FINE VISION TO HIGHLIGHT 3D RENDERING FOR PLAID FABRIC SIMULATION BY USING COMPUTER

Dr. Hanan A. Bukhari

King Abdulaziz University

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Abstract:

The purpose of this study was to design plaid pattern of fabric simulation. And to render the fabric with 3D effects. Qualitative and quantitative methods were used to analysis the data. The study results indicated that:

- The second design was the best designs in achieving the aesthetic side, according to the opinions of the arbitrators, followed by the third design, and then the forth design and then the first, and finally the fifth design.

- The first design was the best designs in achieving the creative side, according to the opinions of the arbitrators, followed by the third design, and then the fifth design and then the second, and finally the fourth design.

- The third design was the best designs according to the opinions of the arbitrators, followed by the first design, and then the second design and then the fifth, and finally the fourth design.

The study concluded that the 3D rendering whether in clothing design or furniture fabric takes the same draping steps with emphasis on light and shadow in each piece of the design. Finally, in order to get a realistic 3D rendering, the designer needs to be more experienced and flexible with the shadow and light tools. The more they can manipulate these tools, the more realistic the simulation will be.

Key words: Textile design, Plaid fabric, 3D Rendering.

Introduction:

Nowadays, one can find technology in the hands of children before adults. This forces everyone including designers to learn more about the changes and methodologies in textile. Textile indicate social, economic, and technological changes. Textile is also impacted by these change. As times and societies evolve, so does textile (Spring, & Hudson, 1995).

Many software's have been developed such as Auto CAD, Gerber Scientific (USA), Lectra (France), I- designer (Japan), and Assyst (Germany) (Song & Ashdown, 2015, P. 315). CAD technology is not only limited to clothing and textile, but it is also included in fabric furniture industries as well (Fontana, Rizzi, & Cugini, 2005) and interior design, architecture, and environmental planning (Parsons & Campbell, 2005). Drawing by computer has many different advantages such as modifying the colors without starting over, adding effects on the shapes, manipulating with zoom view, and possibility of using simulated environment (Al Halbi, 2010).

Rendering is how a design or fabric is put on an object to make it realistic, it adds more realism and "reflection, refraction, and the true effects of lighting" (Cohn, 2009, P.2). Rendering allows designers to get a realistic 3D view with different angels. Without technology, the design process to get 3D image is time consuming because the designers need to use different light sources and shadows to get the accurate view. Using technology enables the user to use 3D draping effectivity. Within a few seconds the fabric can be draped on the model and even furniture (Mitra, 2014). According to Gong, & Shin (2013), technology is advancing with three-dimensional printing, laser, and simulate fabric. Designers these days are expected to know how to use uprising technology to create realistic texture. A good designer is one that can effectively use shadowing and light to create a three dimensional image. The need to be able to control different brightness and contrast to have a simulated texture that look like a real surface. Song and Ashdown (2015, P. 315) stated that technology such as 3D scan and 3D simulation allows designers to zoom in and focus on certain aspects of the design. This allows them to modify and comprehend "depth, origin, and stress folds".

Liu, Zhang, and Yuen (2010) describe the process of creating 3D garment design involving "mesh painting, mesh cutting, mesh extrusion, and mesh partition". Draping involves fabric manipulation to create a realistic simulation on the model. Zink and Hardy (2007) studied the techniques used in clothing simulation. They found that using geometric shapes to turn mesh from 2D to 3D image achieves a realistic effect from the draping. Thanks to the geometric images in technology, the process of simulation has become easier. Geometric draping helps fill in the mesh

gaps on a mannequin model. Geometric shapes are combined to make a 2D pattern. Then the pattern is draped onto the mesh, this forms a 3D image (Zink & Hardy, 2007). Decaudin, Julius, Wither, Boissieux, Sheffer, & Paule Cani (2006) present a multistep method to create a 3D image using the mannequin's geometric. First, they sketch the garment and label the seam lines. Then, the computer software takes the sketch and measurement of the model to create the overall shape. Then, the designer uses the body's geometry to create a 3D image that looks realistic. Bukhari & Al-Shamarani (2015) indicate that 3D design software in garment industry is an effective tool in both reducing the production time, as well as the cost.

In the pre computer era, creating check and plaid fabrics was a nightmare because it was a time consuming process. CAD software has made the process easier. CAD gives unlimited varieties of checked and striped designs whether the fabric may be woven or print (Mitra, 2014). According to Mathur and Seyam (2011), in CAD system, woven fabrics can be created using a variety of tools and they can be simulated which provides a visualization of the real fabric. Moreover, CAD fabric simulation allows the user to simulate the fabric effect, user can also simulate "yarn, wrap pattern, and weft pattern" (Mitra, 2014, P.47). Many software provides a grid tool which aides in the design process of plaid or tartan pattern. It organizes dimensions and lines in an alternating sequence. The grid tool also allows the designer to use specific measures repeatedly (Gross, 1991). To create the plaid patterns square, the user needs to start with a line to guide the other lines used in making the square. This guide line is called a "Horizontal Line" and it is one of the four lines needed in making a square. The user must input the length and width for the horizontal line. The computer then automatically creates the three other lines with the same measurements needed as the horizontal line. Once the four lines of the square are created, the user can arrange them into a square (Derrington, & Suero, 1991). According to Stoner and Albright (1996, P.1291), plaid patterns demonstrate realistic "overlapping retinal projections". There are three tools used in creating plaid designs which are drifting, luminance, and transparency. Drifting includes overlapping lines, and luminance makes these lines darker or lighter, while transparency involves making the background lighter or darker. A

designer can experiment with these three elements to create many varieties of plaid surface designs.

The problem of the study:

The researcher observed in her teaching in fashion design courses that the students had difficulty in designing plaid fabric despite the length of time required for designing one piece by hand of plaid fabric. One the other hand, the students when they draped the fabric over the mannequin, they only draped in 2-D which did not show a realistic image of the design.
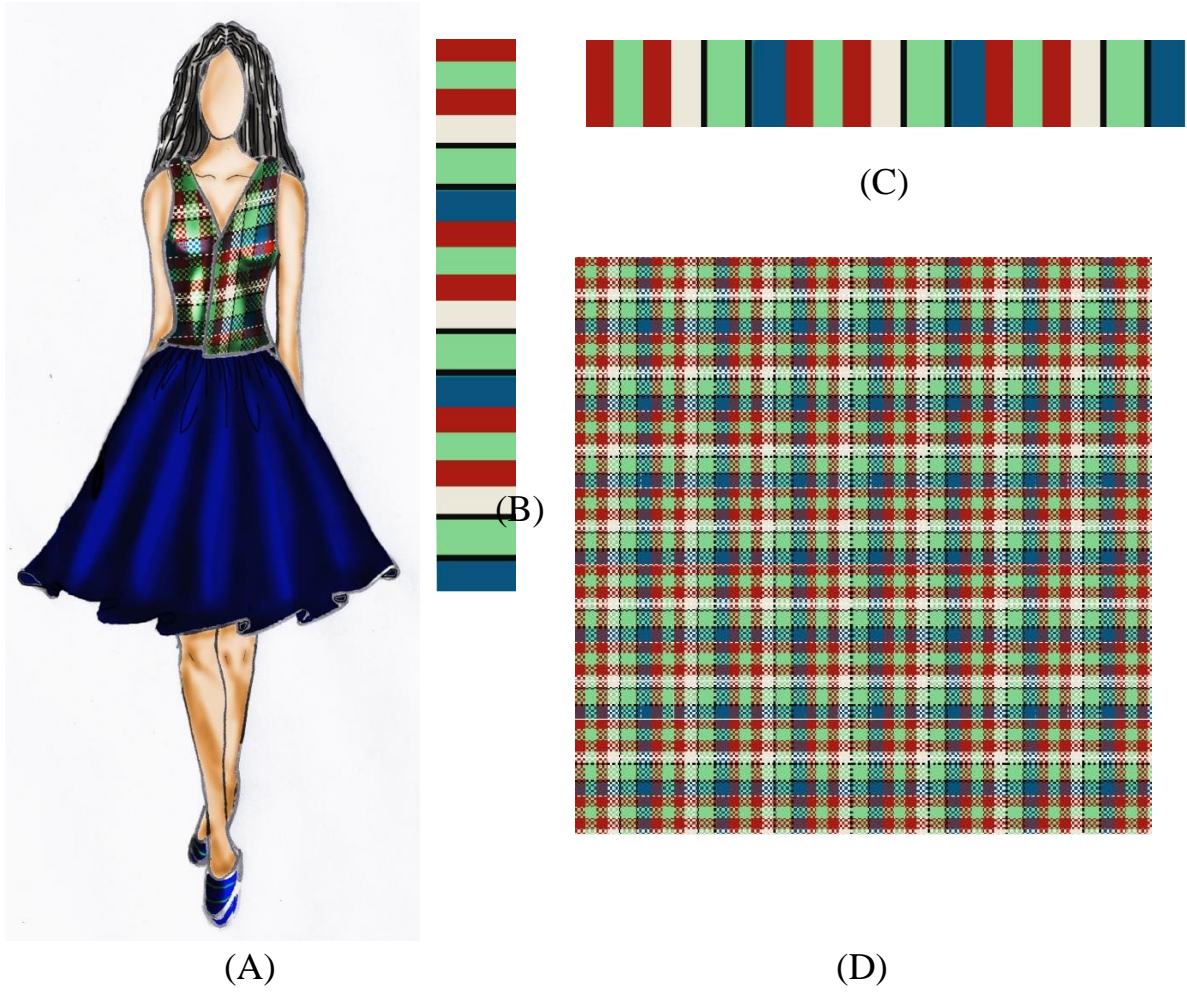
The purpose of this study is:

To prepare design program that helps students step by steps how to design plaid pattern of fabric simulation by using computer. Beside using the rendering tools of the fabric with 3D effects.

Findings and Analysis:

The design plaid fabric program by using computer has been presented to the arbitrators in the field with applying their effective's comments and opinions. Finally, the students were asked to use the program to design plaid pattern. Then, they were asked to use the render tools and show the 3D effect over the final shapes. The following five plaid patterns were created by using Photoshop software. Each design was rendered with 3D fabric simulation effects.

Qualitative and quantitative methods were used to analysis the data as following:
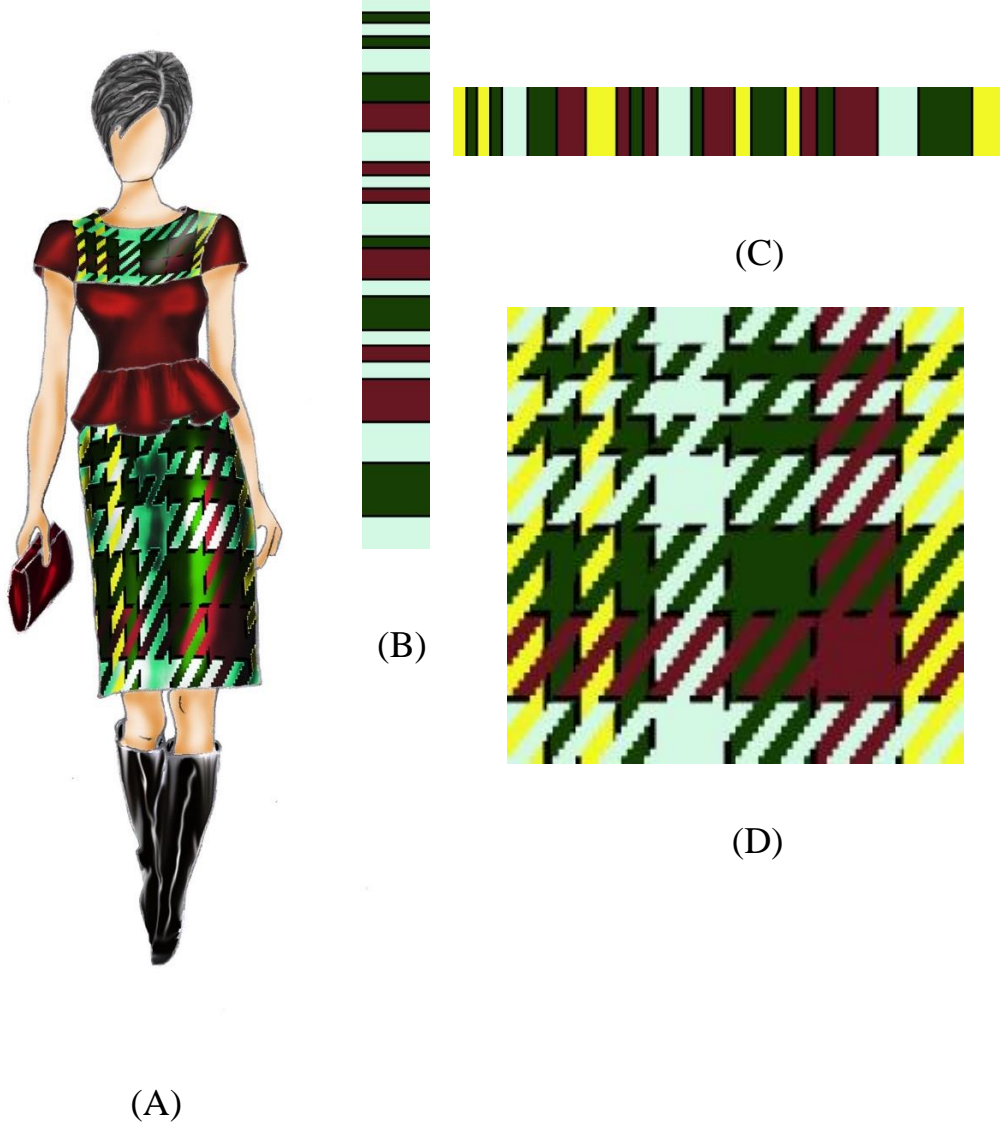
(C)

(B)

(A)

(D)

Design (1)

The first design consists of two pieces (A), a skirt and a tank top. The tank is made of plaid fabric combined with red, green, and navy (dark blue) colors (B.C). it also has a piece that overlaps the other. The plaid lines are mixed of thin and thick lines which combine to form squares (D). Different concentration of light and shadow were used around the neckline, tips of the shoulders, and both sides under the chest area. Shadow was also placed under the first piece which overlaps the seconds.

The lower part was "A" designed skirt. The color chosen was navy to match the upper design. In the hemline the flare was present due to ruffles created by shadow and light. In between the folded area more shadowing is present, while more light is present from the waist going down and on the front surface of the folds. Shadow was also present in the mid waistline area under the tank top. More shadow was added between the
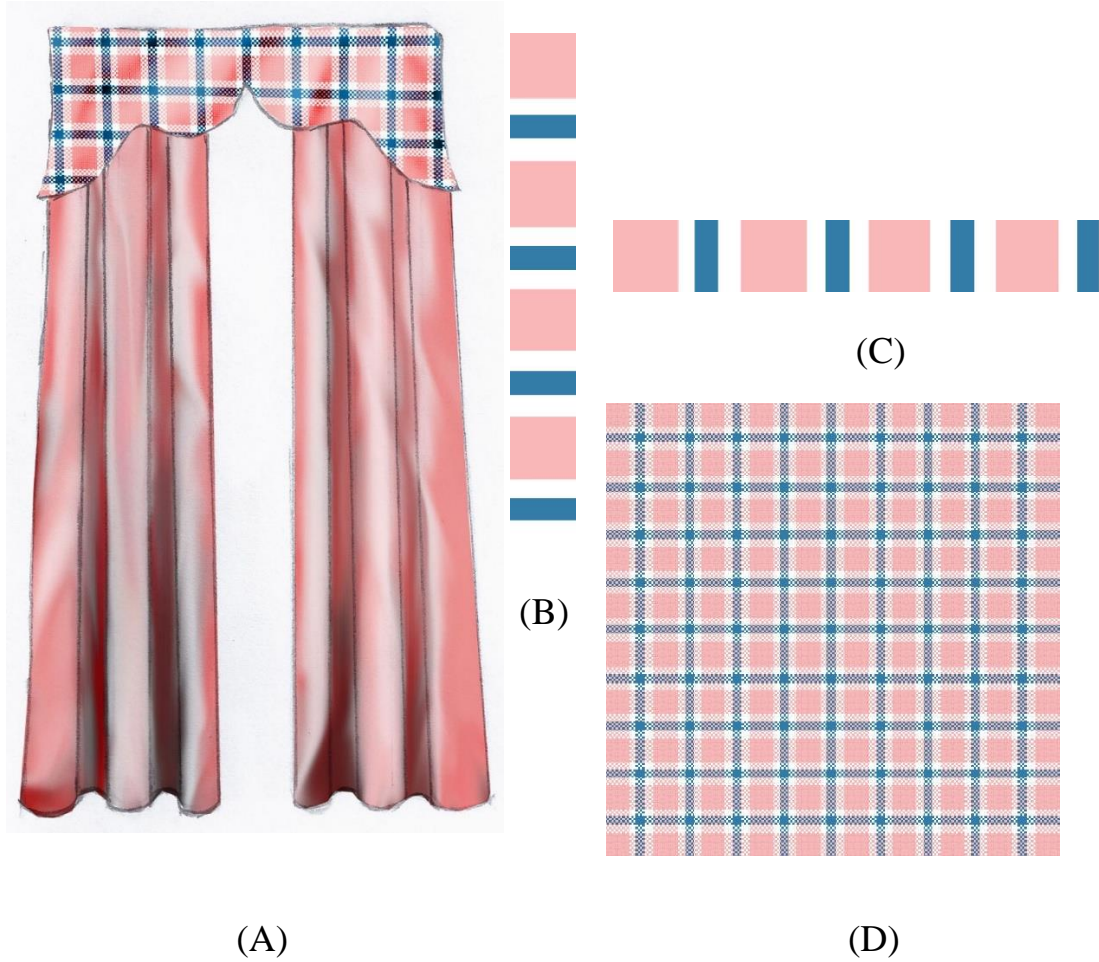
folds to show the many layers in the skirt. These effects result in a realistic design which gives a 3-D simulation on the body shape.

(C)

(B)

(D)

(A)

Design (2)

The second design is a dress consisting of four parts (A). The colors used are yellow, white, dark green, and maroon (B, C). The design lines were simple in order to match the twill pattern which is a complex design. The lower chest area and waist were a basic maroon color. A flare design was added around the waist. Shadow was present on the tips of the shoulders and near the skin body. The most important effect was the chest and the lighting on the chest area. The flare at the waist consists of shadowed ruffles and light on the surfaces which shows a difference in the design.
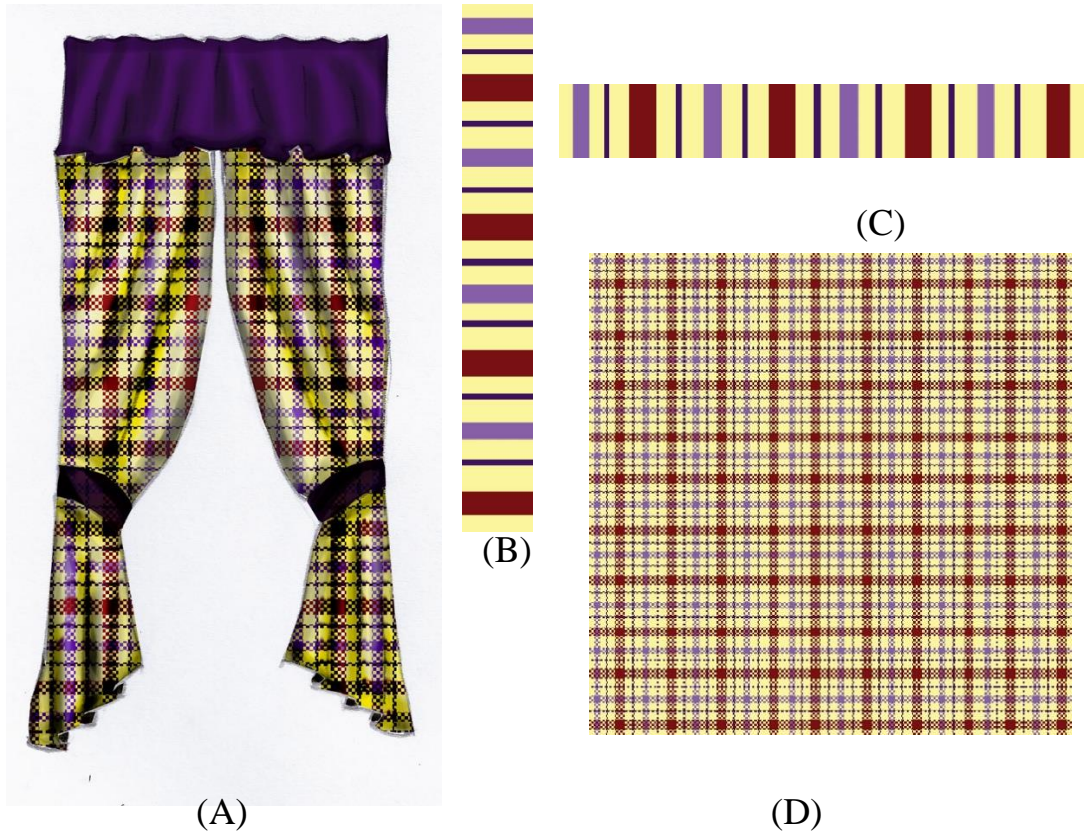
In the lower part, a twill fabric was used (D) because the pattern is complex enough to be its own design. The shadow was added at the sides and underneath the ruffles, while light was used in the middle to enhance the shadow to create a realistic effect. At the upper chest area, the same twill pattern was used with shadow and light effect around the neck. Manipulating with shadow and light around the body in specific areas results in 3-D simulation with a realistic image.

(B)

(C)

(A)

(D)

Design (3)

The third design was a curtain (A), the intention was to have a simple design. The head fabric was made of plaid and the curtains were a plain, subtle color. The design lines in the head were evenly spaced out resulting in symmetric appearance (B,C). The colors in the lines included blue and white, while the background was a bright pink color (D). To make the head appear realistically draped, shadow was placed at the border, while the light was out on the surface. The texture chosen was Gaussian blurring which is closest to furniture fabric.

The bottom part of the curtain is long enough to cover the whole window. It is a plain bright pink color in order to match the upper plaid background. These colors were chosen because they are soft colors and the design is meant for a children's room. The bottom curtain consists of ruffles. The inner part is darker and it primarily where shadowing is present. The shadowing is light at the top and as it gets lower the shadow increases and becomes darker between the folded parts of the curtain. This is to create a realistic image where the sun will come in. The lighter parts indicate that the sun is coming through while the darker parts are where the wall is and no sun comes through. The shadow is also present at the edges of the curtain. On the other hand, the light effect was placed on the surfaces of the ruffles from the top going down. For the same reason, more light was placed at the top of the curtain then the bottom. This creates a confliction between the upper and lower part of the curtain. Manipulating shadow and light creates folds which gives a realistic image.
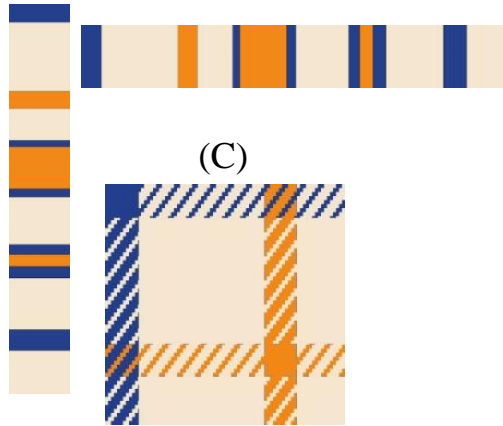
(A)

(B)

(C)

(D)

Design (4)

The forth image also was a curtain but more complex. In this design the plaid was placed in the lower curtain while the plain color was the head. Also a curtain holder was added to both sides (A). The colors chosen for the lines were mauve and maroon, while the background was a bright yellow (B.C). The design lines consisted of small squares distributed unevenly where the lines were thick and thin rather than uniform (D). The thick lines were more faded then the thin lines which were bolder. Shadowing was placed in certain areas to make the curtain look like it is pulled to both sides. The shadow was slanted on both sides rather than straight to realistically show that the curtain is being pulled. As the folding gets deeper more shadowing is present and because the curtain is folded there is an uneven alignment between the plaid pattern. At the bottom of the curtain there is more ruffles and folding because it is not being held. These ruffles are not as present in the top part because they are being held differently on both sides. Shadow was placed underneath the head and underneath both curtain holders.

The head was a plain mauve color in order to balance the bottom plaid colors. It consists of many ruffles. Shadow was placed in between the ruffles and around the head. Also it was placed at the hemline of each ruffle to show the many layers that make up the head. The lighting was put in between the shadows and layers to show the surface of the folds and to create a balance between the light and shadow. The curtain holder was also mauve to match the head and plaid lines. Shadow was put at the edges. All these steps play a role to create a realistic image which enables the observer to get an idea as to how the design will actually look.
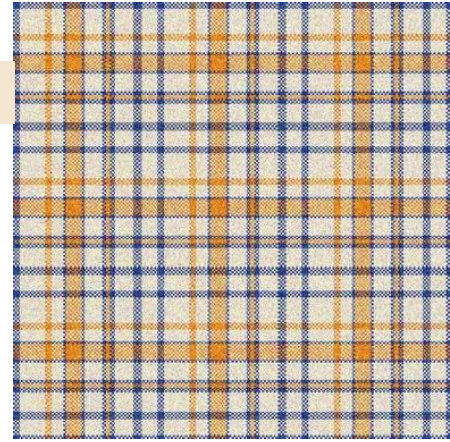
(A)

(C)

(B)   (E)   (D)

Design (5)

The fifth design combines plain, twill, and plain pattern (A). The colors used were orange, beige, and dark blue. The plaid consists of uneven lines with a beige background color which brings out the other lines (B, C). The texture Gaussian blur was specifically made for furniture. The plaid fabric (D) was placed at the backset and the border of the cushion seat. The first cushion was the template and it was easier to drape. The symmetric cushion was more challenging because the lines and colors had to be aligned equally to the first cushion. The lower borders were the most challenge because it takes time to align patterns in each cushion seat. It also was a challenge to accurately have the plaid on the cushion be symmetric. There were three pillows; two were a plain dark blue color while the third had a twill design (E). This created a variety in the pillow patterns. Every other part of the sofa was plain because it brought out the different patterns. Shadow was used in certain areas such as under the pillow and on the sides. Whole the light was on the middle surface of each piece of the design.

Validity and reliability:

The validity of the questionnaire:

It means that the ability of the questionnaire to measure what is the status of the measure. www.uni.edu/chfasoa/reliabilityandvalidity.htm)

Validity using the internal consistency of the total score for each axis and the total score of the questionnaire:

The validity is calculated by using internal consistency and thus by calculated the correlation coefficient (Pearson correlation coefficient) between the total score for each axis (the aesthetic side, the creative side) and the total score of the questionnaire, the following table clarify this.

Table (1): The correlation coefficient values between the score of each axis and the score of the questionnaire

Axes	correlation	Significance
The first axis: the aesthetic side	0.854	0.01
The second axis: the creative side	0.779	0.01

The Table (1) clarify that the correlation coefficients are all significant at the level of (0.01) for it approached the right one which shows the validity and the analogy of the questionnaire axes.

The Reliability:

Intended reliability test the accuracy of measurement and observation, not contradiction with itself, and its consistency as provide us with information on Screened behavior, which is the ratio between the score variation on the scale which refers to the actual performance of the screened (www.uni.edu/chfasoa/reliabilityandvalidity.htm).

The reliability is calculated by:

1- Alpha Cronbach
2- Split-half

Table (2): The reliability coefficient values for the questionnaire axes

Axes	Alpha Cronbach	Split-half

The first axis: the aesthetic side	0.741	0.702–0.791
The second axis: the creative side	0.903	0.863–0.952
The validity of the questionnaire as a whole	0.822	0.789–0.871

The above Table (2) clarifies that all the values of reliability coefficients: Alpha Cronbach, Split-half, significant at a level of 0.01, which indicates the reliability of the questionnaire.

Results and Discussion:

The first hypothesis:

"There are significant differences between the five designs to achieve the aesthetic side, according to the opinions of arbitrators"

To investigate this hypothesis, the analysis of variance of the five designs to achieve the aesthetic aspect calculated according to the opinions of the arbitrators and the following table clarifies this.

Table (3): The analysis of variance of the five designs to achieve the aesthetic side, according to the opinions of arbitrators

The Aesthetic Side	Sum of squares (SS)	Mean squares (MS)	DF	(F) Value	Significant
Between croups	13749.899	3437.475	4	58.965	0.01 Sig
Within groups	8453.024	58.297	145		
SUM	22202.923		149		

The Table (3) clarify that the value (F) was (58.965), a statistically significant value at the level of (0.01), which indicates the existence of differences between the five designs achieving the aesthetic side according to the opinions of the arbitrators, and to find out the direction of significance was applied scheffe test for multiple comparisons and the following table clarify this.

Table (4): Scheffe test for multiple comparisons

The Aesthetic	The first	The second	The third	The forth	The fifth

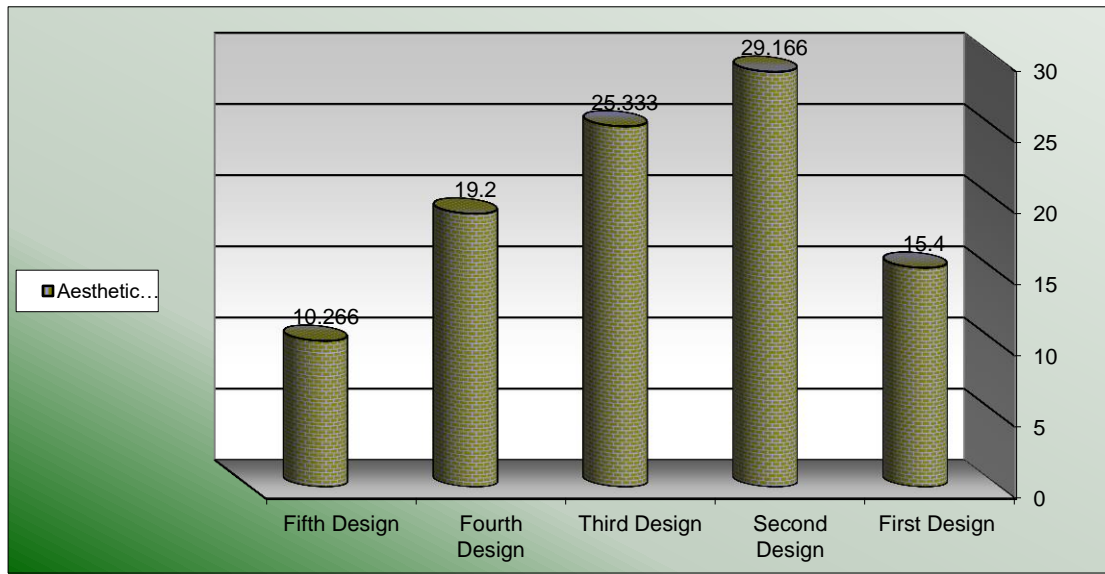| Side	design M=15.400	design M=29.166	design M=25.333	design M=19.200	design M=10.266
The first design	-				
The second design	13.766**	-			
The third design	9.933**	3.833*	-		
The forth design	3.800*	9.966**	6.133**	-	
The fifth design	5.133**	18.900**	15.066**	8.933**	-

Fig. (1): The differences of the five designs in achieving the aesthetic side, according to the opinions of arbitrators

Figure 1 and Table 4 clarify the following:

1. There are significant differences between the second design and both the fourth design, the first design and the fifth design at significance level 0.01 for the second design.

2. There are significant differences between the second design and the third design at significance level 0.05 for the second design.

3. There are significant differences between the third design and both the fourth design, the first design and the fifth design at significance level 0.01 for the third design.

4. There are significant differences between the forth design and the first design at significance level 0.05 for the fourth design.

5. There are significant differences between the forth design and the fifth design at significance level 0.01 for the fourth design.

6. There are significant differences between the first design and the fifth design at significance level 0.01 for the first design.

The previous results clarify that.

The second design was the best designs in achieving the aesthetic side, according to the opinions of the arbitrators, followed by the third design, and then the forth design and then the first, and finally the fifth design.

The second hypothesis:

"There are significant differences between the five designs to achieve the creative side, according to the opinions of arbitrators"

To investigate this hypothesis, the analysis of variance of the five designs to achieve the creative aspect calculated according to the opinions of the arbitrators and the following table clarifies this.

Table (5): The analysis of variance of the five designs to achieve the creative side, according to the opinions of arbitrators

The creative Side	Sum of squares (SS)	Mean squares (MS)	DF	(F) Value	Significant
Between Groups	12703.568	3175.892	4		0.01 Sig
Within Groups	14143.553	97.542	145	32.559	

SUM	26847.121		149		

Table (5) clarify that the value (F) was (32.559), a statistically significant value at the level of (0.01), which indicates the existence of differences between the five designs achieving the creative side according to the opinions of the arbitrators, and to find out the direction of significance was applied scheffe test for multiple comparisons and the following table clarify this.

Table (6): Scheffe test for multiple comparisons

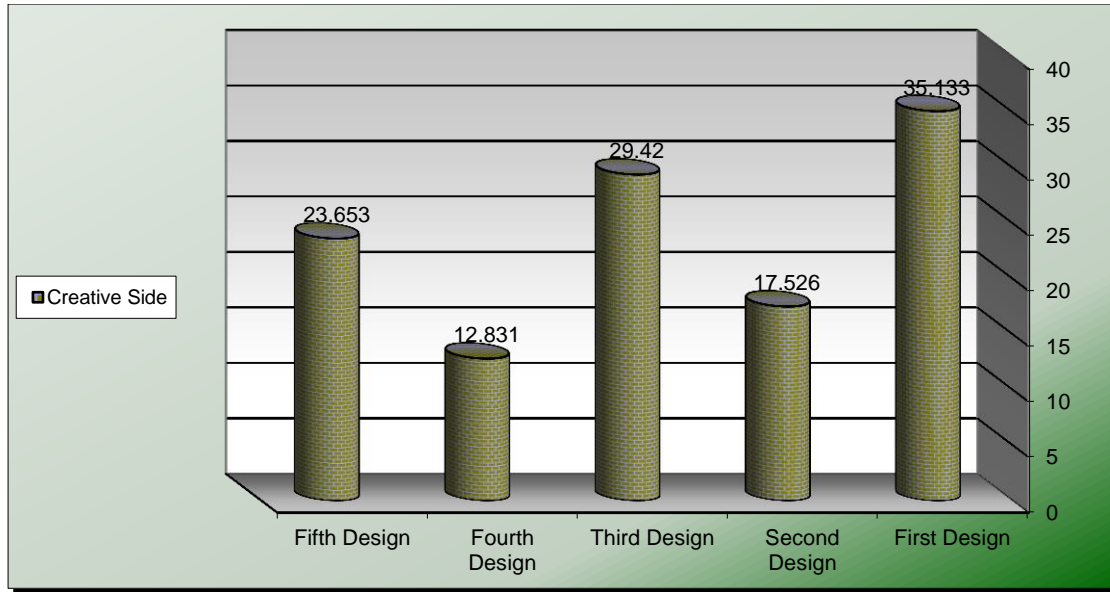| The Aesthetic Side	The first design M=35.133	The second design M=17.526	The third design M=29.420	The forth design M=12.831	The fifth design M=23.653
The first design	-				
The second design	17.606**	-			
The third design	5.713**	11.893**	-		
The forth design	22.302**	4.695**	16.588**	-	
The fifth design	11.480**	6.126**	5.766**	10.822**	-

Fig. (2): The differences of the five designs in achieving the creative side, according to the opinions of arbitrators

Figure 2 and Table 6 clarify the following:

1. There are significant differences between the first design and both the third design, the fifth design, the second design and fourth design at significance level 0.01 for the first design.

2. There are significant differences between the third design and both, the fifth design, the second design and fourth design at significance level 0.01 for the third design.

3. There are significant differences between the fifth design and both, the second design, the fourth design at significance level 0.01 for the fifth design.

4. There are significant differences between the second design and the fourth design at significance level 0.01 for the second design.

The previous results: clarify that:

The first design was the best designs in achieving the creative side, according to the opinions of the arbitrators, followed by the third design, and then the fifth design and then the second, and finally the fourth design.

The third hypothesis:

"There are significant differences five designs according to the opinions of arbitrators"

To investigate this hypothesis, the analysis of variance of the five designs according to the opinions of the arbitrators and the following table clarify this:

Table (7): The analysis of variance of the five designs according to the opinions of arbitrators

Total sum	Sum of squares (SS)	Mean squares (MS)	DF	(F) Value	Significant
Between groups	6348.132	1587.033	4		0.01 Sig
Within croups	5667.960	39.089	145	40.600	
SUM	12016.092		149		

Table (7) clarify that the value (F) was (40.600), a statistically significant value at the level of (0.01), which indicates the existence of differences between the five designs, and to find out the direction of significance was applied scheffe test for multiple comparisons and the following table clarify this.

Table (8): Scheffe test for multiple comparisons

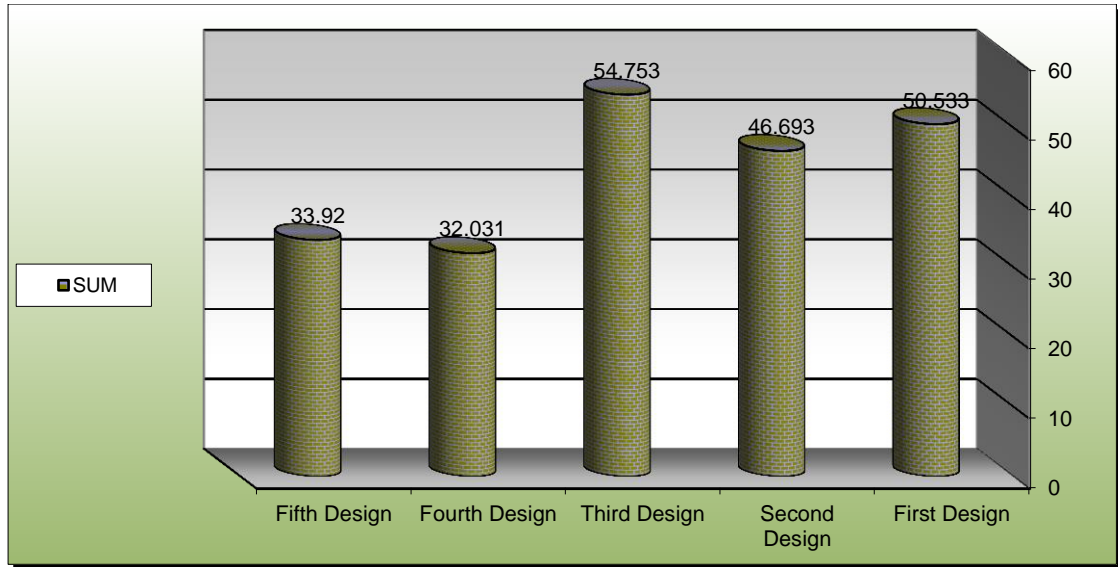| The Aesthetic Side	The first design M=50.533	The second design M=46.693	The third design M=54.753	The forth design M=32.031	The fifth design M=33.920
The first design	-				
The second design	3.840*	-			
The third design	4.220**	8.060**	-		
The forth design	18.502**	14.662**	22.722**	-	
The fifth design	16.613**	12.773**	20.833**	1.888	-

Fig. (3): The differences of the five designs according to the opinions of arbitrators

Figure 3 and Table 8 clarify the following:

1. There are significant differences between the third design and both the first design, the second design, the fifth design and fourth design at significance level 0.01 for the third design.

2. There are significant differences between the first design, fifth design and the fourth design at significance level 0.05 for the first design.

3. There are significant differences between the first design and the second design at significance level 0.01 for the first design.

4. There are significant differences between the second design and both the fifth design and fourth design at significance level 0.05 for the second design.

5. There are no significant differences between the forth design and the fifth design.

The previous results clarify that.

The third design was the best designs according to the opinions of the arbitrators, followed by the first design, and then the second design and then the fifth, and finally the fourth design.

Conclusion:

The study concluded that the design of the plaid fabric requires accuracy beginning from the wrap and fill design, as well as choosing the right colors at this stage. After this step the weave needs to be designed

in a precise manner. Once these steps are complete the designer needs to begin the process of inserting the wrap and fill in to the weave which results in many variation of plaid design.

The study also indicated that the 3-D draping whether in clothing design or furniture fabric (curtain and sofa) takes the same draping steps with emphasis on light and shadow in each piece of the design. These pieces need to be taken one by one to create an overall realistic image. Finally, in order to get a realistic 3-D drape the designer needs to be more experienced and flexible with the shadow and light tools. The more they can manipulate these tools, the more realistic the simulation will be.

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رؤية تشكيلة لإبراز إنسدالية البعد الثلاثي في محاكاة أقمشة الكاروهات باستخدام الحاسب الآلي

د. حنان عبد الحليم بخاري

أستاذ مشارك/ جامعه الملك عبدالعزيز

الملخص:

تشير اختلاف انواع النسيج الى التغيرات الاجتماعيه والاقتصاديه والتكنولوجيه، وأيضاً يتأثر النسيج بتلك التغييرات. ومع مرور الوقت وتطور المجتمع فان هذا النسيج ايضا يتطور (Spring, & Hudson,1995). إن استخدام التكنولوجيا يسمح للمصمم لاستخدام تقنيه 3D Draping بفعاليه حيث انه في غضون ثوان قليله يمكن للنسيج الانسدال على النموذج او على الاثاث (Mitra, 2014). فقد حقق برنامج CAD عمليه محاكاه اقمشه الكاروهات بطريقه سهله. وقد أشار كل من Mathur, & Seyam (2011) ان نظام CAD يمكن إنشاء الاقمشه المنسوجه باستخدام مجموعه مختلفه من الادوات كما يمكن استخدام المحاكاه لتصور انسداليه القماش علي الشكل الحقيقي.

الهدف من هذه الدراسه هو تصميم اقمشة الكاروهات عن طريق المحاكاه مع استخدام خاصيه 3D الثلاثي الأبعاد، في هذه الدراسه تم استخدام الطريقه النوعيه والكمية لتحليل البيانات.

وأشارت نتائج الدراسة إلى أن:

– التصميم الثاني كان أفضل التصاميم في تحقيق الجانب الجمالي، وفقا لآراء المحكمين، يليها التصميم الثالث، ومن ثم التصميم الرابع ثم الاول، وأخيرا التصميم الخامس.

– حقق التصميم الأول أفضل التصاميم في تحقيق الجانب الإبداعي، وفقا لآراء المحكمين، يليها التصميم الثالث، ومن ثم التصميم الخامس فالتصميم الثاني، وأخيرا التصميم الرابع.

– حقق التصميم الثالث على أفضل التصاميم وفقا لآراء المحكمين، يليه التصميم الأول، ومن ثم التصميم الثاني ثم الخامس، وأخيرا التصميم الرابع وذلك وفقا لاختبارات شيفيه للمقارنات المتعددة.

وخلصت الدراسة إلى أن استخدام المحاكاه بنظام الثلاثي الابعاد سواء في تصميم الملابس أو الاقمشه أو الاثاث تاخذ نفس الخطوات المتبعه من حيث الانسداليه مع اهميه التركيز على خاصيتي الضوء والظل في كل قطعه من قطع التصميم. واخيرا من اجل الحصول على خاصيه الثلاثي الابعاد الواقعي فان المصمم يحتاج ان يكون اكثر خبره ومرونه مع ادوات الظل والضوء. حيث انه كلما زادت ممارسه واستخدام هذه الأدوات بإحترافيه كلما تكون المحاكاه أكثر واقعيه.

الكلمات الاسترشادية: تصميم النسيج، أقمشه الكاروهات، نظام الثلاثي الابعاد.