of the knitwear with the dimensional, dynamic and texture changes.

**The Application Method of Paper-Folding Art in the Design of Woolen Knitwear**

*Structural Paper-Folding Art*

Structural paper-folding art is usually applied to the overall shaping of woolen knitwear by discarding the previous styles or the simple combination of parts and nimbly integrating the two-dimensions with the three-dimensions so as to create a brand-new structural morphology of knitwear. By means of the interweave and bar tack of strip knitted fabric, it could generate a interlaced and twisted with a sense of three-dimensionality and a visual illusion. Figure 1 refers to a fashion style with the structural paper-folding art, which relies on the outline of the upper part of the human body. The strip knitted fabrics, processed with woven and winding techniques, could highlight its architecture-like block surface and sharp-cut lines and create a ‘non-structural’ apparel modeling.
**Repetitive Paper-Folding Art**

Repetitive paper-folding could be applied to part of the woolen knitwear, or create a unique outer contour through repetitive folding. It is featured by a sense of space, texture and rhythm with a strong visual sense of relief. The large-area of repetitive folding is usually expressed in the form of geometrical morphology to demonstrate the aesthetic order of the fashion style; the small-area repetitive folding displays diverse forms and strong regularity, which could be used to shape the stereoscopic and unique modeling. Figure 2 introduces a fashion style with overall repetitive folding. With the repetitive stripe as the basic folding, stripes with different length are set according to people’s body curve so as to enhance the texture of the knitted fabrics, shape the new visual contour and strengthen the comfort feelings.

**Decorative Paper-Folding Art**

The peculiarity of decorative paper-folding art is reflected in its function as structural support and the carrier of details, thus being heralded as a special decoration in knitwear. This technique could be applied to part of the clothes, creating different visual variations at different parts. The folding method of the same direction, different direction and interlace could add radiance and uniqueness to the apparels besides its function of demonstrating the orderly or disorderly structures of apparels. Figure 3 offers an introduction of a decorative folding fashion style that is intimately connected with structure. The decorative paper-folding art could be applied to the placket front. The extensibility of the fabrics and the interlaced folding types could draw people’s attention, testifying the importance of decorative performance.

![Figure 1. Structural Paper-Folding Knitwear.](image1)
![Figure 2. Repetitive Paper-Folding Knitwear.](image2)
![Figure 3. Decorative Paper-Folding Knitwear.](image3)

**The Application of Paper-Cut Elements in the Design of Woolen Knitwear**

Paper-cutting is an artistic form that enjoys great popularity in China. Originating from the countryside and daily life, it is an art of simplicity and vividness. With exaggerated expression, unique decorativeness and attractiveness, it is the fruit of the wisdom of the laboring people that is popular among people’s folk life and delivers the same aesthetic standards. The folk paper-cut is an indispensable decoration on the doors, windows, ceiling and illuminations during the festivals; meanwhile, it also serves as an important component in embroidery as well as printing and dyeing baseplate. Before paper was used for paper-cut, silhouette and hollow-out as well as other artistic forms were applied to the thin materials, thus laying a foundation for folk paper-cut. Later on, it gradually became an independent artistic form with expanded applied range and ever closer relationship with the folk costume.

Nowadays, costume designers usually express paper-cut art by hollow-out means; in terms of the design of woolen sweater, paper-cut hollow-out method, as a three-dimensional contouring that causes bumping changes, only works on the internal outline. It brings visual sense of hollowness and layering, breaking the monotony of knitted fabrics and enhancing the decorative performance of woolen sweaters.
The Modeling Features of Paper-Cut Art

Age of plain composition. The appropriate density of thickness of the dots, lines and surfaces exert its decorative effects through the different pattern expression. However, in the design of woolen knitwear, the designers usually express the paper-cut art in the form of hollow-out and give thought to modeling, color and the technique of expression. The modeling features are listed in the follow 3 aspects: 1. the application of hollow-out paper-cut in the design of woolen knitwear has its uniqueness. Thanks to the hollow-out patterns of different sizes and types woven by crochet hook and the regular eyelet changes brought about by the knitting machine, the hollow-out effect of different patterns could be formed with outstanding texture effect, providing new design elements and enriching the styles of woolen knitwear. 2. The knitwear with hollow-out paper-cut elements is characterized by variation and permeability, imparting a special visual effect to people; the overlaying knitted fabrics also generates in people a sense of layering and aesthetic appreciation. 3. Hollow-out paper-cut art is of both function and decoration. The modeling of woolen knitwear includes the external and internal space modeling. The former is mainly reflected in the overall outer image while the latter mainly consists of segment line and structure line. The line-connected patterns in the hollow-out paper-cut could replace the segment line and structure line in the knitwear, a fact that meets the functions of human surface and also gives expression to the strong ornamental feature.

The Application Mode of Paper-Cut Art in the Design of Woolen Knitwear

Utilize the Addition Design of Paper-Cut Elements

The addition design of paper-cut elements refers to the shaping of embellishment, sense of layering and three-dimension of the woolen knitwear; to be more specific, it aims at increasing the design or fabrics of other elements on the basis of the existing fabrics, such as the knitted fabrics with geometrical hollow-out patterns, or the specific hollow-out patterns such as flowers and animals. The hollow-out elements could be the fabrics of the same texture and color or the totally different fabrics. The same or different textures are combined to create an effect of piling-up, lining, penetration and coverage and an effect of layering contrast, texture contrast and concavo-convex texture. Figure 4 contains a knitwear with specific paper-cut elements addition design. The lower part is a semi-transparent knitted fabrics with geometric patterns that have undergone the paper-cut hollow-out process. This addition design could nimbly enhance the expression of the apparel modeling, create a three-dimensional visual effect by matching texture effects of different materials.

Utilize the Subtraction Design of Paper-Cut

Different from the complicated decorative effect of addition design, the subtraction design enables people to use their imagination. Besides the hollow-out technique, the geometric patterns and floral designs are also widely used in the design of knitwear. By replacing its original texture effect of the overall garment materials, it could create a hollow-out fabric with contrastive layerings, texture and concavo-convex knitted yarns. The large-area hollow-out technique could be applied to the all the parts of the apparel. The small-area hollow-out technique could be applied to the key areas of the apparel, such as collar, cuff and front fly. The black knitted fabrics, once added the geometric hollow-out patterns, could strike a contrast with the white skin of human body.

Utilize the Detailing of Paper-Cut Elements

According to the design principles of the designer, the hollow-out design is applied to part of the knitwear as decorations. As a matter of fact, the detailing hollow-out design could be used for many parts of the knitwear, namely, the edge and the central part. However, the application of this technique at different parts could bring about diverse effects. The design of the edge, such as the collar, cuff, shoulder and lower hem could also strengthen the contour of the clothing; the central part refers to the parts surrounded by the edge, such as the breast, abdomen and back. These parts, after the processing of hollow-out design, will inevitably become the visual center with distinctive features. Figure 6 includes the knitwear with the edge processed by hollow-out design. Besides this,
the fabrics with hollow-out design could be used for breast, shoulder and princess line to outline the silhouette of the body and highlight the curve characters of the females. This design could help get rid of the dullness and heaviness of the overall clothing, enhance the enjoyment and make the detailing design more exquisite.

**The Significance and Innovation of Applying Paper Modeling Art in the Design of Woolen Knitwear**

The design of modern knitwear has failed to meet people’s demands. The design elements of paper modeling art have brought brand-new inspiration to fabrics and modeling of the knitwear, thus turning the originally plain and structured style into multi-faceted and innovative design, displaying the unique artistic charm and design features of the knitwear and meeting people’s demands for fashion and aesthetic appreciation. Besides its function of attracting the consumers’ eyes, paper technique also has great utility, such as the knitwear with hollow-out design could help the human body sweat, reduce the body temperature and enhance the comfort during sports; the knitwear with folding designs could make up for the deficiencies of the wearers’ figures by creating an effect of visual illusion.

In recent years, paper technique has a frequent presence in the international knitwear design works in different artistic forms, signifying that the paper art has been integrated into the international fashion. We could take actions from the following aspects so as to better combine the paper art elements and the modern knitwear design principles and blaze a trail of innovation. Firstly, it is demanding to excavate the cultural connotation of paper art. The paper-folding elements may exert diverse artistic effect if applied to the knitted fabrics of different thickness. The folding effect of the knitted fabric is sustained by the new technology with memory materials added to ensure the fixed effect; by doing so, it will easier to be taken off. Thirdly, the paper modeling art is applied to the knitwear by means of neutral design method. Since ancient times, paper art is intimately connected with females. A mere mention of paper art reminds people of females. The paper-folding or paper-cut art is not exclusive to the clothing for females; as a matter of fact, this unique design if used in the men’s knitwear, may enhance the diversity of the clothing. Therefore, we should excavate the value of this art for further creation and expand its application in modern men’s knitwear, such as knitwear and overcoat.

**Conclusions**

Today, we are called to reserve the regional cultural characteristics, respect the development of regional, folk and traditional culture so as to form a pluralistic pattern of virtuous circle. Under such
circumstances, fashion design is becoming increasingly characterized by cultural nature, aesthetic appreciation and utility and innovation. The traditional paper modeling, as one of the sources of inspiration for modern knitwear design, gives new impetus to the innovation of knitwear; from which, the designers could explore the creative inspirational and design languages. With the constant innovation and development of knitwear, the traditional paper art will enjoy broader space of application. However, the collision between traditional visual effect and modern design concepts, together with the advanced technologies, could spark new designs and enable the traditional paper modeling to be applied to the modern knitwear and even carried forward.

References


