# The Impacts of Different Woven Fabrics on Three Draping Techniques

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**Abstract:**
Three woven fabrics, chiffon, taffeta and velvet were used to create twists, drabeah and pleats on mannequin using draping techniques. Twenty-seven finished samples were draped, videotaped and evaluated for their appropriate use of materials and aesthetic appeal by participants. Although lab results indicated that velvet has the lowest drape coefficient, the subjective evaluations did not rank velvet as the most appropriate fabric for these draping techniques. ANOVA results showed that all three fabrics achieved equally desirable designs for all four twist and two of the drabeah techniques. However, as the difficulties of the techniques increased, chiffon produced a better result. For pleats, taffeta (the stiffest fabric) was rated as the most suitable fabric. This study has demonstrated that choosing fabrics to achieve desirable draping designs depending on a combination of factors such as drape coefficient, fabric thickness as well as the complexity of draping techniques.

**Keywords:**
***Draping***
***Twist***
***Drabeah***
***pleats***

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## Introduction

Draping is a unique design and pattern making process that allows designers to work with the actual materials on the 3D form while creating their designs. By using a combination of manipulations such as cuts, twists, folds, and tucks, a designer can skillfully transform a piece of fabric into garments (Cerda, Mahadevan, Pasini, & Hutchinson, 2004). Seeing the development of a 2D sketch into a 3D form during the draping process can eliminate some of the guessing that would be involves if the designers are using flat pattern. According to Armstrong (2008), draping not only gives the designers freedom to be more creative but also allows the designers to evaluate the design at each step of the process. In addition, using flat pattern to create complicated designs could be challenging but draping would make this possible since it enables the designers to work directly on the dress form or human body (Chang, 2005; Kiisel, 2013; Schactler, 2010).

Fabric properties are among the first factors that designers have to consider while draping their designs. Fabric properties play a key role in draping and have significant effects on the final design outcomes (Armstrong, 2008). The ways that fabrics hang and fold in draping are highly heterogeneous especially in complex garment designs (Cerda et al., 2004). Therefore, choosing the appropriate fabrics for the designs becomes a challenge especially for the inexperienced designers.

Based on many years of teaching experience, we noticed the difficulties that students face when choosing suitable fabrics for their draping projects. These difficulties are coming from their lack of understanding the complex relationship between fabric properties and draping techniques. For example, a common misconception among students is that soft fabrics are more suitable than stiff fabrics to achieve desirable pleats techniques, which contradict with one of the results of this study. Searching through the literature to guide our students, we noticed the scarcity of research that has been devoted to the study of fabric properties affecting complex draping techniques. Therefore, the purpose of this study is to investigate the relationship between fabric properties and complex draping techniques.

## Literature Review and Hypotheses

Fabric drape determines how gracefully the material will hang on a 3D form. The drape is influenced by fiber content, yarn & fabric structures, fabric thickness & weight, and finishing process (Giooello, 1982). The parameters affecting fabric drape have been the focus of many studies (Hu & Chan, 1998; Orzada, 2001;

Sidabraites & Masteikaite, 2003). Studies have suggested that fabrics with different properties would lead to different design results even with the same draping technique (Kenkare & Plumlee, 2005). DC (DC) is the commonly use parameter to quantify the drapeability of flat fabric piece. Studies have been working on developing testing and evaluating methods to capture complex drape information of fabric (Hu, 2001; Kenkare & Plumlee, 2005). Other studies have been focusing on the relationship between fabric characteristics and their DCs. Behera and Pattanayak (2008) found a strong correlation between fabric bending rigidity and DC. They also concluded that rigid fabrics will form less falls and are less likely to drape than soft fabrics. Another factor that affects DC is fabric extensibility (at low load); fabrics with higher extensibility will fold more when hung (Behera & Pattanayak, 2008).

Extensive information of 2D flat fabric drape characteristics can be obtained from image analysis and instrument measurement. On the other hand, since other factors such as the methods of clothing construction also affect clothing drape, textile researchers suggested that the drape characteristics of complex forms requires drape measurement of sewn fabrics and garments (Kenkare & Plumlee, 2005; Pant, 2010). Jevšnik and Lojen (2007) studied sewn fabrics and analyzed the effect of seam types and directions on fabric drape. The results showed that the DC increased on the samples with seams than the samples without seams, indicating the effects of sewing on fabric drapeability. Sharma, Behera, and Schenk (2005) found that the fabric DC is affected by different stitches and fusing of interlining types. Krishnaraj, Thanikaivelan, Phebeaardn, and Chandrasekaran (2010) analyzed the draping behaviors of sewn suede leather. They found different stitches used to combine various cuts components play a significant role on the drape behavior of the final garment.

The draping research has been focusing on using the 2D non-seamed fabrics to create designs on the dress form (Armstrong, 2008; Chang , 2005; Crawford, 2012; Schactler, 2010). Other studies use computer to predict and simulate fabric drapability through the virtual techniques (Hamdi, Ghith, Fayala, 2014; Hu, 2001; Kim & Ma. 2013; Thalmann & Volino, 2005). There are no previous studies that investigated the relationship between fabric properties and the complex draping techniques. Therefore, in this study, we evaluated the impacts of three synthetic fiber woven fabrics, chiffon taffeta and velvet, on three complex draping techniques, twist, drabeah and pleats. The results of this study will contribute to the body of literature on draping techniques as well as provide useful guide to help both students and the professional when choosing fabrics for their draping designs. The hypotheses of this study are:

**Hypothesis1**. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the twist techniques on the dress form.

**Hypothesis2**. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the drabeah techniques on the dress form.

**Hypothesis3**. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the pleats techniques on the dress form.

## Method

### Materials

Three synthetic fiber woven fabrics (chiffon, taffeta and velvet) with different fabric constructions, weights and thicknesses were selected for this study. Chiffon represented lightweight, thin fabrics; taffeta, as a rib weave fabric, represented medium weight and thick fabrics; velvet, as a pile fabric, represented heavy weight and thick fabrics. The variation of fabric parameters allows comparisons to be made among all fabrics and their properties affecting the draping techniques. Standard dress form size 40 was used for draping the study samples. A digital video camera (Panasonic NV-MX500) was used to record the finished samples on the dress form from different directions.

### Laboratory Testing

Basic fabric characteristic data were collected using the laboratory testing equipment including: weight (ASTM D-3776), thickness (ASTM D-1777), and DC (Table 1). Three samples of each fabric were conditioned in standard atmospheric conditions for at least 24 hours to allow them to attain a stable condition. Then they were subjected to laboratory tests and the results were then averaged. Since there is no standard ASTM test method for fabric drape, in this study, fabric DC data were collected by a nonstandard procedure using a drapemeter, and calculated using the following equation (Merkel, 1991, p.338):

$$DC\% = \frac{\text{Weight in grams of fabric shadow}}{\text{Weight in grams of paper ring shadow}} \times 100$$

Based on the equation, the closer the DC is to 100 percent, the stiffer and the less drapable the fabric is (Kadolph, 2007).

## Draping Techniques

Three different draping techniques, twist, drabeah, and pleats developed by Shokri (2001) were chosen for this study. These techniques were chosen because of their complexity. They also often presents a challenge to our students when they were choosing suitable fabrics for their draping projects. Four twist techniques (simple twist 1&2, complex twist 1&2), three drabeah techniques (simple square drabeah, wide high drabeah, gathering drabeah), and three pleats techniques (even horizontal pleats, even diagonal pleats, uneven diagonal pleats) were draped using the three synthetic fiber woven fabrics. Because the even horizontal and diagonal pleats were draped on the same design sample, this study created 27 finished samples (3 fabrics x 9 draping designs) for subject evaluation. Even though the draping techniques were only on the front side of the finished samples, the backsides of the samples were finished with a piece of the same fabric. The draping steps for all the techniques started with marking the outlines of the garment design on the dress form, ended by draping the back and finishing the sample. The length and width of the fabrics used in all techniques have to cover the technique area with a 2” seam allowance. In the following section, only the draping steps of the techniques not available in English literature will be listed.

a. Complex Twist 1

Chiffon Taffeta Velvet

b. Complex Twist 2

Chiffon Taffeta Velvet

Figure 2. Complex Twist Technique Samples

**Twist.**

The twist technique is described as “twist and loop one or two continuous pieces of fabrics (around the central axis) in a manner of overlapping to form regular or random folds or gathers” (Abdulgaffar, 2005, p.11). In this study, twist technique was divided as simple twist, using one piece of fabric (Figure 1a &1b), and complex twist, using two pieces of fabric (Figure 2a &2b).

a. Simple Twist 1

Chiffon Taffeta Velvet

b. Simple Twist 2

Chiffon Taffeta Velvet

Figure 1. Simple Twist Technique Samples

***Draping steps for simple twist 1(Figure 1a) and simple twist 2 (Figure 1b)***

See instructions on (Armstrong, 2008, p. 419-422).

***Draping steps for complex twist 1(Figure 2a) and complex twist 2 (Figure 2b).***

1. For the suspending strap in both complex twist techniques, cut a rectangular piece of fabric on the bias direction that has double the length from the back neckline to the front twist center.
2. Sew the suspended strap along the length of the fabric, turn the inside out, and iron it making the seam line in the middle of the back side of the strap.
3. Cut another piece of fabric that has a length enough to cover from the design neckline to the waistline, and a width to cover from side to side over the bust.
4. Intersect the strap and the fabric and drape them on the dress form by placing the intersection point on the center of the twist.
5. Distribute the narrow folds around the twist center, and end them to the side seam and the waistline seam.
6. Complete the draping of the design, pin, and mark.
7. Since complex twist 2 has two twists on the front chest area, the same steps 1-6 are repeated for the other side of the design.

**Drabeah.**

Drabeah is defined as “a set of compact cloth folds that sit next to each other, and usually takes the form of the body shape and curve depending on the requirements of the design" (Abdulgaffar, 2005, p.162). The drabeah can be thick or thin, low or high, close or far apart from each other according to the desired shape. The simple drabeah can be around the neck or the armhole, and can have a circle or square shape. Drabeah can be formed directly on the dress form or by using the gathering stitches on the fabric first then drape it. Simple square drabeah (Figure 3a), wide high drabeah (Figure 3b), and gathering drabeah (Figure 3c) are the three techniques used in this study.


Figure 3. Drabeah Technique Samples

***Draping steps for simple square drabeah (Figure 3a)***

See instructions on (Jaffe & Relis, 2005, p. 70-72).

***Draping steps for wide high drabeah (Figure 3b).***

1. Construct the base garment using a suitable fabric weight and color as the desired design.
2. Start the drabeah on the right chest by using a piece of bias fabric that has treble the length of the drabeah design area.
3. Fold down the edge of the fabric and pin the bias line parallel to the fabric edge.
4. Fold up the first fold as the desire height and pin along the fold to the base garment only.
5. Leave the desired space between folds, and then create the second fold identical to the first one using step 4.
6. Repeat steps 4-5 for all folds to cover the drabeah design area on the right chest.
7. After draping all the folds, remove the garment, and stitch the folds by hand.
8. For the drabeah on the left chest, follow the same steps as in the right chest (steps 3-7).
9. For the drabeah that goes over the right chest and under the left chest, follow the same steps 3-7.

***Draping steps for the gathering drabeah (Figure 3c***) See instructions on (Armstrong, 2008, p. 362, 364).

**Pleat.**

A pleat is "A fold of cloth, stitched or unstitched into hard or soft pressed pleats to achieve design and fullness" (Blair, 1992, p.90). There are different types of pleats depending on their shape and width. Even pleats have the same shape and width while uneven pleads have different shape and width. In a design, pleats can also take different directions such as horizontal, vertical, or diagonal. Three kinds of pleats were used in this study: even horizontal and even diagonal pleats (Figure 4a), and uneven diagonal pleats (Figure 4b).


Figure 4. Pleats Technique Samples

***Draping steps for even horizontal and diagonal pleats (Figure 4a).***

1. For the even horizontal pleats, cut a piece of bias fabric that covers the width of the pleats design area and the length is treble the area of the design, and pin the bias line parallel to the edge of the design.
2. Fold up the first pleat as the desired width, then flatten it and pin along the fold.
3. Fold the second pleat identical to the first one using step 2.

4. Repeat step 3 for all pleats to cover the horizontal design area on the dress form.
5. For the even diagonal pleats repeat steps 1-3 for both sides of the design.
6. After draping all the pleats remove the pleated fabric from the dress form, stitch the folds by hand. Sew the even diagonal and the horizontal pleats together.

***Draping steps for uneven diagonal pleats (Figure 4b)*** See instructions on (Armstrong, 2008, p. 396, 399).

**Videotaping the Samples**

After draping, the 27 finished samples were videotaped under the same natural light condition with approximately one minuet shot for each sample. The researchers chose to videotape the samples since it was very hard and expensive to move and present all the 27 samples on 27 dress forms at the same time during the evaluation process. The video was downloaded to the computer allowing the participants to watch the samples and provide the evaluation using the questionnaire.

**The Questionnaire and Participants**

A 3-point Likert scale (Agree, disagree, no response) questionnaire was developed and used to evaluate the aesthetics of the designs and the appropriate use of the fabrics for the techniques. The first version of the questionnaire had 18 positive statements and no negative ones. To evaluate the questionnaire's validity, a pilot study was conducted by recruiting 15 volunteers experts subjects (instructors and professors in the field of apparel design and textiles) to review the questionnaire. The subjects were asked to evaluate the statements' wording, the sequence and the arrangement of the statements, the reconciliation and sufficiency, and whether or not the questionnaire would succeed to test the study's hypotheses. The results showed that 73.3% of the experts indicated the statements were able to achieve the study goals and 66.7% agreed that the statements had appropriate sequences, arrangement, reconciliation and sufficiency. For the statements wording, 53% agreed that the wording of the statements were clear and 66.7% were agreed that the questionnaire would succeed to examine the study's hypotheses.

To improve the validity of the questionnaire, it was edited according to the experts' notes. Some of the statements were eliminated while others were reworded. The questionnaire then split into three categories of 13 positive statements. The first category has three statements that discussed the accuracy of the techniques such as the technique was draped correctly in the design. The second category contains four statements, which discussed the appropriateness of the fabrics for the techniques such as the fabric succeeded in achieving the desire technique's shape and aesthetics. The last category has six statements regarding the properties of the fabrics' texture, weight, drape, flexibility, rigidness and thickness. The same experts then evaluated the new edited questionnaire and a 95% agreement was obtained on the appropriateness of the questionnaire to be used for the study.

Cronbach's alpha and Spearman- Brown tests were used to measure the reliability of the questionnaire. The results of Cronbach's alpha and Spearman- Brown test were 0.76 and 0.81 when $\alpha = .01$, which are highly significant since they are bigger than 0.5. This study was conducted in Jeddah, Saudi Arabia and Cairo, Egypt. Twenty-six faculty and specialists were recruited from the apparel design and textile schools in the area using the purposive sampling method. The participants filled out the questionnaire while they were watching the videotape of the draping samples. The analysis of variance (ANOVA) was used to test the research hypotheses.

**Result and discussion**

**Laboratory Testing Result**

Table 1 summarizes the results of fabric characteristics. The results showed that velvet, a pile weave fabric, is the heaviest fabric while the plain weave fabric, chiffon, is the lightest weight fabric. On the other hand, velvet has the smallest DC (0.44), followed by chiffon (0.55) and finally taffeta (0.93), suggesting that velvet has the best and taffeta has the least drape capability among the three fabrics. This contradicts with what people commonly believe that chiffon would give the best draping results.

**Table 1** *Laboratory Testing Results of Fabric Properties*

| Test | Velvet | Taffeta | Chiffon |
|---|---|---|---|
| Contents | 100% Polyester | 50% Polyester, 50% Nylon | 100% Polyester |
| Construction | Pile weave | Rib weave | Plain weave |
| Weight (gm) | 251 | 97 | 48 |
| Thickness (mm) | 1.14 | 0.15 | 0.15 |
| Drape Coefficient (DC)% | 0.4best | 0.93 worst | 0.55 middle |

**The Twist Technique**

Hypothesis 1. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the twist techniques on the dress form. Table 2 shows the results of ANOVA for the twist techniques. The results indicate that there are no significant differences among all three fabrics used to drape the simple twists 1 & 2, and the complex twist 1. As for complex twist 2, chiffon gives the best result (α=.05) compared to taffeta and velvet. The design of complex twist 2 has two twists in it, the fabric overlap in some of the its area, and it has more gathers than the other twists which make it more complicated. Therefore lightweight and thin fabrics gives better result in draping the complex twist 2 than heavier and thicker fabrics. Overall, for the four twist techniques investigated in this study, since there are no significant difference among all three fabrics used suggesting that they are all suitable be used to achieve similar desirable design. This is because all the statements used in the questionnaire for the technique evaluation are all positive (e.g. the technique was draped correctly in the design). However, as the difficulties of the technique increased, such as complex twist 2, using thin and lightweight fabrics such as chiffon would achieve better results compared to taffeta and velvet. Therefore, the first hypothesis is only partly supported.

***Table 2 ANOVA Results for the Twist Techniques (N= 25)***

| Technique | Chi-Squire | Significant at α=0.05 | Degrees of Freedom | Fabric | Total Ranks |
|---|---|---|---|---|---|
| Simple Twist 1 | 0.73 | Not significant | 2 | Chiffon | 41.00 |
| | | | | Taffeta | 36.00 |
| | | | | Velvet | 36.00 |
| Simple Twist 2 | 0.45 | Not significant | 2 | Chiffon | 37.60 |
| | | | | Taffeta | 36.20 |
| | | | | Velvet | 40.18 |
| Complex Twist 1 | 0.33 | Not significant | 2 | Chiffon | 36.84 |
| | | | | Taffeta | 39.98 |
| | | | | Velvet | 37.18 |
| Complex Twist 2 | 6.73 | Significant | 2 | Chiffon | 47.20 |
| | | | | Taffeta | 33.40 |
| | | | | Velvet | 33.00 |

**The Drabeah Technique**

Hypothesis 2. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the drabeah techniques on the dress form. Table 3 shows the results of ANOVA for the drabeah techniques. The results indicate that there are no significant differences when the three fabrics were used to drape the simple square drabeah and the gathering drabeah. However, significant differences (α=.05) were found among the three fabrics used for the wide high drabeah: chiffon gives the best result, followed by taffeta, then velvet. By looking back at the draping steps of the drabeah techniques, we notice that square drabeah is a simple and direct drabeah that has only two folds in it. In the gathering drabeah, the designer uses gathering stitches to create pleats and folds, which makes it less complicated to construct. On the other hand, the difficulties were increased in the wide high drabeah since the designer has to drape each fold separately, make sure that all the folds have the same height, and keep the same distance between all the folds. Chiffon has the best rank in the ANOVA test. Lightweight fabrics with medium drapability are the best choice for complex drabeah techniques, followed by middleweight fabrics that have less drapability such as taffeta, and finally, thick fabrics that have more drapability such as velvet. Therefore, the second hypothesis is only partly supported.

***Table 3 ANOVA Results for the Drabeah Techniques (N= 25)***

| Technique | Chi-Squire | Significant at α=0.05 | Degrees of Freedom | Fabric | Total Ranks |
|---|---|---|---|---|---|
| Simple Square Drabeah | 0.08 | Not significant | 2 | Chiffon | 38.78 |
| | | | | Taffeta | 37.02 |
| | | | | Velvet | 38.20 |

| | | | | | |
|---|---|---|---|---|---|
| Wide High Drabeah | 9.96 | Significant | 2 | Chiffon<br>Taffeta<br>Velvet | 48.78<br>33.66<br>31.56 |
| Gathering Drabeah | 2.40 | Not significant | 2 | Chiffon<br>Taffeta<br>Velvet | 41.16<br>39.82<br>33.02 |

**The Pleats Technique**

Hypothesis 3. There are significant differences between chiffon, taffeta, and velvet when they are used to drape the pleats techniques on the dress form. Results from Table 4 indicate that there are significant differences (α=.05) between ANOVA results for the three fabrics when they were used to drape the pleats techniques. Taffeta was ranked as the best and most suitable among the three fabrics used for all the three pleats techniques. For the even horizontal and even diagonal pleats, velvet was ranked as the second while chiffon came in the third rank. In the uneven diagonal pleats, chiffon was in the second rank and velvet was in the third rank. However the differences between chiffon and velvet's ranks were less than two ranks for all the three pleats techniques, which make both of them, have the same rank. Since taffeta is the stiffest among the three fabrics (Table 1), this result indicates that stiffer fabrics are more suitable for the pleats techniques than soft fabrics with high drapability. The third hypothesis is supported.

***Table 4 ANOVA Results for the Pleats Technique (N= 25)***

| Technique | Chi-Squire | Significant α=.05 | Degrees of Freedom | Fabric | Total Ranks |
|---|---|---|---|---|---|
| Even Horizontal Pleats | 6.7 | Significant | 2 | Chiffon<br>Taffeta<br>Velvet | 33.00<br>46.86<br>34.00 |
| Even Diagonal Pleats | 4.5 | Significant | 2 | Chiffon<br>Taffeta<br>Velvet | 33.92<br>45.24<br>34.82 |
| Uneven Diagonal Pleats | 7.7 | Significant | 2 | Chiffon<br>Taffeta<br>Velvet | 34.12<br>47.68<br>32.18 |

## Conclusion

This study focused on examining the impacts of fabric properties on complex draping techniques, twist, drabeah, and pleat, by draping them and producing real garments. The study also intends to fill the gap in the literature since most of the draping studies have been focusing on studying fabric characteristics to virtually simulate fabric drapability. The results of this study demonstrated the complexity of predicting the suitability of the fabrics to be used for draping techniques. We found that velvet has the lowest DC (meaning the best drape), but it was rated as the least suitable fabric to be used for all techniques except for simple twist 2.

Although all fabrics could be used to create desirable designs using the twist and drabeah techniques, when the difficulty of the techniques increased, lightweight fabrics (not most drapable fabrics) such as chiffon ranked as the most suitable one. Jaffe & Relis (2005) indicated the suitability of soft fabrics for the twist and drabeah techniques and that supported this result. For the pleat techniques, taffeta was rated the best fabric: suggesting that fabric stiffness is a more important factor to be considered than fabric weight or drapability.

We have noted two limitations in the experimental design of this study. The first one is the use of different colors of fabrics especially the choice of the black velvet. The color could make the viewing of garment details difficult during the evaluation process. We addressed this limitation before we started the evaluation process so we provided improved and more focused photos in addition to the videos for each design to the reviewers. However, none of the reviewers asked for the focused photo during the evaluation because the video provided enough clarity for them to evaluate the garments.

The other limitation is the use of videotaping for the samples instead of allowing the subjects to evaluate the garments in person. Even though the reviewers had the chance to feel and touch the fabrics through small fabric samples, evaluating the study samples in person would make it easy for them to notice the differences between the samples. A further limitation of the study was using a 3- points Likert scale in the questionnaire, which could have affected the statistical validity of the results. Future works could use 6-point scales on the questionnaire to potentially increase its validity. To facilitate in person evaluation of the garments and eliminate the needs of digital images, future research could drape the samples on half-scale dress forms.

This study is the first step to help students and designers explore how fabric properties affect complex draping techniques. More research is needed to further study the relationship between fabric parameters and complex draping techniques. For example, using a wide range of the draping techniques and including different fabric structures such as lace and knitted fabrics.

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