



## Fabric Drape Measurement: A Modified Method Using Digital Image Processing

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### ABSTRACT

*The textile and clothing industry has traditionally used Cusick Drapemeter for the assessment of fabric drape. In this paper, a modified method of measuring fabric drape using the Cusick Drapemeter was demonstrated. The modified method involves digitally capturing image and processing it in simple steps using image processing software. The study was conducted using a range of woven fabric samples. The fabrics were conventionally evaluated using the Cusick Drapemeter (British Standard Institute: BS5058, 1974). Digital images of the draped fabrics were captured and processed as well using the modified method. Drape coefficient was selected to use as the comparative parameter to evaluate the results from conventional and digital method. The average drape coefficient of each fabric sample obtained through the conventional cut-and-weigh technique was compared statistically with that obtained through the modified digital technique. The study demonstrates that results of the modified digital method for evaluating drape were similar to that of conventional method of drape evaluation.*

*Keywords: Fabric Drape, Cusick Drapemeter, Testing Instruments, Textile Measurement*

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### Introduction:

Drape, along with color, luster, and texture is an important factor affecting the aesthetics and dynamic functionality of fabrics. Drape is defined as "the extent to which a fabric will deform when it is allowed to hang under its own weight" (British Standard Institute, 1974, p. 4/29). Drape is a critical textile characteristic in determining how clothing conforms to the shape of the human silhouette. It prescribes the fabric deformation produced by gravity when a part of the fabric is directly supported. In use, this unique characteristic can provide a sense of fullness and a graceful appearance, which ultimately distinguishes fabric from other sheet materials.

Drape of fabrics was evaluated subjectively by a panel of judges in the early days of evaluating fabric aesthetic characteristics. Constant disagreement in the resulting value of the fabric resulted in development of quantitative methods for evaluating drape. Structured objective investigation of fabric drape behavior can be traced back to a classic paper authored by Peirce (1930). Peirce (1930) developed the 'cantilever method' to measure fabric bending properties and then used the two dimensional bending characteristic as a measure of fabric drape. Commercially, the Shirley Stiffness Tester based on the cantilever principle was marketed as the first instrument to measure bending properties. Characterizing drape using a two

dimensional measure imposed many limitations in describing the complex, anisotropic behavior of fabrics. To overcome the limitations of estimating fabric drape via two dimensional measurement of stiffness, researchers in Fabric Research Laboratories developed the F.R.L. Drapemeter (Chu, Cummings and Teixeira, 1950). Later Cusick (1968), developed a drapemeter (Figure 1) based on a similar principle. By developing drapemeters, Chu et al., (1950) and Cusick (1961, 1965, 1968) made significant contribution to the practical determination of this fabric property by measuring drape in three-dimensions. However, these methods are tedious, slow and prone to operator error.

In this work, we advance measurement of this complex property by applying digital technology to create a modified process. In this process, a digital image of each draped sample was captured. Then, *Adobe Photoshop*® software was used to process the captured digital image of the draped fabric. *Adobe Photoshop*® is image editing software useful for working with digitized photographic images. It is widely used in image editing applications, and is often used as a benchmark for other imaging application software. A few simple tools from the *Adobe Photoshop*® menu were used in processing each image, then a drape coefficient was calculated.

### Conventional and Digital Methods for Measuring Drape Using Cusick Drapemeter

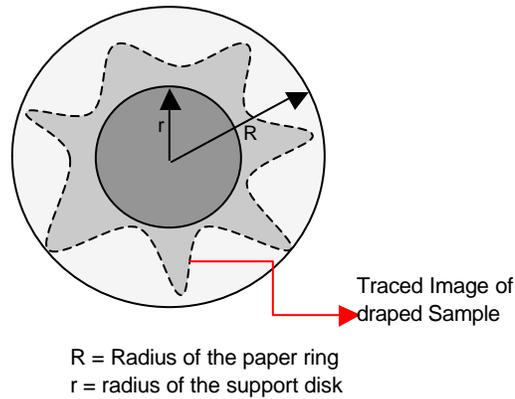
Figure 1(a) shows the front view of the Cusick Drapemeter designed and developed by Cusick (1961, 1965, 1968). The Cusick Drapemeter is widely used to measure drape of the fabrics in the textile and apparel industries. The instrument is capable of testing fabric samples of 24 centimeters, 30 centimeters, and 36 centimeters in diameter supported on a disk 18 centimeters in diameter. In evaluating drape, the unsupported area of a sample drapes over the edges of the support disk forming the drape configuration of the fabric specimen. The drape configuration of the fabric can be quantified using the 'Drape Coefficient' (DC).

Even though any single parameter is insufficient to completely characterize fabric drape, 'Drape coefficient (DC)' has been used as the main parameter to quantify fabric drape. The drape coefficient, defined as the fraction of the area of the annular ring covered by the projection of the draped sample, can provide an objective description of drape deformation, although not a complete description. The number of nodes developed due to the draping of circular fabric samples on the pedestal, and the node dimensions, are other parameters generally used to quantify drape. But Drape Coefficient still remains the most popular and widely used parameter to quantify drape. A low DC indicates easy deformation of a fabric and a high drape coefficient indicates less deformation. DC was conventionally calculated as:

$$F = \frac{\text{Area Under the Draped Sample} - \text{Area of Support Disk}}{\text{Area of the Specimen} - \text{Area of Support Disk}}$$

To calculate DC, Cusick (1968) introduced a simple method using defined weights. As illustrated in Figure 1(b), in this method "A circular piece of paper, of radius *R*, is placed under the center of the tester. The perimeter of the shadow of the draped fabric is then drawn on the paper. The circle

of paper is folded and weighed to give *W*<sub>1</sub>. The paper is then cut along the perimeter of the shadow, and the paper in the shape of the shadow is weighed to give *W*<sub>2</sub>" (Cusick, 1968, p. 258). DC is expressed as the ratio of *W*<sub>1</sub> and *W*<sub>2</sub>.



**Figure 1:** (a) Front view of Cusick Drapemeter, (b) Draped configuration of fabric

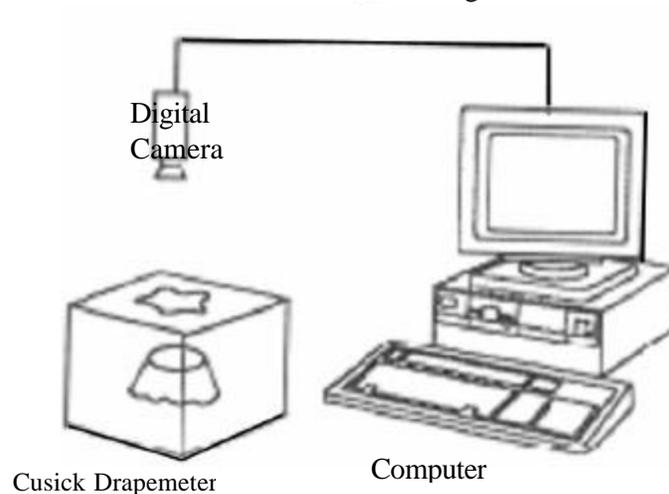
## Methods

In the conventional method, a circular fabric sample 36 centimeters in diameter is allowed to drape over a horizontally placed circular rigid disk of 18 centimeters in diameter. Typically, the fabric deforms as a series of folds around the disk. By vertically projecting the shadow of the draped sample onto the paper ring placed on the top plate of the Drapemeter, the shadow configuration of the draped image can be traced onto the paper ring. The paper ring containing the shadow image of the draped configuration is then weighed ( $W_1$ ). The shadow image is cut from the paper ring and weighed ( $W_2$ ). The

ratio of  $W_1$  and  $W_2$  multiplied by 100 gives the DC as a percentage.

$$DC = \frac{W_2}{W_1} \times 100$$

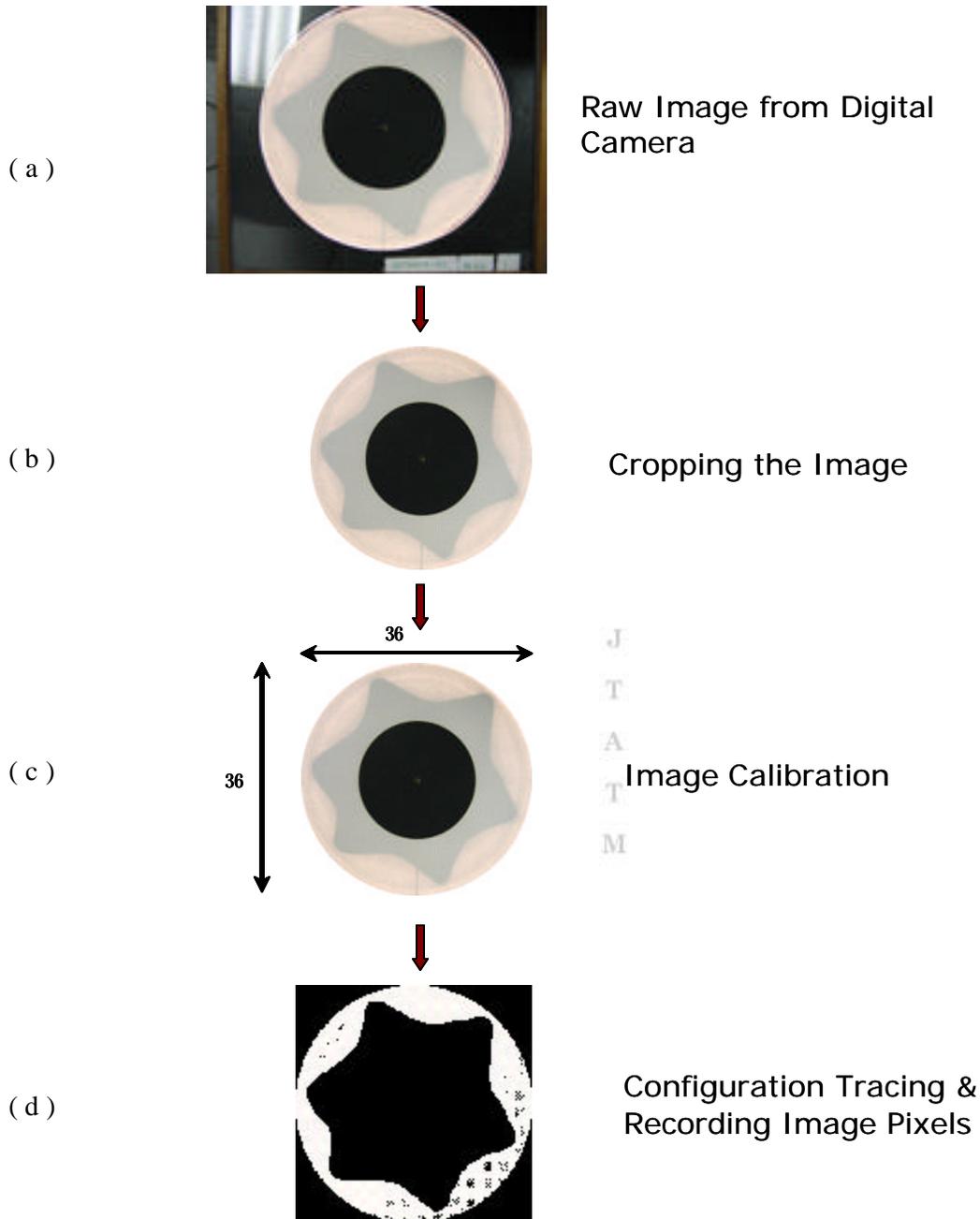
In the modified (digital) process, the instrument setup (Figure 2) consists of a Cusick Drapemeter, a digital camera to capture the draped image of the mounted fabric sample, and a computer to analyze the captured image and translate it into appropriate output. A digital camera was placed above the Cusick Drapemeter as shown in Figure 2. The camera was mounted at a distance sufficient to focus the paper ring placed on the top plate of the Cusick Drapemeter. The images were captured using 2048 X 1568 image resolution.



**Figure 2:** Digital setup for the measurement of fabric drape

In this investigation, a 36 centimeter diameter fabric sample was used to provide a uniform platform for testing the fabric samples in conventional and digital methods. In the modified process, sample mounting, that is lowering the sample to form the drape configuration of the fabric, was executed identically to the conventional method. After allowing the sample to fall,

the image of the draped configuration was captured using a commercial digital camera. Next, the captured image was transferred to a computer and processed using *Adobe Photoshop®* software. Figure 3 diagrams the steps for calculating the DC from the raw images of draped fabrics using *Adobe Photoshop®* software.



**Figure 3:** Flow Chart of the Digital Processing of Captured Draped Images

Initially, Figure 3(a), the captured digital image of the draped fabrics was transferred into a computer. Then, extraneous portions of the raw image were cropped using *Adobe Photoshop®* software (Figure 3(b)) before further processing. The image was calibrated by setting the dimension of the circular ring to 36 cm (Figure 3(c)). The draped configuration of the image was then selected using the 'magnetic lasso' tool in *Adobe Photoshop®*.

The 'magnetic lasso' tool attaches a boundary to select the dark region based on pixel value, reducing the variation in the selection process. The selected configuration was used to calculate drape coefficient of the fabric. The Drape Coefficient of the fabric was calculated using the image pixels and the image resolution from the draped specimen. The following formula was used to calculate Drape Coefficient in the modified digital method:

$$DC (\%) = \left[ \frac{\text{Total Selected Pixels} \div \text{Pixels per cm}^2 - \text{Area of Support disk(cm}^2\text{)}}{\text{Area of the Specimen(cm}^2\text{)} - \text{Area of Support disk(cm}^2\text{)}} \right] \times 100$$

## Results and Discussion

Physical characteristics of the ten woven fabrics selected for study are shown

in Table I. All the fabrics were conditioned in standard atmospheric conditions before testing on the Cusick Drapemeter (British Standard Institute: BS1932, 1954).

Sample No.	Sample Name	Weight (g/sq.mt)	Fabric thickness (mm)	Yarn Thread Density (n)		Yarn Count (N)	
				Wp	Wf	Wp	Wf
1	Plain	110	0.32	72	62	29.52	29.52
2	Twill	190	0.45	112	54	21.09	21.09
3	Oxford 5	211	0.55	94	28	15.96	8.20
4	Plain 4	168	0.38	96	46	42.17	10.54
5	Plain 2	194	0.4	96	56	18.45	21.87
6	Twill 3	292	0.7	72	42	8.68	9.23
7	Lawn	95	0.26	90	80	42.17	36.90
8	Momie	180	0.47	62	52	18.45	15.96
9	Sateen	248	0.61	96	64	15.96	16.40
10	Sheeting	189	0.45	54	44	13.12	10.54

**Table I:** Physical characteristics of sample fabrics

The face, back and overall average DC values using both conventional and digital processes are tabulated in Table II. Each face and back value is the average of six readings from two test samples. The

overall average is the average value of twelve readings, six each from two samples.

<b>Fabrics</b>	<b>Face Conventional</b>	<b>Back Conventional</b>	<b>Average Conventional</b>	<b>Face Digital</b>	<b>Back Digital</b>	<b>Average Digital</b>
Plain 1	35.08	33.56	34.32	34.73	33.52	34.13
Twill1	43.17	44.52	43.84	43.15	44.17	43.66
Oxford 5	51.57	52.20	51.89	51.71	51.93	51.82
Plain 4	51.18	51.33	51.25	51.62	52.04	51.83
Plain2	51.47	51.07	51.27	52.56	52.35	52.46
Twill3	51.56	50.87	51.21	52.44	52.32	52.38
Lawn	52.86	51.95	52.40	53.38	53.63	53.50
Momie	52.71	50.40	51.55	53.51	51.97	52.74
Sateen	51.03	48.86	49.95	52.06	49.73	50.89
Sheeting	63.27	62.80	63.03	64.40	63.96	64.18

**Table II:** Drape coefficient of sample fabrics

The overall average DC for each of the ten fabrics tested with conventional and digital processes is shown in Figure 4. Pearson product-moment correlations were used to carry out pairwise comparisons and determine if similar results were obtained using the two methods. A correlation coefficient of 0.9971 (n=120, p=0.0000) demonstrates that the modified digital method of obtaining drupe coefficient provided results comparable to those obtained using the conventional cut and weigh technique.

The difference in DC obtained with the modified digital process and the conventional process for each trial is plotted sequentially in Figure 5. The variation plot illustrates how, for each sample, the DC obtained from the modified digital method differs from that obtained using the conventional process. It should be noted that the value of each DC measurement ranges from 34.32 to 63.03 percent for the conventional process, and 34.13 to 64.18 for the modified digital process, with the differences of 3 percent or less.

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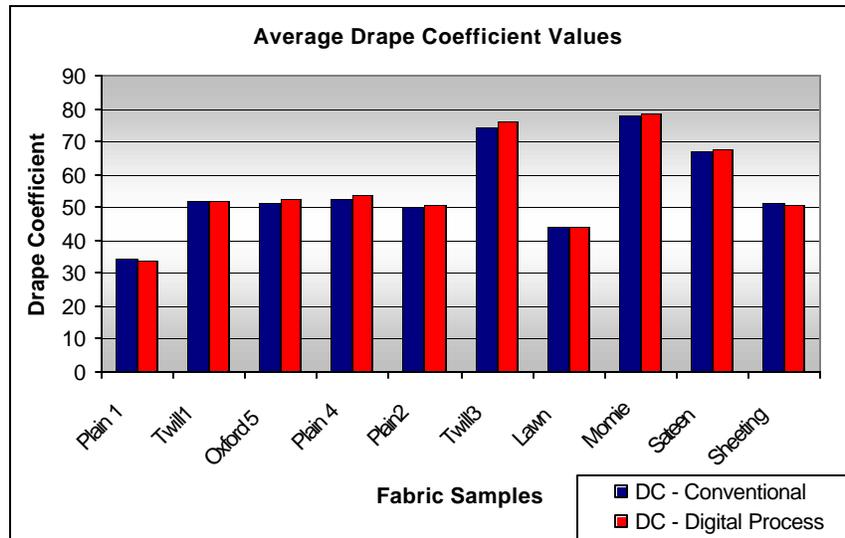


Figure 4: Average DC values from conventional and modified digital processes

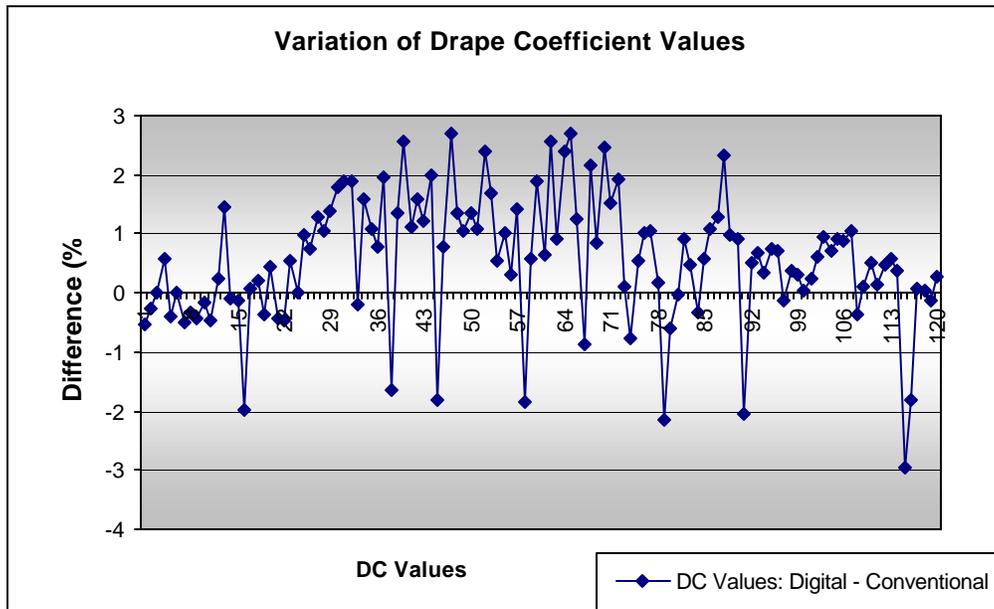


Figure 5: Variation in DC measured through conventional and modified digital processes

### Conclusions

Conventional methods for measuring drupe utilize processes developed by Chu et al., (1950) and Cusick (1961, 1965, 1968) more than thirty years ago, before digital technologies were widely available. This research developed a modified technique for the measurement of fabric drupe using widely available digital technologies and an off the shelf graphics software, *Adobe Photoshop*®. DC obtained through the

modified digital method has been shown to be highly correlated with the DC obtained through the conventional cut and weigh technique.

The digital method was found to have advantages of eliminating the need for paper rings, reducing manual error and storing an archived image of the draped samples for future reference. Due to the benefits of processing draped images using the modified digital method, it is a viable

alternative to the current industry practice of processing drape characteristics using conventional cut and weigh processes.

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