COMPUTER ASSISTED FABRIC PROPERTIES DESIGN

BY

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ABSTRACT

Material, structure and finishing processes influence fabric properties. Out of these factors, material has greater influence on properties. The Previous methods used to measure fabric properties by blending of materials, required a number of laboratory trials in order to choose the optimum material combination, which meets the end use of fabric. The main objective of this paper is to develop a software to enable the user to select the proper material which suits the end use. By estimating the properties of fabric produced by blending of fibers the designer must choose the material and the optimum ratio of blend that satisfy the consumer in terms of quality as well as price. The fiber properties are classified into four grades (excellent, good, fair and unsatisfactory); each grade is given a weight. The fabric is also classified into classes according to the end use and thus the required properties for each class were set. Ten properties were tested for each fabric (absorbency, strength, etc). When Summer and Winter dressings were tested the software showed that cotton is quite suitable for Summer, polyester is unacceptable for Winter as well as Summer and wool is excellent for Winter. These results coincide with results obtained by old methods.

ملخص

تؤثر كل من المواد الخام والتركيب النسيجي والتجهيز على خواص القماش المنتج، فالمادة الخام المستخدمة أكثر تأثيراً على الخواص مقارنة مع العوامل الأخرى. الطرق المستخدمة سابقاً في تحديد خواص القماش المصنوع من الألياف المخلوطة

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تحتاج إلى عدد من التجارب المعملية بغية الوصول إلى الخلطة التي تناسب الغرض المحدد للقماش.

الغرض من هذه الورقة العلمية استخدام الحاسوب لعمل برنامج يساعد المستخدم على اختيار الألياف والخلطات التي تناسب الغرض المحدد للقماش آخذاً في الاعتبار دخل المستهلك مع عدم التفريط في الخواص المطلوبة.

تم تقسيم خواص المواد الخام المستخدمة (الألياف) إلى أربعة أقسام (ممتازة، وجيدة، ومقبولة، وغير مقبولة) ثم أعطى وزناً معيناً لكل قسم وتم من بعد ذلك اختبار عشر من المواصفات المهمة مثل الامتصاص، والمتانة، والتكور، والطراوة، ومقاومة الاحتكاك، والانسدال، والموصلية الحرارية، وتأثير الضوء، والقابلية للصباغة والمطاطية.

وبإجراء التجارب على الأقمشة الصيفية والشتوية المصنوعة من الألياف الطبيعية والألياف الصناعية أظهرت النتائج أن القطن هو الأفضل للملابس الصيفية والصوف للملابس الشتوية أما البولستر فهو غير ملائم للملابس إطلاقاً. كما أظهرت النتائج أن خلط الصوف مع القطن أفضل من خلطه مع البولستر من حيث الجودة، فهذه النتائج المأخوذة باستخدام أجهزة القياس المتعارف عليها في هذا المجال.

INTRODUCTION

Computer plays a vital role in many aspects of life. In 1970's it made its first entry to textile industry. Many companies now acquire and integrate Computer Aided Design (CAD) in their design and other production processes. The scope of CAD has been extended to include the whole spectrum from initial design up to decision-making, with subsequent link to production plant and machinery [I]. CAD involves any, type of design activity that uses the Computer to develop, analyze, modify, or enhance an engineering design [2]. The use of Computer in textile has brought up significant effects that give the designer more direct relationships with the machine. It has also provided a wide room for creative designers to manouver and change the imagination to reality [3]. According to a survey conducted by the National Knitwear and Sportwear Association (NKSA) in the United States, 79% of respondents reported that they use CAD. Chief

uses were coloring, printing and fabric design. Among those using CAD, 50% strongly agreed that it had helped them to increase their production and 79% agreed that it had enhanced their creative processes [4].

Factors that determine the fabric properties are material, structure and finishing processes. In some cases the yarn produced from one type of fibres will fail to meet the required properties, even if it met, the price might be beyond the reach of low-income consumers. Hence it is better to blend two fibres together in order to overcome the above problem. All fibres will have excellent, good, fair or unsatisfactory characteristics. A competent textile technologist can use these characteristics to produce a yarn in which properties for desired end use are maximized and the undesired properties are minimized.

MATERIALS AND METHODS

The properties of each fibre are classified into four grades: excellent, good, fair and unsatisfactory, see (Table 1), each grade is given a special weight called the balance weight. The weight varied according to the unsatisfaction. The fabric was classified into classes according to their end use (eg: dressing, curtain, furniture, etc.) and criterias were set for each class of fabric. This criteria is referred to the required properties and ten properties were tested for each class, the properties tested are namely absorbency, strength, pilling resistance, abrasion, heat conductivity, resilience, drapability, effect of light, elasticity and dyeability.

The following methodology is used to estimate the properties of fibres obtained from blending two different materials. The methodology used consists of the following steps:

1- Classify the fibres properties into grades (excellent, good, fair and unsatisfactory), and give assumed weight (60, 45, 30 and 15) to each grade respectively. The user has the right to change the assumed weight but the range within each class should not be changed (Table 1).

2- Enter the properties required (R) that you want to appear in the final product where the properties of fabric depend on the fabric end use.

3- Multiply the required properties by their balance weights, these weights vary according to the contribution of property and its importance in the final product. These weights are assumed to be: 4,3,2, and 1 for critical, very important, important and considerable respectively. The user of the software may change the assumed balance weight mentioned above, but he should keep in mind that the higher weight should be assigned to critical and the lower weight to considerable.

4- Enter the properties of the first material you want to use in the blend (S_1) from (Table 1).

5- Enter the properties of the second material you want to use in the blend (S_2) from (Table 1).

6- Enter the blending ratio of the first material (br1), and let the blending ratio of the second material be (100-br1).

7- Multiply each property of material with its corresponding blending ratio.

8- Add the properties obtained from the step (7) check together, these are called properties after blending (B).

9- Multiply each property obtained from the step (8) by the weight corresponding to each property.

10- Add the weights of the required properties together (wt_1).

11- Add the weights of the properties after blending together (wt 2).

12- Add the weights of the critical required properties together (wcr).

13- Add also the weight of the critical properties after blending (wcb).

14- Compare the total weight of required properties and the total weight of properties after blending. See how these two weights are close or far from each other, if weights are closer together better result will be obtained.

15- Compare the total critical weight of the required properties and the total critical weight of the properties required after blending, the closer the weights the better the result and the materials should be used.

16- Display the required properties after blending in a histogram form. The following steps should be followed if the price of the material is necessary to be considered.
17- Enter the price of the first and second material.
18- Assign weight to each material's price, the higher weight would be assigned to material of low price and lower weight to material of higher price.
19- Multiply each price with its corresponding weight.
20- Multiply the weight obtained from step (19) by the blending ratio of the material concerned.
21- Multiply the weight obtained from step (20) by income weight. The income weight changes according to income consumers. Assign the lower weights for high-income consumers and higher weight to low-income consumers.
22- Add the weights obtained from the step 21 to the weights of requiredproperties after blending. Choose the higher weight obtained from step (22) as the optimum material considering price as well as properties.

Table (1): Classification of Fibres Properties

Property	Cotton	Wool	Polyester	Nylon	Acrylic	Accetate
Absorpency	Excellent	Excellent	Unsatisfactory	Unsatisfactory	Unsatisfactory	Fair
Strength	Good	Fair	Excellent	Excellent	Fair	Unsatisfactory
Elasticity	Unsatisfactory	Good	Fair	Excellent	Unsatisfactory	Unsatisfactory
Resilience	Unsatisfactory	Excellent	Excellent	Good	Excellent	Excellent
Heat Conductivity	Good	Unsatisfactory	Fair	Unsatisfactory	Unsatisfactory	Fair
Abrasion resistance	Excellent	Good	Excellent	Excellent	Fair	Unsatisfactory
Drapability	Good	Excellent	Fair	Excellent	Fair	Unsatisfactory
Pilling resistance	Excellent	Fair	Unsatisfactory	Fair	Fair	Good
Effect of light	Unsatisfactory	Good	Good	Fair	Excellent	Fair
Effect of dyes	Good	Good	Fair	Good	Unsatisfactory	Good

Software Analysis: This software is developed to estimate the properties of fabric produced from blending two fibers together with different blending ratios. It has been developed to select the proper material for the proper end use and to choose the optimum ratio that will satisfies the consumer.

TABLE (2) PROPERTIES OF FABRIC USED FOR DRESSING

PROPERTIES	DRESSING SUMMER	BALANCE WINTER	WEIGHT DRESSING	BALANCE WINTER
Absorbency	Excellent	Critical	Excellent	Critical
Strength	Good	V. Important	Good	V important
Pilling resistance	Good	V important	Good	V important
Elasticity	Good	Important	Good	Important
Abrasion	Good	V. Important	Good	V important
Resilience	Excellent	Critical	Excellent	Critical
Heat conductivity	Excellent	Critical	Unsatisfactory	Critical
Effect of lights	Good	V important	Good	V. Important
Affinity for dyes	Good	V important	Good	V. Important
Drapability	Good	Important	Good	Important

Designers specify the properties of the fabric they want to produce, which are called required properties. As we mentioned before there are specific required properties for each specific end use. For example, if the designer decided to fabricate a dressing used in Summer, he should refer to properties of such fabric, (Table 2), and enter the properties carefully, then the program multiplies these properties with weight corresponding to each property.

After the required properties are successfully entered, the user may blend two different materials together, with different blending ratios in order to approach the required properties. The user should enter the properties of first material he wanted to use in blending from (Table I) and enter the properties of second material from the same table. Then the blending ratio of first material is entered and the program would subtract the blending ratio of first material from (100), the residue is the blending ratio of second material. Then the program according to the data entered would perform certain calculations and display the properties after blending and the properties required. A comparison between the required properties and properties after blending as well would take place. Also the program would compare the total critical weights required and the total critical weights of properties after blending. See Fig. (1)

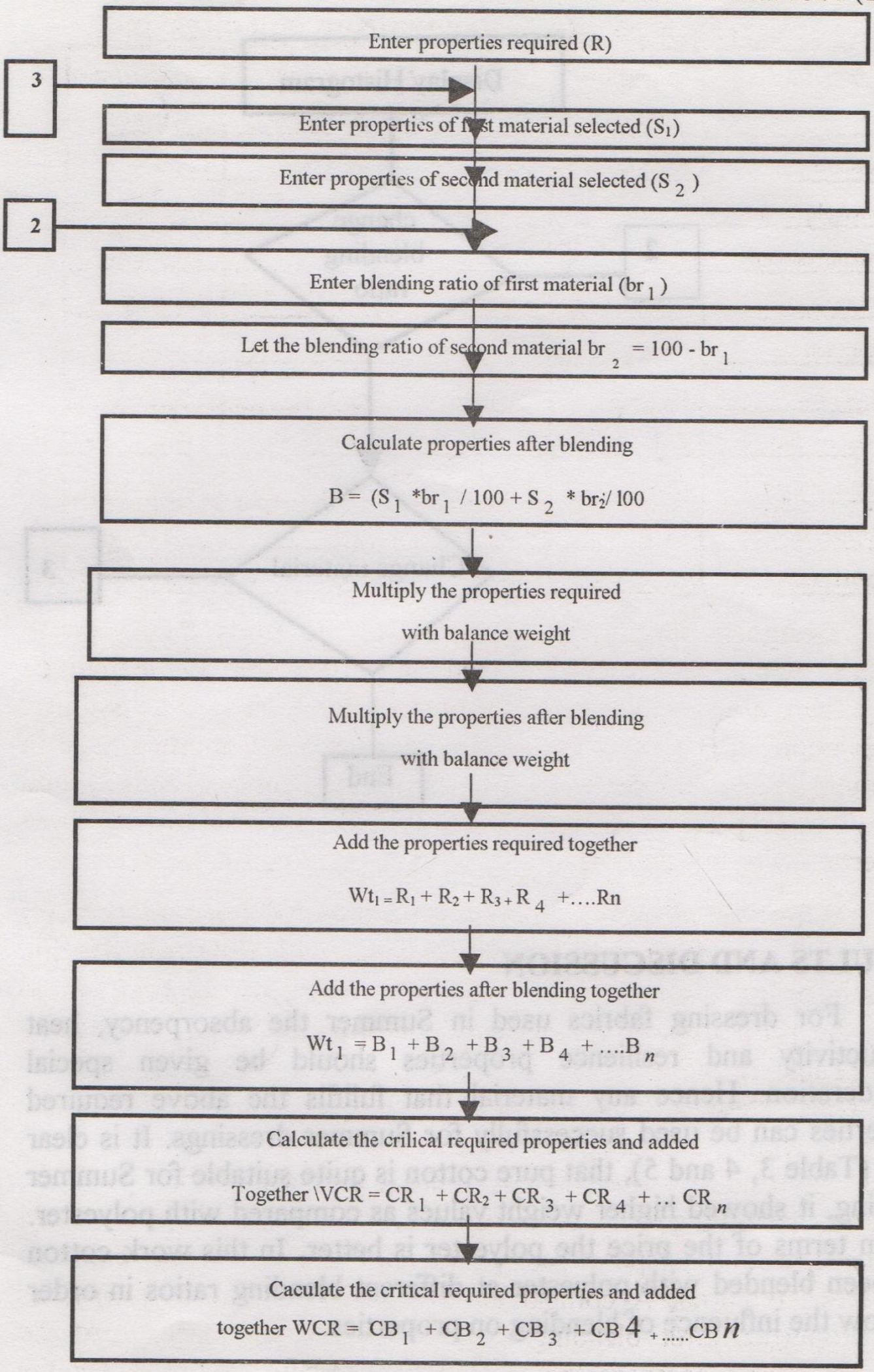
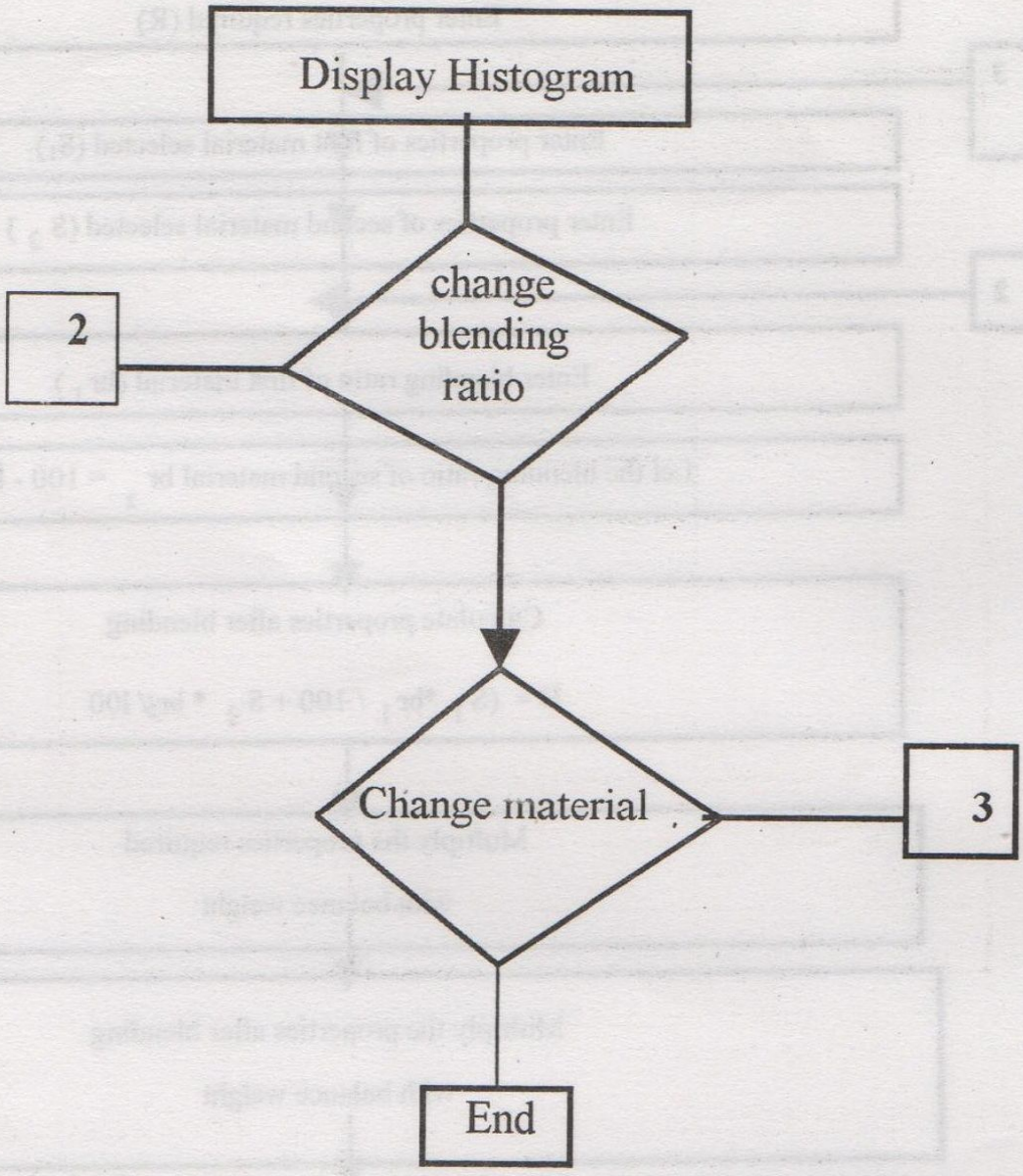


Fig.(1): Algorithm of material selection software



RESULTS AND DISCUSSION

For dressing fabrics used in Summer the absorpency, heat conductivity and resilience properties should be given special consideration. Hence any material that fullfils the above required properties can be used successfully for Summer dressings. It is clear from (Table 3, 4 and 5), that pure cotton is quite suitable for Summer dressing, it showed higher weight values as compared with polyester. But in terms of the price the polyester is better. In this work cotton has been blended with polyester at different blending ratios in order to show the influence of blending on properties.

Table (3) Material Selected For Summer Dressing

Property Name	Property required	Pure Cotton	Pure Polyester
Absorpency	240	240	60
Strength	135	135	180
Pilling resistance	90	30	60
Elasticity	135	180	45
Abrasion	240	180	120
Resilience	240	60	240
Heat conductivity	135	90	180
Effect of lights	90	90	60
Affinity for dyes	30	15	45
Drapability	135	135	90
Total properties	1470	1155	1080
*Price weight	-	1600	1800
Final weight	-	2755	2880

*W/P = wool and polyester blended respectively, the first figure in each blending ration used for wool ratio and second figure for polyester ratio, ** Price is not a property, but it is useful when the income is considered.

Table(4): Winter dressing produced from Wool and Cotton (*W/C) blended at different ratios

	Blending ratio of (w/c)								
Property Name	**90/10**	**80/20**	**70/30**	**60/40**	**50/50**	**40/60**	**30/70**	**20/80**	**10/90**
Absorpency	240	240	240	240	240	240	240	240	240
strength	93	99	102	108	111	117	120	126	129
elasticity	82	78	70	66	58	54	46	42	34
Pilling	99	108	117	126	135	144	153	162	171
Heatconductivity	68	84	92	108	116	132	140	156	164
Resilience	220	204	184	168	148	132	112	96	76
abrasion	129	126	120	117	111	108	102	99	93
Drapability	116	114	111	108	104	102	98	96	92
Effect of lights	41	39	35	33	29	27	23	21	17
Drapability	135	135	135	135	135	135	135	135	135
Properties wight	1223	1227	1209	1209	1187	1191	1169	1173	1151
****Price wight**	1060	1120	1240	1240	1300	1360	1420	1480	1540
Final weight	2283	2347	2449	2449	2487	2551	2589	2653	2691

* WIC = wool and cotton blended together. The first figure of blending ratio used for wool and second figure used for cotton, * Price is not property. But sometime it is useful when income considered.

Table (5): Comparison of Weight of Wool Blended With Cotton (*W/C) and Wool Blended With Polyester (w/P) Respectively.**

	Blending Ratios								
Weights	90/10	80/20	70/30	60/40	50/50	40/60	30/70	20/80	10/90
Properties of w/c	1223	1227	1206	1209	1187	11191	1169	1173	1151
Properties of w/p	1219	1209	1186	1179	1153	1146	1113	1113	1087
Properties of w/c including price	2283	2347	2421	2449	2487	2551	2653	2653	2691
Properties of w/p including price	2299	2369	2426	2499	2553	2626	2753	2753	2807

* W/c wool blended with cotton. The first Figure in each blending ratio represent wool ratio and second figure represent cotton ratio, * W/p wool blended with polyester. The first figure in each blending ratio represent wool ratio and second figure represent polyester ratio.

When the price was not considered, the blending ratios (80/20) and (90/10) was found to be the best for blends (w/c) and (w/p) respectively. But when the price was considered the blend (w/p) showed higher weight values than blend (w/c).

CONCLUSION

This software enables designers to select the proper material, which meet the specific purpose. Also this software considers the price of material used, taking into account the income of consumers. Suitable material for the specific purpose is not suitable sometimes low-income consumers. To overcome this situation two materials are blended together at different ratios where the cheap combination is selected without losing the required properties. By using this software, the test which requires more than 24 hours can be carried out within a few minutes. Cotton is desirable for Summer dressings, where wool is quite suitable for Winter and polyester is unacceptable for dressing in general. These results coincided with the results obtained by old techniques and tedious methods.

REFERENCES

1- **Winifred Aldrich,** (1992). CAD in clothing and Textiles, Hartnolls Ltd Bodmin Britain, [pp 81].

2- **Lamit, Gray Louis and Kitto, L. Kathleen** (1977). Engineering Graphics and Design, wes publishing, [pp 14-18].

3- **Aplin, Andy,** (1986). Design in Transition. Canadian Textile journal, [pp40].

4- **Grudier, Alison** (1995). Design Goes High Tech, Apparel July/Augvl 19, [15].