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COMPOSITE SEWN SEAMS, Part III: THE SEWABILITY OF WEFT KNITTED FABRICS.

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ABSTRACT

The present work is focused on the interrelations between fabric handle and seam quality – fabric sew ability information on men's summer outerwear T-shirt out of thin weft knitted fabrics. To achieve this, an electrical device (fabric resistance to sewing needle penetration – FRNP), was used. Seam quality – fabric sew ability were studied in terms of subjective evaluation, and objective measurements (fabric resistance to sewing needle –FRNP). .
It was found that, a) FRNP depends on the sewing direction; and b) the correlation between fabric hand modulus (objective measurement) and fabric hand (subjective evaluation) was very good.
Tailorability index of cotton fabrics reaches 77.3%, while knitted fabrics out of cotton –blended Tailorability index reaches 73%, i.e. increasing the blend ratio, increasing fabric tailor ability.
In addition, it was found that the ranking correlation coefficient reaches (R = -1), i.e. excellent correlation was found between fabric Tailorability index and fabric fashion ability index.

Keywords
Hand modulus, Seam quality, Fabric Sewability, Fabric- Hand Subjective Evaluation & Objective measurements, Fabric Tailorability Index, and Fabric Fashion ability Index.

Terminology:

1- Fabric quality is an attribute , a property, a special feature or characteristic or a manner , a style , the quality of knitted fabrics has several components ,playing different roles in appreciating its value , namely :a) quality of the construction or structure , b) functional quality , c) production execution , and d) realization recognition quality.
Quality analyses are the resolution or breaking up of something complex into its various simple elements. Fabric quality, in terms of comfort and aesthetic appearance, is perceptible in a subjective evaluation way, it depends on each person's individuality, and is influenced by culture, social status, and other factors, i.e.:
Fabric Quality = f (Comfort & Aesthetic Appearance) = Subjective Evaluation = f Culture (, Social ….etc.) …….. (1)
2-Tailorability Index, may be defined as the integration of process ability, sew ability, and formability, therefore its needs to be divided into narrow parts according to the experience of experts in manufacturing.
3- Fabric Fashion ability Index is a particular make , shape , style , or pattern, specifically a particular style of clothing.
4- Fabric Sew ability Index, means sewing without troubles. It is well known that sewing textiles is a very complex procedure to which various industry branches contribute (spinning, weaving, finishing, and producers of machines, sewing threads and sewing needles). Most ambitious of all of the garment industry is sewing knitwear. A large number of influence factors therefore must be carefully coordinated with each other, such as : sewing machine speed , sewing needle size , sewing needle tip , thickness of sewing thread(count) , relative air humidity , type of sewing stitch , type of sewing seam , and finish of goods to be sewn.

1. INTRODUCTION

Products of textile and ready-made garment have a great impact on Egyptian economy , so that the value of exporting one ready-made tone is almost five times the value of exporting one tone cotton fiber[1].Therefore the export policy of textile industry and ready-made garment should concentrated on exclusively ready-made garment exports as shown in Ref.[1] .
The increasing demand for apparel goods of high quality and low cost has imposed great stress on the textile and apparel industries to improve their production and quality evaluation. Therefore, the need for simple and easy test method to measure the quality – sew ability – hand of knitted fabrics is badly needed.
1.1. Fabric Sewability - Quality.
According to Refs.[2,3 &4] it was found that the greater the force produced by the thrusting sewing needle , the higher is the number of problems during sewing process , i.e. this determines fabric sew ability. Studies on the sew ability of knitted fabrics were

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undertaken by Leeming and Munden in 1973 [5] .However to the best of our knowledge, the sew ability – hand – quality of knitted fabrics was not studied by them.

1.2. Fabric Sew ability Assessment.

Fabric sew ability has a quantitative aspect as well as qualitative measure. Fabric sew ability is the ability with which fabric can be sewn, qualitatively and quantitatively. It is includes the ability to sew a fabric with: a) control of fabric distortion, and b) acceptable utility – durability factor. So we not agree with U.S."R&D", which uses seam strength only as a measure of fabric, sews ability [2].

The aim of this investigation is finding out the inter relation between fabric hand-sew ability, fabric hand – sew ability –seam quality, tailor ability – fashion ability i.e.: null hypothesis are:

H_1: Fabric hand + Fabric Sewability = Fabric Tailorability,

H2: Fabric hand + Fabric Sewability + Seam quality = Seam Fashion ability,

H3: Fabric Sewability is a function of sewing direction, and

H4: Subjective evaluation and Objective measurements of fabrics are highly related to each other.

Also the information given by the suggested sew ability tester in this investigation can be used to calculate the following parameters: a) fabric anisotropy) , b) seam springing , and c) seam crispiness , the values of ten-point average , and fabric roughness as shown in Refs.[6 and 7] .

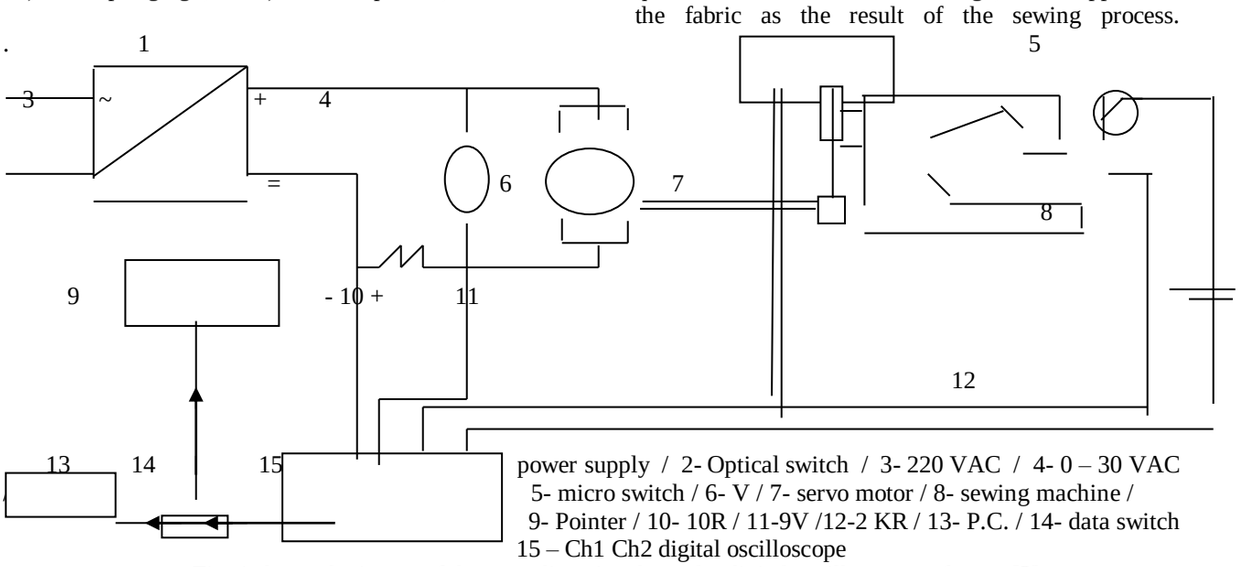
2. Experimental Procedure:

2.1 Fabrics:

Commercially available knitted fabrics produced by the pioneer fabric manufacturers of Egypt, of two different compositions (100% cotton and cotton-blended), and structures were selected for sew ability – handle – seam quality assessment, and covering a wide range of weights, and commonly used for clothing's, were selected for the study.12 fabrics were used in the investigation, which was a part of a study for development of alternate knitted fabrics for dress summer T-shirt. These fabrics were limited to combinations of cotton and polyester blends. The majority of the fabrics fell within a weight range of 150 to 270 g/m2. Samples for testing were preconditioned to the standard environment of 20 + 2oC, and 65 + 2% R.H

2.2 Fabric-Resistance to Needle Penetration Sew ability Tester:

An investigation is reported in which penetration of the sewing needle in tested fabric was recorded by using a measuring system, depends on measuring the change of the electric power under Dynamic conditions by using measuring electric circuit and a digital oscilloscope connected to PC computer [3], as shown in Fig. 1. The penetration force of the sewing needle is the quantitative measure of the damage, which appears in the fabric as the result of the sewing process.



power supply / 2- Optical switch / 3- 220 VAC / 4- 0 – 30 VAC
5- micro switch / 6- V / 7- servo motor / 8- sewing machine /
9- Pointer / 10- 10R / 11-9V /12-2 KR / 13- P.C. / 14- data switch
15 – Ch1 Ch2 digital oscilloscope

Fig. 1 shows the image of the recording signals on the digital oscilloscope software [3].

2.2.1. Calibration procedure:

Paper has been used for calibration because the paper is the uniform material can be sewed. The following steps carried out calibration:

1- Measuring the NPT (needle penetration torque),
2- Record the results for 2, 3, 4, 5, 6 layers,
3- put a known weight oh the needle rod until the needle penetrate then , this weight in kilogram will be equal to the corresponding voltage measured from the system for this case , and
4- Plot the curves of real voltage versus the penetration force in cN for all the tested layers. That curve is a calibration curve, which is used to determine the sewing needle penetration (FRNP-cN) [4].

2.3 Seam Quality:

Seam distortion or quality may be evaluated subjectively according to the following terms: a) Pinching; b) Ruffling; c) Shirring; and Fusion. Seam quality may be given in terms of, seam stretching (SSt), seam puckering (SP), and seam gathering (SG) [7].

2.4. Subjective Evaluation of Fabric Hand:

Paired comparison of several tested knitted fabrics is usually carried out and then the ranks are calculated. This method is easy for statistical data processing but it is suitable for small sets only [8]. A panel of 30 textile experts qualitatively evaluated the tested knitted fabrics. The panel was informed that the end use of the knitted fabrics was summer fabrics, e.g. T-shirt. Groups of knitted fabrics were established according to the scale grade shown in Fig. 2.

The experiments, in this investigation have accordingly been conducted to study four different effects: i) tactile sensations; ii) thermal sensations; and iii) structure sensations.

. For prediction of fabric hand value using that method, it is necessary to solve the following problems [8 -11]:

i) Choice of respondents, ii) choice of grade scale; and iii) definition of semantic.

2.4.1. Statistical Treatment of Subjective Evaluation:

For characterization of location or ordinal variable the sample rating median can be computed. The median category "Me" is defined by inequalities [8]:

$FMe-1 < 0.5\ FMe \geq 0.5 \rightarrow (2)$

The sample-rating median of ordinal variable has the form:

$XMe = Me + 0.5 - (FMe - 0.5)/fMe \rightarrow (3)$

Where:

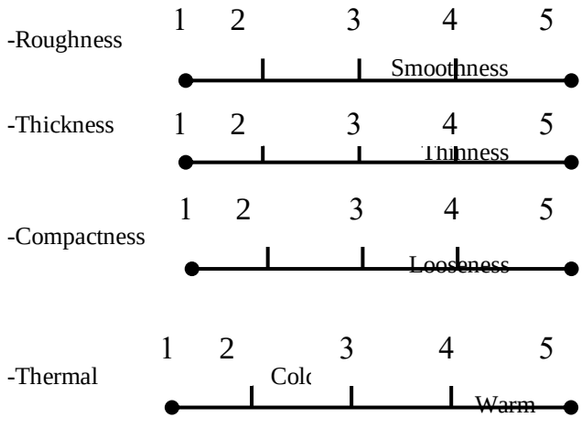
$fi = ni/n \rightarrow (4)$; $Fj = \Sigma\ fi \rightarrow (5)$

i.e., relative frequencies and cumulative relative frequencies respectively.

2.4.2. Components of Fabric Hand – Sensorial Comfort:

The sensory signals are processed by the brain to formulate subjective perception of sensations, which are clustered as follows:

Hand Sensations Grade Scale and Components



Σ = Undesirable (Discomfort)

Σ = Desirable (Comfort)

Fig. 2: Subjective Evaluation Elements for Fabric Comfort and Grade Scale [10 & 11].

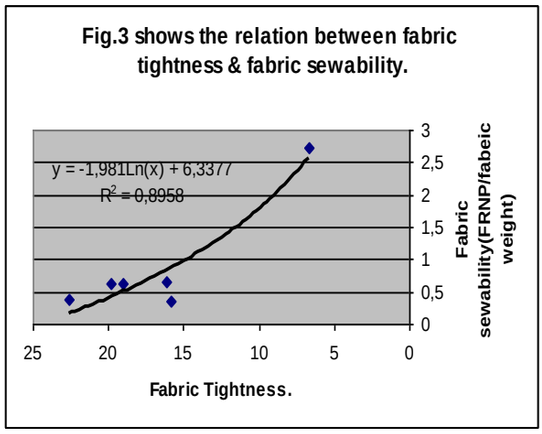
3. RESULTS.

3.1. Effect of Fabric Construction Parameters on Fabric Sew ability.

It is well known that during sewing, fabric structure, fiber composition, and finish have an important effect on needle temperature and forces opposing needle penetration. However, the relationship between fabric parameters and needle temperature or forces opposing needle penetration has not been determined, and some information on this subject is given here. Our investigation into the effect of fabric structure on the fabric sew ability (FRNP) ,using a 1 mm diameter needle , showed that there is a positive correlation between FRNP and the product of fabric tightness and fabric mass. The same trend was observed in Ref. [11].It is evident (see Fig. 3) that fabric tightness is varied in range 6.722 to 19.841.

The correlation between fabric tightness and fabric sew ability is very good (r=0.946). Using linear regression, the regression line was found:

Fabrics sew ability = 1.981 Ln Fabric tightness + 6.377 ……. (6)



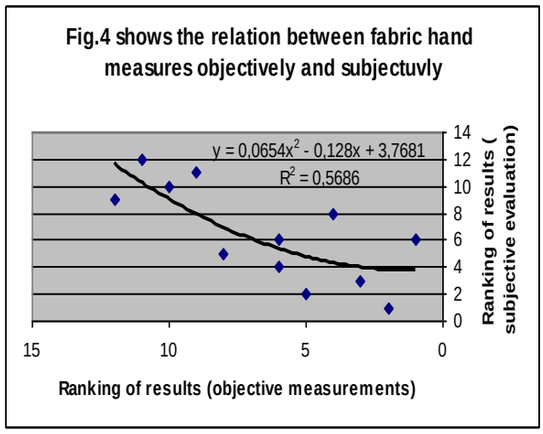


Table I Tested Fabric Specifications

Fabrics Weave	Fabric Set. W * C	Loop length (cm)	Yarn Count (Tex)	Tightens ($Tex^{0.5}$)	Weight (g/m^2)	FRNP (cN)	Product of Tight& Weight
Jersey	15 x 21	0.261	24.604	19.005	180	112.5	3420.9
Pique	10 x 15	0.250	24.604	19.841	190	117.5	3769.79
Tuck	11 x 20	0.308	24.604	16.105	190	125	3059.95
Rib 2x2	8 x 14	0.343	29.525	15.842	220	75	3485.24
Melton	11 x 14	0.240	29.525	22.640	235	87.5	5320.4
Plush	8 x 11	0.660	19.683	6.722	220	600	1478.84

Table I shows the amount of fabric damage due to sewing operation (FRNP-cN) conferred

ANOVA						
Sig.	F	Mean Square	df	Sum of Squares		
	,	13	11	143	Between Groups	HM
		,	0	0	Within Groups	
			11	143	Total	

ANOVA						
Sig.	F	Mean Square	df	Sum of Squares		
0,649189	1,044	13,05	10	130,5	Between Groups	HM
		12,5	1	12,5	Within Groups	
			11	143	Total	

To test knitted fabrics. It is evident that fabric set-weave-relative thickness results in a considerable fabric damage .Rib 2x2 acquires more resistance to sewing damage than Plush , though both fabric varieties are seriously affected at the same sewing conditions. However, the magnitude of fabric damage depends on fabric parameters. Out of the varieties examined Rib 2x2 shows the lowest damage whereas Plush fabric

shows the highest fabric damage. A Jersey, Pique, Tuck, and Melton structure stands in a midway position between Rib 2x2 and Plush structures, respectively.

3.2. Effect of Sewing Direction on Fabric Sew ability.

The purpose of this part is to determine whether variation of sewing direction will affect the fabric sew ability index, i.e.:

Sew ability Index (SI) = Fabric Resistance to Sewing Penetration (FRNP-cN) / Fabric weight (g/m2) x Needle Size (Nm) …… (7).

The SI values corresponds to the surface profile in selected directions from O (course direction) to 90 (Wales direction) is measured. Test of significance ANOVA was used , and the results show that , the significant effect of sewing direction and / or hand (objective measurements & subjective evaluation) , is higher than effect of hand modulus – seam quality .This means that variation in sewing direction from course direction to wall direction , and / or fabric hand assessment , led to significant difference in fabric sew ability values. Therefore, sewing direction affects the penetration forces so it must be mentioned the swing direction when it is spoken about fabric sew ability or defect occurring in sewn fabrics due to sewing operation or on any factor derived from previous penetration forces.

Table II, shows ANOVA results of fabric hand modulus, (objective & subjective).

Table III, shows ANOVA results of fabric hand modulus, versus seam quality.

It was found that:

$$F_o < F_{(\alpha, a-1, N-a)} \quad \text{.....(8).}$$

Thus, we fail to reject the null hypothesis , this means that the differences in sewing directions and / or fabric hand modulus and seam quality lead to significant differences in fabric resistance to needle penetration, i.e. fabric sew ability and / or fabric damage.

It was found also that, the output of sew ability tester in walls & courses reaches 6.9828 cN and 5.7574 cN respectively and highly significant at 95%.

It was found that the correlation between fabric hand modulus and seam quality reaches 0.75 and 0.52 respectively, also the value of correlation between hand modulus and fabric hand reaches Ca0.745. Significant relationships were also found, as shown in Figs. 4 and 5.

Figs 4 & 5 show a scatter diagram to find out if there is any relationship between subjective evaluation and objective measurements of tested knitted fabric hand. There does seam to be a positive (+r) between objective measurements and subjective evaluation. It is not cause / effect relationship, i.e. that relation could be caused by something totally different, as example the two variables could be related to a third, such as fabric properties (fabric tightness).

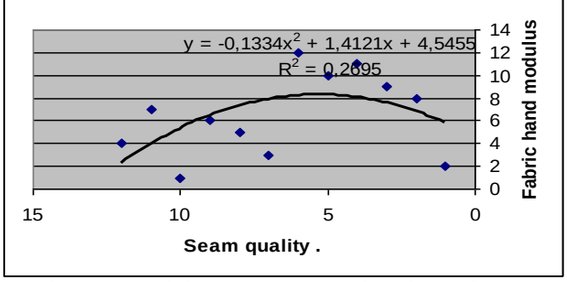
Figs. 4 and 5 shows that, coefficient of correlation between the ranking of both subjective evaluation and objective measurements of fabric hand and / or hand modulus – seam quality are only 0.754 and 0.519. Using linear regression the regression line was found

Ranking of Subjective Evaluation = 0.065 (Ranking of Objective measurements) 2 + 3.768 ……. (9).

Ranking of Hand modulus = - 0.1334(Seam Quality) 2 + 4.5455..…….. (10)

Only slope is significant at significance level 0.95.

Fig.5 shows the relation between the ranking of fabric hand modulus & seam quality



a) Fabric sew ability assessment, b) physical tests related to fabric hand , such as , compression properties , bending characteristics , and fabric draping , and c) seam quality data , such as seam gathering , seam puckering , seam stretching , and seam flexibility

Table IV shows the overall tested knitted fabrics and or / seams properties such as, fabric sew ability – fabric hand – seam quality, i.e. fabric fashion ability index of both fabrics made from 100% cotton and fabrics out of cotton-blended .It is clear that knitted fabrics made of cotton – blended are better than that of 100% cotton from fabric sew ability – fabric hand – seam quality point of views.

Table IV shows overall results of cotton & cotton – blended fibers.

Fabrics	Fabric Sew ability	Fabric hand	Seam quality	Seam fashion ability
100% cotton	48.05%	60.5%	68.25%	81.9%
Cotton - Blended	60.85%	40.4%	63.50%	97.70%

CONSLUSIONS

Proposed technique is very simple. It is based on measuring fabric resistance to sewing needle penetration (SI)) .We have developed a new test method for evaluating the fabric handle - quality-sew ability – fashion ability parameters at low sewing speeds(800 stitches/mime., stitch length =2 mm , pressure as presser foot =2cN/mm2, and sewing was in walls direction) .For good fabric handle-quality-Sewability – fashion ability , it is recommended to minimize the FRNP (cN), which is the best choice for fabric evaluation.

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