

## **INVESTIGATION OF FABRIC SEWABILITY PROBLEMS AND SOLUTIONS: AN OVERVIEW**

**\*V. Parthasarathi, S. Revathy, R. Praveena and S. Saranya**

*Department of Fashion Technology, PSG College of Technology, Coimbatore – 641004*

*\*Author for Correspondence*

### **ABSTRACT**

Sewability problems are displayed in finished garments in the form of effects such as damage by the needle, thread breakage, seam slippage and seam pucker. The number of problems related to sewability, and their economic severity has increased with modern trends towards higher speeds, partial and/or full automation, and changes in textile material input such as fabric and sewing threads, new dyes and fabric finishes, together with the use of synthetic fibres in both fabric materials and sewing threads. These have created many new problems during sewing operations, especially at higher speeds over 3000 stitches per minute. The increased speed of sewing machines had been one of the contributing factors towards the increased difficulties in achieving satisfactory seam performance e.g. pucker less and strong seams.

**Keywords:** *Sewability, Seam Pucker, Sewing Performance, Fabric Sewability*

### **INTRODUCTION**

Clothing manufacturing operations are basically involved with the conversion of initially flat textile materials into a three-dimensional garment, through a number of operations. These start with spreading the fabrics into single and/or multi layer blocks, cutting all layers in the spread simultaneously, and then sewing, fusing and pressing to convert the components into garments. In order to do this, a fabric has to be converted into a three-dimensional, smooth, unbuckled shape through a very complex production process with a large number of operations, the majority of which are sewing operations in which fabric sewability is becoming of the utmost importance. The principal type of sewing machine remains the lock-stitch, which is most widely used and is likely to remain the most common and versatile machine, particularly for sewing woven fabrics. The pressure from industry for higher productivity has been matched in recent years by considerable increases in sewing speeds. Apart from increases in speed, new types of textile materials and new finer sewing threads have also been developed, which have required finer sewing needles and improved control of the sewing process. These developments have not been without their associated problems during the course of clothing manufacturing, e.g. achieving pucker less seams at higher sewing speeds required finding the appropriate combination of needle, thread and sewing parameters. In each case the solution of such problems required an understanding of commercial sewing related to seam characteristics and properties such as seam strength, extension, damage, and appearance (Ryszard, 1993).

#### ***Needle influencing the sewability***

Measurements of the needle penetration forces and measurement of the heat generated by the needle and its effect on fabric damage in the process of sewing. This type of work led to many innovations in sewing, such as new shapes and coatings of needles, lubrication of threads, the finishing of fabrics and recommendations on the revised setting of sewing machine parameters. Soldhelm (1953) discovered that wax content in a cotton fabric reduced the needle temperature, as did other lubricants. Frederick and Zabieboylo (1952) mounted silver soldered constantan wire in the back groove of the needle at different positions. By using a special pyrometer the needle temperature was measured during sewing and the conclusion was reached that the interior of the needle was hottest and that the heat generated was a function of fibre frictional properties and cloth tightness. Needle heating became more important when synthetic fabrics were sewn at higher speeds (a trend brought about for productivity reasons). Needle heating (as a result of friction between the needle and fabric) increases with machine speed and can cause melting of the fabric and sewing threads, blocking of the needle eye and consequent thread breakage or even needle fail-

## **Review Article**

ure. Khan (1970) studied the behaviour of needle penetration forces in simulated conditions, using an Instron tensile testing instrument, with the aim of identifying needle-fabric interactions leading to heat generation. The penetration and withdrawal forces and energy expended were measured as functions of needle velocity. The needle velocities were; however, 3-4 times lower than in actual sewing conditions. The results obtained for three major variables (the number of layers, the needle diameter and needle finish) confirmed that they affect the magnitude of needle penetration forces and that the relation of the needle piercing force to needle diameter is linear. This was confirmed also with respect to the number of the fabric layers. Howard (1970) confirmed the effect of increasing needle diameter in generating more heat. But because the heat detector could not respond to rapid changes in needle temperature, the profile of needle temperature distribution was inaccurate. Leeming and Munden (1978) studied the factors affecting needle penetration forces in knitted fabrics and designed the "Land M Sewability Tester", which has also been used for woven fabrics.

### *Needle Penetration Force Measurement*

The work described in this paper focuses on the measurement of needle penetration in real time, with a sensor integrated into an industrial sewing machine. The main objective is to evaluate the feasibility of real-time measurement of the needle penetration forces, in an actual industrial situation. This involves not only an examination of the measured values and its relation to the sewing conditions in hand, but also an assessment of the accuracy of the measurement process itself, as it is influenced by several disturbing factors.

The expected outcomes of this work are techniques

- a) To monitor the process in order to detect needle wear, needle damage, excessive penetration forces, changes in penetration forces due to needle heating, damage or other abnormal situations;
  - b) To create process planning and sewability testing tools, with which it is possible to support needle choice, definition of maximum sewing speeds, test sewability problems of fabrics prior to production, etc.
- The subject of needle penetration force measurement has been studied by several researchers since the 1960's. The work focuses on two aspects: the development of instruments to measure penetration forces, and studies to relate the material, machine and needle variables to the penetration forces, needle heating and resulting seam damage. Regarding fabric finishing, Leeming and Munden (1978) have found that the force of penetration is critically affected by the use of lubricant or softener. The fabrics exhibiting high penetration values were also the fabrics which exhibited sewing damage when sewn using standard sewing tests. These authors contributed decisively with the LandM sewability tester (US Patent 3979951, 1976), a device used in many studies on needle penetration force. This equipment simulates a sewing machine by penetrating the tested fabric with an unthreaded needle, at a rate of 100 penetrations per minute. A force measurement is taken and the device counts the number of times the value is higher than a preset threshold.

Although this situation is quite different from industrial operation, it allowed many laboratorial studies to be developed. The work herein presented is different from other work because it intends to develop systems that can be used in real industrial situations, during actual sewing, with thread and varying sewing speed. The presence of thread (producing forces on the needle that are largely unrelated to the penetration itself) and variable sewing speed are two aspects of industrial operation that have only partially been analysed in other research. The LandM sewability tester, used in much of the referenced work, produces measurements at 100 penetrations/minute. This is a single, constant speed that is also very low when compared to industrial speeds. Other work developed on sewing machines has focused mainly other aspects (thread forces, fabric feeding). Measuring needle penetration and withdrawal forces is very difficult. Sensing penetration and withdrawal forces with a single sensor is only possible by inserting a sensor into the needle bar.

In this configuration, the signal picked up by the sensor contains three distinct components. Forces necessary for needle bar motion. Forces produced by the interaction between needle/thread and fabric. Forces produced on the needle bar by thread motion. Of these three components, only the one related to penetra-

## **Review Article**

tion and withdrawal forces is interesting for the measurement. Typical needle penetration force waveform, division into penetration phases.

The forces related to needle penetration are the most demanding parameters to measure in a sewing machine, being partially affected by some parasitic effects, noise and inaccuracies due to the measurement setup. Nonetheless, the results display some trends that can be considered effective for the analysis of needle-fabric interaction. It has been shown that with this system it is possible to detect different needle sizes, and draw the relation of penetration forces to needle size for a particular fabric, in a comparative analysis. This relation is different from fabric to fabric, and is linked to its sewability. It is also possible to perform comparative analyses to evaluate fabrics in different states, different needles or other sewing conditions. The factor most influencing the penetration values has been found to be sewing speed.

The computation of peak ratios was an approach for a speed-independent indicator of penetration efficiency. As a result, it has been found that the value of the ratio peak2/peak1 tends to decrease when sewing conditions get worse (thicker or damaged needles). However, this peak ratio also varies with sewing speed, meaning that a comparative analysis of different sewing situations should only be done at the same sewing speed (Anonymous, No date).

### ***The effect of sewing thread on sewability***

Sewing thread tension variations during the sewing process, which they linked to the number of resistance points from, thread guides which cause an increase in thread tension. The physical and mechanical properties by which the quality of thread should be judged include breaking strength, elongation at break, variation of physical and mechanical properties, and twist stability (thread liveliness). However these parameters still do not mirror the conditions of sewing thread behaviour during the process of sewing. During sewing, a thread is subjected to a multitude of frequent changes of tensile forces (Rusakow, 1957; Tomanec and Sramec, 1962; Nowak and Wiezlak, 1967; Miyashita, 1947), which are destructive and reduce thread strength in lock-stitch machines by 30% and more. This reduction in seam strength requires stronger threads, which are consequently more expensive (Chmielowiec, 1985). A weakened thread is also prone to break, which consequently leads to stoppages of the sewing machine. The total production time wasted in a lock-stitch sewing machine amounts to 1%. The result suggests the importance of the selection of adequate sewing conditions, where sewing threads will be less subjected to damaging tensile stresses and strains. In some circumstances particularly in the unfavourable speed range with maximum thread tensions, a high static tension and the existence of weak places in the thread itself could cause thread breakages. Derry (1984) found tension was related to factors stemming from the sewing machine design, sewing speed, needle number and the load on the plates of the thread tensioner, and thread characteristics such as fibre type and thread construction.

### ***Problems faced in garment industry***

The problem of puckered seams occurs in most branches of the sewing industry and is accentuated by the recent increase in the amount of man-made fibres used in fabrics. The problem is one of the most recurring and troublesome facing the clothing industry and is frequently a cause of serious economic losses to the producers of garments made from woven as well as knitted fabrics (Cram, 1984). "Pucker - as the contracting or gathering (of brow, seam, and material) into wrinkles, folds, or bulges, intentionally or as a fault e.g. in sewing. Galuszynski (1986) in his wide survey on seam pucker (over 50 related publications), used the following definition: -a distortion of the fabric along the seam line, causing a wrinkled appearance". The sewing thread was pulled (under tension), through the stitch holes and after load release the thread contracted, which led to a corrugated surface (simulating a puckered seam). It should be noted that the above three attempts to define seam pucker did not take into account any environmental factors: the operation of the sewing machine, the operator's skill, the manufacturing technology or end use/after-care conditions, the latter being very important commercially. The garment industry as a whole is making considerable efforts to reduce pucker severity by using various tools, attachments and specialised sewing machines to improve seam appearance.

There were several basic causes of pucker which are differential fabric stretch, fabric dimensional instability, sewing thread pucker fabric structural jamming and pucker due to mismatched patterns seams sewn

## **Review Article**

in the warp direction pucker more than weft or bias directions: the latter produces the least amount of pucker. Wash-wear treated fabrics puckered less than untreated ones, but there was no appreciable difference after laundering, mercerised threads gave smoother seams than soft finished ones before laundering: after laundering the seam appearances were similar. Thinner threads produced less pucker - before and after laundering, puckering increases with the number of stitches per unit length, some were flat before laundering, whereas French seams only became flat after laundering. Some of the treated threads used caused pucker during the sewing process, others appeared initially to give smooth seams, but these puckered shortly after removal from the machine (as described in many technical magazines and reports). Inherent seam pucker in woven fabrics was defined as fabric structural jamming caused by insertion of the needle and sewing thread.

### **Remedial for sewing problem**

Pucker as a "mechanical instability phenomenon" and as a "fabric garment defect" has already been described. A considerable amount of work has already been done on the mechanisms of seam pucker, as well as on methods to prevent it. Hope for finding a speedy solution to the problem of pucker elimination or its reduction, through the design of fabrics without a tendency to pucker, arose when a series of studies started on the link between pucker occurrence and the evaluation of the physical-mechanical properties of fabrics, through the use of the recently developed Fabric Objective Measurement Technology- Postle (1990). In garment processing sewing operations play the most important part. During this process there are many complex interactions between the sewing components, which if optimised, can lead to an optimum seam, and consequently to an acceptable quality of garments with a pucker less appearance and greater durability. The increased processing speed of sewing machines and the range of new fabrics available increase the importance of the new methods of pucker prevention through the modification of the presser-foot (Roberts, 1986). Examples of these are: the feeding of fabric layers by the needle itself, a method of "slowing down the bottom layer of the fabric" (before the needle) and finally a means for pulling the sewn fabrics by a pair of rolls installed beyond the stitch formation zone (Spickerman, 1991; Doughty, 1991; Bodenschatz, 1985). All these factors have contributed greatly to improvements in seam quality. However, they are only auxiliary techniques, applied by the clothing manufacturers themselves or the sewing machine producers.

The principal features of the needle thread tension trace remain broadly unaffected by increasing machine speed. The distribution of the presser-foot pressure and displacement signals with speed increases. During stitch formation the fabric layers are sandwiched between the presser-foot from the top (which applies a considerable pressure on the fabric) and the throat plate or feed dog on the underside. The transportation of the fabric by the feed dog is only possible, when an adequate pressure caused by the presser foot bar's spring is applied. The lack of an adequate level of pressure may cause negative effects during stitch formation and result in e.g. buckling of the fabric along the seam line (seam pucker). Some aspects of a model of seam pucker mechanism caused by the drop-feed system (pressure-foot bar mechanism) such as the effect of the pressure-foot force on the system of frictional (retarding/advancing) forces caused by the advance movement of fabric layers (due to feed dog movement), have already been considered (Galuszynski, 1987). For the satisfactory passage of the needle (dynamic penetration) through the fabric layers, the following optimum sewing machine kinetic conditions have to be attained (Galuszynski, 1987; Kamata *et al.*, 1984; Weizlak, 1993). The presser-foot should be at its lowest position, the timing of the rotating hooks of the bobbin has to be synchronised with the needle movement (Kamata *et al.*, 1984). The NTt (Needle thread tension) has to be at a minimum (Weizlak, 1993), the unique design of the sensor which is placed under the throat plate which indirectly senses the needle penetration force and automatically it controls the sewability problems (Anonymous, 1998).

## **REFERENCES**

**Anonymous (1998).** Development of sensors for industrial sewing machines. *University of Windsor*, Available: <http://scholar.uwindsor.ca/cgi/viewcontent.cgi?article=2718&context=etd> (Assessed on Oct 10, 2013).



## **Review Article**

- Anonymous (No date).** Carvalho Needle Penetration. Available: <http://repositorium.sdum.uminho.pt/bitstream/1822/9628/1/CarvalhoNeedlePenetration.pdf> (Assessed Oct 8, 2013).
- Bodenschatz S (1985).** Verbesserung der Vernachbarkeit von Textilien [In German], [Improvement of sewability in textiles]. Institut von Textiltechnik. *Textil Praxis International* 30-34.
- Chmielowiec R (1985).** Optimum stitching conditions. *SABS project* No.441/500040.
- Chmielowiec Ryszard (1993).** Sewing machine, fabric and thread dynamics. PhD thesis, University of Leeds. Available: [http://etheses.whiterose.ac.uk/4045/1/uk\\_bl\\_ethos\\_268813.pdf](http://etheses.whiterose.ac.uk/4045/1/uk_bl_ethos_268813.pdf) [accessed 4 Oct 2013]
- Cram RJ (1984).** Fabric Joining Methods (Survey of over 500 published references) Shirley Institute.
- Curiskis JI (1989).** *Private Polytechnic*. communication. Hong Kong
- Deery FC (1984).** Continuous measurement of thread tension. MSc Thesis, Leeds University, 1984.
- Doughty PJ (1991).** Advancing thread tension understanding. *Apparel International* June 1991.
- Frederick E and Zabieboylo W (1952).** Measurement of needle heat generated during sewing of wool and wool-nylon fabrics. *Textile Research Journal* 22 1025-1029.
- Galuszynski S (1986).** Seam pucker. Survey of 56 publications. *SAWTRI Special Publication* 76.
- Galuszynski S (1987).** Some aspects caused by the drop-feed International, of the seam mechanism. *Pucker J.S.N.*
- Howard GM and Parsons D (1970).** Sewing needle temperature. Part II: The effects of needle characteristics. *Textile Research Journal* 40(6).
- Kamata Y, Kinoshita R, Ishikawa S and Fujisaki K (1984).** The needle thread disengagement from the rotating hook, effects from its timing on the tightening tension - in the industrial sewing machines. *Journal of Textile Machinery Society of Japan* 30.
- Khan RA, Hersh SP and Grad YPL (1970).** Simulation of needle-fabric interaction in sewing operations. *Textile Research Journal* 40 (6).
- Leeming CA and Munden DL (1978).** Investigation into factors affecting the penetration force of the sewing needle in a knitted fabric and its relationship with fabric sewability. *Clothing Research Journal* 6 (3) 759-768.
- Miyashita R (1947).** Measuring needle thread tension and detecting skip stitches during sewing process", [In Japanese]. *Journal of Textile Machinery Society of Japan* 27 (1) 55-62.
- Nowak R and Wiezlak W (1967).** Measuring the static and dynamic stresses in the sewing thread during the sewing process", [In Polish]. *Zeszyty Naukowe politechniki Lodzkiej*, No.93, Wlokiennictwo, z. 1967, 16.
- Postle R (1990).** Fabric objective measurement technology: present status and future potential. *Bradford Conference*.
- Roberts F (1986).** Decorative top stitch effects on poplin garments possibilities and limits of a styling method by sewing. *J.S.N. International, Bobbin Show issue*.
- Rusakov SJ (1957).** Provedenenitki cherez tkani priobrazovani stezka, [In Russian], [Needle thread passage in a stitch forming process]. *Nauchnye Trudy, CNiszP*.41(8).
- Sondhelm W (1952).** Causes of seaming damage. *Journal of the Textile Institute* 44 T580-585,
- Spickerman R (1991).** Private communication at IMB'93 in Cologne. Pfaff's GmbH. *New Technology Corner*.
- Tomanec L and Sramec L (1962).** Mereni dynamického napětí nití při šití [In Slovak], [Measurement of the thread dynamic tension during sewing process]. *Textile* 14 (3, 4) 107-108 and 151.
- Wiezlak, W (1993).** Private correspondence. Technical University, Lodz, Poland.