Designing and producing women's blouses by using nonwoven fabrics

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Abstract
For decades, nonwovens used in apparel were only used as fusible interlinings, reinforcements for shirt collars and cuffs, or front interfacings for suits. They were considered disposable and rigid. This has changed drastically in recent years due to the research and development in the properties of nonwoven fabrics. The advanced nonwovens used as an apparel outer fabric, and can be used for leisurewear, active wears and work wear. When we think of fashion apparels as creative instincts, most of us relate them with the traditional classifications – woven and knitted. We would be loath to consider nonwoven fabrics for the scope of fashion outfits. The microfilament fabric combines very good textile and mechanical properties - similar to traditional micro fiber fabrics, but also very durable. Unlike traditional fabric manufacturing process, nonwoven fabrics are directly obtained from fibers. A nonwoven material offers number of advantages over traditional fabrics, cost savings being the most obvious.
This research explores the techniques that can be used in designing and producing the women's blouse by using the nonwoven fabrics and aims to use the nonwoven fabric in designing and producing the women's blouse at low costs. The result identified the best designs that have been produced using nonwoven fabrics were designs no. (8,10&1). They achieved the highest values in the evaluation, specially in the possibility of the production and marketing the design, Implementation techniques achieved advanced levels in the field of designing and implementation, The nonwoven fabrics properties are compatible with techniques used in the implementation, Decorative design enriches the essential design, and The general shape of the design. Designs no. (5&6) achieved the lowest values in the evaluation.

Keywords:
nonwoven fabrics, apparel production, apparel design.

1. Introduction

Nonwoven fabric is one of the oldest and simplest textile fabrics. Its classic example is felt. The first well documented discovery of felt dates back 3500-3000 BC. It was made from hairs of various animals that were pressed together. The fabric was primarily used for protective clothing and to make tents for shelter (Chaudhari, Mandot, Mili & Karansingh, 2008; Anderson, 2005).

Nonwoven offers a number of advantages over woven fabrics, cost savings being the most prominent, due to its direct fiber to fabric process, high volume of production, and less labor compliment. This difference in cost, in fact, is large enough that nonwovens might easily have completely banished woven fabrics for fashion apparel applications, if they were not endured by the distinct disadvantages, mainly in their mechanical properties, poor drape or flexibility. In the late 1960's there were a few efforts to market disposable nonwoven outfits but with little success due to undesirable properties. Since last few years, with innovative developments in nonwoven field, this unconventional fabric produced with better drape, hand, durability, comfort, stretch and recovery, has now also started finding its application into the fashion apparel products. (Dhange, Webster & Govekar, 2012)

Problem statement

In order to engage with problems arising from the issues outlined above, we have set out to examine the following:

- Can we use the nonwoven fabric in designing and producing the women's blouse at low costs?
- What techniques can be used in designing and producing the women's blouse by using the nonwoven fabrics at low costs?
- To what extent the success of the suggested designs?
- What are the best suggested designs that have been produced using non-woven fabrics?

Research objectives

- Using the nonwoven fabric in designing and producing the women's blouse at low costs.
- Access the best techniques that can be applied in designing and producing the women's blouse at low costs.
- Measure the suggested designs success.
- Identify the best suggested designs that have been produced using nonwoven fabrics.

Research limitations

- Design and produce women's blouse by using nonwoven fabrics for age group (20-30 years old)

Research sample

- Application has been set on 18 students in the second year - apparel department- Faculty of applied arts - Helwan University. The students enrolled in the garment production technology course in the first semester of the academic year 2011/2012.
- Preparation and implementation of designs has been set in the apparel department workshop. Using the tables for pattern preparation, cutting, sewing machines and the tools for drawing, cutting, and sewing.

Research methodology

- Research follows the descriptive analytical method and application study.

Research tools

- A questionnaire for evaluating the designs.

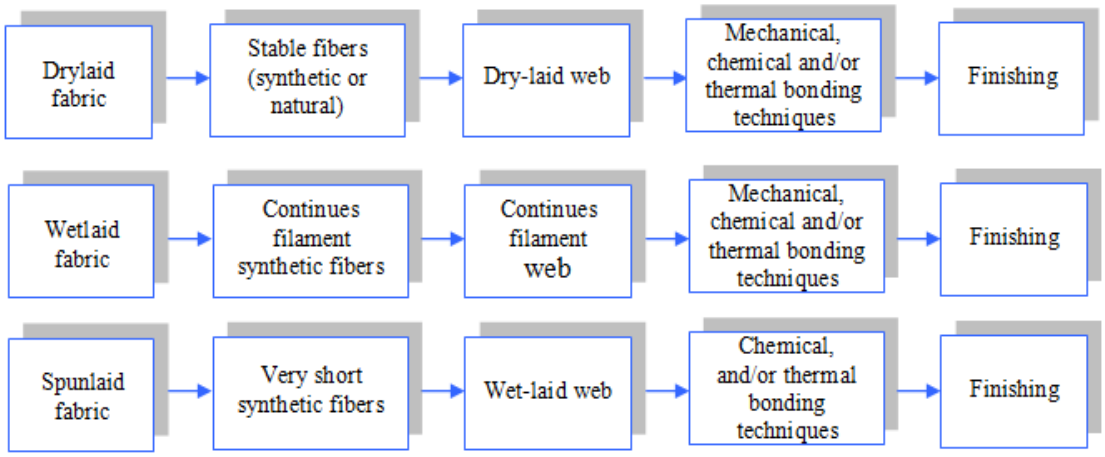
1.1 Manufacturing Nonwoven

Nonwoven fabrics are generally defined as a textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means and combination thereof. A web of fibers is the result.

The definition of nonwoven fabrics states that the fibers are held together by a bonding agent to form a fabric. The art of choosing the right fiber to combine with the right binder by the most efficient process to obtain a desired fabric is the absolute goal of nonwoven manufacturing. Virtually all types of fibrous material can be used to make nonwoven bonded fabrics, the choice being dependent on: The required profile of the fabrics, the cost/ ratio (cost effectiveness), and the demands of further processing.

The fibers used in the greatest volume in nonwoven fabrics today are cotton, rayon, acetate, nylon and wool. The synthetics, such as polyesters and acrylics, are being used increasingly, not necessarily to replace cheaper fiber but in fabrics intended for new and more exacting applications. Finally the very newest fibers are modifications of standard types to make them especially adaptable to nonwovens, e.g. self bonding viscose rayon and the synthetic polymeric fibers known as "fibrids". (Gohen, Johnson, 2010)

There are three major manufacturing methods used to produce nonwoven material: drylaid, wetlaid, and spunlaid. Each differs in fiber, usage, range of properties, financial requirements, and production steps as follows: (Patel& Bhrambhatt, 2011)



Materials are also are referred to by the method in which they are bonded as well as how the web was formed. The following are well-known material:

1.1.1 Carded web nonwovens

Carded web nonwovens were the first nonwoven produced in the early 1940. The large volume of nonwovens is made using this method. They can be made from any staple fiber, and are produced by forming a web of fibers and then bonding the fibers. The web is formed by using mechanical means, such as carding machine, air blowing fibers, or liquid to manipulate the fibers. Careded web nonwovens are used extensively in disposable items.

1.1.2 Spunlaced nonwovens

Spunlaced nonwovens are formed by the enlargement of stable fibers, using needlelike, high-pressure water jets on the web. The fibers knot or curl around each other, causing mechanical binding. Since no binders are used, softness, drape, and bulk result.

1.1.3 Spunbonded nonwoven fabrics

Spunbonded nonwoven fabrics in the polymer has been extruded to form a continuous filament stretch, the filament laying into the net, and then through its own fiber network bonding, thermal bonding, chemical bonding or mechanical reinforcement methods to make into nonwoven Thermally bonded nonwoven fiber is in fibrous or powder added to hot melt adhesive reinforcement material, fiber network and then cooling the heated melt into the fabric reinforcement.

1.1.8 Pulp flow into nets nonwoven fabrics

Pulp flow into nets nonwoven fabrics can be called air laid nonwoven paper or dry paper cloth. It is the use of airflow into nets technology, open the loose fibers into a single state, and then condensed in the air way into the fiber network curtain on the fiber network and then into the fabric reinforcement.

1.1.9 Wet nonwoven fabrics

Wet nonwoven is the fiber raw materials placed in the water medium loosen into a single fiber monofilament, have different fiber material mixed, made to as pulp fiber suspension, suspended slurry into a network of agencies transferred to fiber in the wet state to form a network and then reinforcement into cloth.

1.1.10 Stitch nonwoven felt

Stitch nonwoven is a dry nonwoven, stitch method is to use the warp coil structure of the fiber network, yarn layer, non-textile materials (such as plastic sheets, plastic, thin metal foil, etc.) or their combination body reinforcement, made of nonwoven fabrics. (Hongtek Filtration Co.,Ltd., 2012)

1.2 General properties of nonwoven fabrics

Here properties of Nonwoven fabrics as well as Nonwoven composites are compared with woven fabrics.

1.2.1 Breaking Strength

Values for the breaking load and elongation of a specified width of material are determined by longitudinal application of increasing load at a specified rate within a specified time as measured by grab, raveled strip, or cut strip method. (Behery, 1997)

The breaking strength of woven fabrics is around 450N in transversal direction and 1100N in longitudinal direction were as nonwoven fabrics gives 500N in traverse direction and 1200N in longitudinal direction. Thus we can say that nonwovens provides 10-12%more breaking strength than that of woven fabrics.

1.2.2 Tear Strength

The tearing strength of presently invented nonwoven fabrics is approximately double the tearing strength of woven fabrics.

1.2.3 Fabric Stretch

Presently invented nonwoven fabrics exhibit extensibility in the cross-direction of at least about 50%, and more preferably at least about 60%, with initial recovery of at least about 85%, and initial recovery of at least about 90% being particularly preferred, which is around 20% more than that of woven fabrics.

1.2.4 Abrasion Resistance

Nonwovens have poor abrasion resistance due to its loose structure compared to woven fabrics having compact structure. By using the breaking strength, tearing strength, fabric stretch and abrasion resistance fabric durability is decided.

1.2.5 Fabric Weight

Presently invented nonwoven fabrics garments are 50% lighter than knitted fabrics and 25% lighter than woven fabric garments when the fabrics having same area are compared with each other.

1.2.6 Fabric Thickness

Presently invented nonwoven fabrics has 10-20% more thickness than woven and knitted fabrics when the fabrics of equal weight per unit length are compared. (Chaudhari, Mandot, Mili & Karansingh, 2008)

1.2.7 Air Permeability

Air permeability means the resistance of nonwoven fabric to the passage of air at known pressure differential. Due to the more open structure of nonwoven fabrics than that of woven fabrics they provide more air permeability. Due to this property of nonwoven fabrics provides good comfort to human body. (Behery, 1997)

1.2.8 Thermal Properties

Unconventional nonwoven fabric provides reduction in thermal retention, it is reasonably expected that the wearer would remain cooler, and therefore more comfortable when exposed to elevated environmental temperatures.

Chemical bonded and spray bonded nonwoven materials would be good thermal insulators than the other nonwovens. (Sakthivel & Ramachandran, 2012)

1.2.9 Moisture Absorbance

Absorbency: Is the criteria which is generally characterized by the mode and the extent of the transport of liquid into an absorbing material. The moisture absorbance properties mainly depend on the fibers used to produce the fabric. The nonwoven fabrics produced from hydrophobic fibers can absorb less moisture than that of the fabrics produced from hydrophilic fibers.

Thus we get following advantages over woven fabrics considering properties.

- Presently invented nonwoven fabrics are thin they posses high strength than that of woven fabrics.
- Nonwoven fabrics are lighter and softer than woven fabrics.
- Nonwoven fabrics are softer than woven fabrics.
- Nonwoven fabrics offer more air permeability than that of woven fabrics.

1.2.10 Considering Other Factors

Thus we get following advantages over woven fabrics considering other factors Nonwoven fabrics do not ravel; therefore, seams do not need to be surged, making it easy to incorporate shaped hemlines into the garment design. Seams within the garments also do not require finishing. Nonwoven fabrics are easy to cut and offer a wider range of design than woven fabrics. Nonwovens provide more "sewing" options than woven fabrics. (Chaudhari, Mandot, Mili & Karansingh, 2008)

1.3 Various nonwoven fabrics developed for apparel application

There are several base methods available for binding of fiber webs to produce nonwoven fabrics. Apart from the normal manufacturing of Nonwovens, there are various methods to produce nonwovens fabrics with value addition specifically for apparel purpose. (Chaudhari, Mandot, Mili & Karansingh, 2008)

Technological advancements have made substantial strides in the development of nonwoven fabrics. New generations of nonwoven fabrics are more durable, have better drape, are stretchable, and overall have a better hand than past generations of nonwoven fabrics. With these advancements come new product development opportunities.

Evolon and other nonwoven fabrics included the latest technological advances such as incorporating developments in elastic film composites, thermo-active PCM's, master batch additives, thermochromic finishes, electroconductive fabrics, high temperature protective fabrics, metallised and multi-layer spunbond laminates. (Dhange, Webster & Govekar, 2012)

1.3.1 Evolon®

Freudenberg Nonwovens, Germany based leading nonwoven producer, introduced Evolon®, a spunlaced, bi-component nonwoven, made from polyamide and polyester polymers, one of the first high-tech nonwoven to be used as an apparel outer fabric. Evolon offers ultraviolet protection, wind resistance, thermal insulation, washability, breathability and quick-drying. It also posses better mechanical characteristics and will not lose its uniformity or shape, even after heavy use. In addition, it has a soft hand, drape and is lighter-weight.

Evolon provides increased comfort for the wearer through perspiration as it is permeable to water vapor. The very fine microfilaments create thousands of micro-channels to provide breathability, perspiration absorption and wicking away from the body, and quick drying of the fabric (Dhange, Webster & Govekar, 2012). Evolon® is compatible with a wide range of digital printing technologies: Sublimation (transfer, direct), Inject (aqueous, solvent, eco-solvent, UV-cured), and even laser. Evolon® is an eco-friendly alternative to traditional banner material (Evolon®, 2013). Students from North Carolina State University (NCSU) College of Textiles introduced that unique fabric for their fashion apparels. Fig.1.

1.3.2 Colback ®

Colbond, a globally active leading producer of high quality industrial nonwovens supplied their

Colback® fabric in a range of weights. Colbeck® fabrics were given ingrained imperfections using laser cutting, beading and hand embroidery, adding a sense of story kept up to date in an elegant and contemporary way. The use of high frequency sonic energy to bond the seams around the body and armholes gave the apparel the clean, sharp edge required for the style characteristics. This process of seam bonding requires a high synthetic fiber composition so Colback's® unique thermally bonded spunlaid nonwoven, made from bi-component filament with a polyester core and a polyamide skin proved ideal using the re-engineered pattern blocks. Here the 'transparency' of the nonwoven was exploited to create a mood with many facets, from soft dressing and feminine ruffles through to tailored-inspired looks, Fig. 2. (Dhange, Webster & Govekar, 2012)

Figure 1. Nonwoven creativity of NCSU students

Figure 2. Example of sonic bonding, ruffles and layering

1.3.3 Daltex Frame TX®

Garment one is constructed from Daltex Frame TX® Thermo RFL117 nonwoven in silver (Don & Low). As well as its striking appearance the radiated heat of sunlight is reflected maintaining the wearer cool. Owing to the spunbond laminate construction, the fabric has excellent durability and water-shedding properties whilst remaining moisture vapor breathable and the polyolefin composition ensures hydrophobicity and a low pack-weight. In order to ensure that the garment maintains its clean and classic look the fabric itself provides the main design feature, Fig. 3.

Figure 3. The Re-invention of the Trench Coat – A Future in Nonwovens

1.3.4 Comfortemp®

Comfortemp® nonwoven (Freudenberg) providing an excellent thermal comfort and a soft handle. The qualities of this nonwoven played an

essential role in the reinvention process. The performance provided by the thermal comfort enabled the assembly of a garment with properties that cannot readily be achieved using more conventional fabrics. Thanks to the fabrics ability to keep the wearer cool when in warm environments and warm when in cool environments (thermal buffering) the parka has a more progressive look and feel; the fabric acts as the wearer's personal climate control system, Fig. 4. (Backhouse & Webster, 2008)

Figure 4. Shabby/Sleek: One Garment Two Styles

1.3.5 Wool and Wool rich nonwoven fabrics

Canesis Network Ltd was founded in 1961 by the Wool Research Organization of New Zealand (WRONZ). Cansesis's main objective is to promote the wool industry through internal research and providing product development services to the wool and textile industry. The impetus for pursuing research in the field of nonwoven fashion apparel was to dispel the long held perception that wool apparel is expensive and created to appeal to the more mature and affluent customer. The major benefit of nonwoven fabric is that it is comparably cheaper than a woven or a knit. The nonwoven process is about five times faster and up to 30% cheaper than conventional wool fabric production.

For the last three years the nonwoven team at Canesis has concentrated on developing lightweight apparel fabrics with greater stretch and recovery. Researchers have recently designed a special collection of beautiful 100% wool and wool rich nonwoven fabrics. Fabrics with special finishes in classic coloration were used to produce a collection of very hip, yet elegant garments, Fig. 5. Some fabrics undergo additional processes to create a three dimensional patterning effect. (Anderson, 2005).

Figure 5. Examples of garments constructed out of nonwoven wool and rich wool fabrics by Canesis Network Ltd

1.3.6 Fabrican: Spray-on fabric

Manel Torres, while studying for his MA and Ph.D. during 1995 – 2001, introduced the idea of Spray-on Fabric, a novel way of producing instant garment without any seams directly from of fibers. The spray-on dress is made up of short fibers that are combined with polymers to bind the fibers together, and a solvent that yields the fabric in liquid form and evaporates when the spray reaches a surface. The spray is applied using a high pressure spray gun or an aerosol can straight onto a body or dress form. The fabric can be natural, such as cotton, silk, wool, or linen, or synthetic like polyester, nylon, or acrylic fibers. The clothing can also be produced by spraying recycled fibers, for example, a pair of jeans that are not being worn any longer could be milled into fibers and sprayed in a new design. The

spray on fabric can also be perfumed. It can be in any colors like black, white, red, blue, gold, platinum, bright fluorescent colors, etc. The material may be washed, re-used, re-styled and re-worn. Its properties can be customized to meet the needs of each user. Dr. Torres, founder and managing director of Fabrican Ltd., spent about ten years working on his invention, to create cheap & personalized dresses. He has also unveiled a collection of haute couture made entirely out of spray-on fabric showcased at the 'science in style' fashion show in 2010, Fig. 6. (Dhange, Webster & Govekar, 2012)

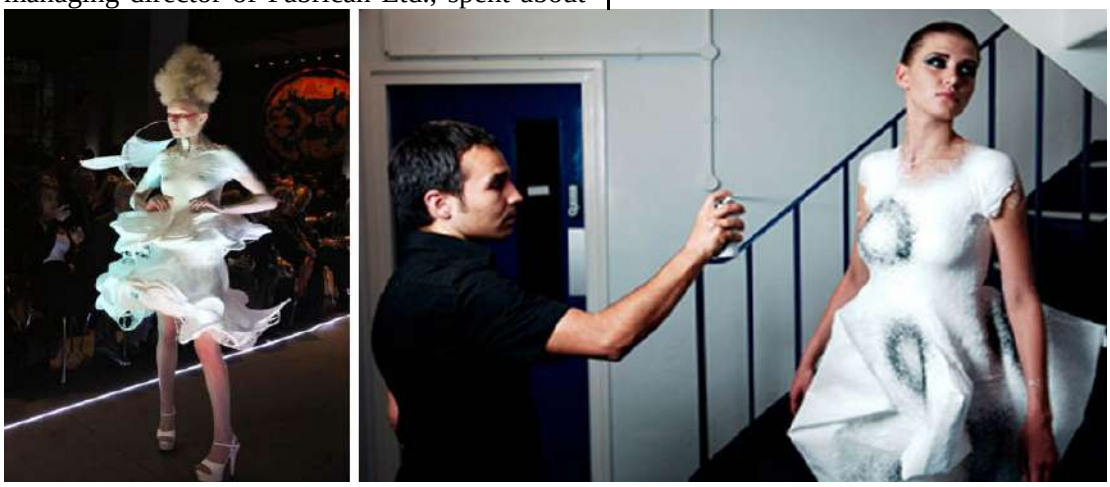


Figure 6. Spray- on dress

1.4 The essential properties of advanced nonwoven fabrics.

This research aimed to achieve three essential properties of nonwoven fabrics which are aesthetics, durability and saving cost.

1.4.1 Aesthetics

The shift from function to aesthetics is a result of recent advances in fabric engineering which have produced truly engineered materials with technical performance properties. With characteristics varying from better drape, durability, stretch and recovery, improved fit, high or low thermal protection, to color-change materials, impact, cut or slashes resistance, water resistance or absorbency - nonwoven fabrics open creative and aesthetic possibilities for non-functional fashion design. (Backhouse & Webster, 2008)

Nonwoven fabrics did not have warp or weft and therefore no grain line, which enabled pattern pieces to be cut more efficiently utilizing less meterage, over locking of seams was not required as fabric did not fray, interlining was not required for collars, seams which normally receive over locking could be left raw and front bodices which by tradition require facings could be produced without. Seams within the garments do not require finishing. Ultrasonic and thermal joining techniques allowed stitching to be replaced and localized thermo-forming offered a mean of improving fit and simplifying garment assembly. (Dhange, Webster & Govekar, 2012)

1.4.2 Durability

Nonwoven fabric provides 10-12% more breaking strength than that of woven fabrics. The tearing strength of presently invented nonwoven fabrics is approximately double the tearing strength of woven fabrics. The strength of a nonwoven fabric is more closely related to the strength of the applied binder (Chaudhari, Mandot, Mili & Karansingh, 2008). The resistance to abrasion of nonwovens is affected by many factors that include the inherent mechanical properties of the fibers; the dimensions of the fibers; the blends of fibers, the construction of the fabrics; the type, kind, and amount of treatment added to the fibers, or fabric; the nature of the abradant; the variable action of the abradant over the specimen area abraded; the tension on the specimen; the pressure between the specimen and the abradant; and the dimensional changes in the specimen (Sahbaee, 2008). By using the breaking strength, tearing strength, fabric strength and abrasion resistance fabric durability is decided (Chaudhari, Mandot, Mili & Karansingh, 2008). Freudenberg's Evolon® is the first and most revolutionary departure from single-use nonwovens. A segmented pie spunbonded filament is split and entangled in one step by hydroentangling to form a micro-denier high-performance durable, launderable fabric. (Pourdeyhim, 2010)

1.4.3 Saving cost

The production of nonwoven fabrics from staple fibers is known to be more efficient than

traditional textile processes as the fabrics are produced directly from the carding process. The number of machines used in woven fabric manufacturing is comparatively higher than that of nonwoven fabrics. Thus the major benefit of a nonwoven fabric is that it is comparatively cheaper than a woven and/or knitting. Also due to the elimination of several machines of spinning and preparatory department nonwoven fabrics provide certain advantages over woven fabrics viz.

- The nonwoven process is about five times faster and up to 30% cheaper than conventional woven fabric production.
- Whole process of nonwoven fabrics can be set as single line under one roof.
- Initial investment is comparatively low.
- Land & labor requirement is comparatively low. (Chaudhari, Mandot, Mili & Karansingh, 2008)

1.5 Technical requirements for designing and producing nonwoven garments

There are some points should be considered in designing and producing nonwoven garments as follows:

- Nonwoven fabric properties can be used in producing patterns that could be cut to give a structured, sculpture, fullness shape and silhouette. They enabled the designer to demonstrate unusual shapes and silhouettes.
- Nonwoven fabrics can be molded into three-dimensional shapes under the influence of heat and pressure, giving endless opportunities, adding volume and structure like permanent pleating. (Backhouse& Webster,2008)
- Pattern maker should add both minimum and design ease to the body measurements at shoulder line, neck line, armhole, bust line, waist line…..etc. (Mcledon, 2011)
- Reduced seam allowances and hem finishes were required during the pattern drafting process. This gave creative freedom to choose detailed neck edgings and to experiment with cuffs without encountering technical difficulties.
- By scaling the patterns to more extreme proportions, we produced contemporary pieces, complemented by the chosen nonwoven fabrics in which they had been produced. (Backhouse& Webster,2008)
- For cutting nowoven pattern and trimmings:
- Laser cutter.
- Tailor scissors.
- For sewing nonwoven garments:
- Ultra sonic bonding machine.
- Block stitch machine (single needle stitches):
  - Special seams: welt, lapped, mock flat-fell, topstitched, plain seam.
  - Machine needle size: 11/75, 14/90, 16/100.
  - Machine needle type: Wedge Points or Leather needles.
  - Thread: cotton- wrapped polyester, long-fiber polyester.
  - Number of stitches per inch: 9 to 11. (Sewing Machine Needle Charts)
- Nonwovens do not fray; no need for conventional seams, over locking or hemming.

2. Materials and methods

Under the direction of researchers, undergraduate students in apparel department - Faculty of applied arts- Helwan University designed a variety of stylish blouses, constructed with nonwoven fabrics in the department workshop.

2.1 Material

Fabrics were nonwoven with fairly good drape. Tailor scissors and industrial sewing machines (plain seam, wedge point needle, polyester thread) were used.

2.1 Method

After the researchers explained the properties and technical requirements of nonwoven garments for students (18 students), students started drawing fashion sketches for women's blouses according to nonwoven properties and the department workshop's available equipments. Then, students prepared patterns for blouses' designs and began the production process. They use Embroidery, appliqué, and patchwork with traditional methods to add aesthetic look to designs.

For evaluation of the designs, researchers designed and constructed a questionnaire through certain steps:

1. Decide the goals and information required.
2. Define the target respondents.
3. Choose the method(s) of reaching the target respondents.
4. Decide on item content.
5. Develop the item wording.
6. Put items into a meaningful order and format.
7. Check the length of the questionnaire.
8. Pre-test the questionnaire.
9. Develop the final survey form.

The questionnaire includes 10 Items as follows:

1- The design is suitable for being a product which can be produced and marketed.
2- The design complies with the properties of nonwoven fabrics.
3- Implementation techniques achieved advanced levels in the field of designing and implementation.
4- Pattern sizes commensurate with the motor performance properties of non-woven fabrics.
5- The nonwoven fabrics properties are compatible with techniques used in the implementation.
6- The design achieves comfort to the wearer.
7- The color of materials used in embroidery, appliqué, and patchwork are compatible with the design colors.
8- Unity is achieved between the design elements (line- shape- color- material, decoration ...etc).
9- Decorative design enriches the essential design.
10- The general shape of the design.

Each item was assessed on a 5-degree (5= strongly agree, 1= strongly disagree).

The researchers chose twelve finished blouses and asked ten professors and assistant professors in the field of fashion design and garment production technology to evaluate them through a questionnaire, each participant viewed the twelve blouses and was instructed to read the items in the questionnaire and put a degree for each items through a personal interview.

3. Results and discussion

The use of conventionally woven cloth and, more recently, weft- or warp-knitted fabrics has dominated garment production for the past century and before. Meanwhile, at least in the latter half of the twentieth century, nonwoven forms of fabric increasingly dominated various industrial, domestic, medical, automotive and hygiene end uses. Technological developments over the past few decades have extended nonwoven fabric end uses further and, in the first decade of the twentieth century, nonwovens seem to be on the threshold of offering a genuine challenge in garment (and fashion) end uses.

There are high-tech nonwoven fabrics that can function perfectly well as clothing; they are durable, dimensionally stable, launderable, flexible, soft and comfortable, similar to conventional woven fabrics. Nonwoven fabrics could offer a number of advantages over traditional fashion fabrics; reducing assembling cost and allowing recycling at the end of life, thereby reducing the overall life-cycle impact of clothing with obvious cost saving. Nonwoven industry focus on improving the creative and aesthetic possibilities of nonwovens, these fabrics could soon be finding a place of pride in the fashion market. In order to ensure that this anticipated market development is realized, it is crucial that relevant producing and supplying companies participate and encourage the engagement of staff and students involved in fashion design education.

The following is an overview of twelve creative blouses and their technical drawings:

Design 1

Design 1: The blouse was embraced some of the original design aspects, it has been re-engineered, adding new elements (decorative beads) in order to create an innovative and original garment. Patterning with curved lines gave the blouse a soft, pretty, feminine look. Nonwoven materials provide an exciting balance between aesthetic appeal, and physical properties, a balance which is difficult to reach with existing woven and knitted fabrics.

Design 2

Design 2: The blouse represent simplicity in its purest form, showing that even the most basic of construction methods can produce quite unique, wearable garments**.** The simplicity of it perfectly

expresses the major benefits of using nonwovens; no need for conventional seams, overlocking or hemming, meaning that garments can be produced easier and quicker. Using colored threads in a free design, satin stitches in triangular shapes and metallic accessories added aesthetic values to the design.

Design 3

Design 3: As the nonwoven fabric had a relatively high tensile modulus, the blouse pattern could be cut to give a structured shape. Using appliqués in rectangular shapes with raw endings, which embroidered with cross stitches and beads improved the aesthetic appearance of the blouse, in addition of using a trimming tape at the hip line. The benefits of nonwovens were highlighted in the visual appeal of the garments, ease and speed of construction, as well as the technical performance offered by the fabrics.

Design 4

Design 4: This is an attempt to revamp one of subcultures most well known and loved outerwear garments; the blouse, using innovative nonwovens which contribute not only aesthetic value but physical properties as well. Using free embroidery stitches in circular lines around the neck line and beads in slanted lines added an aesthetic look to the design. Working and experimenting with nonwoven fabrics was a very positive experience. They are easy to handle and gave us the opportunity to explore a completely different way of being creative.

Design 5

Design 5: The design and construction of the vest, composed entirely of nonwoven fabrics, provided the opportunity to explore new techniques and implement new finishes. Aesthetic values achieved by using trimming tape in the out line of the pattern and appliqué which decorated with running stitches and beads.

Design 6

Design 6: Due to the non-fray properties of the fabrics, reduced seam allowances and hem finishes were required during the pattern drafting process. This gave creative freedom to choose detailed neck edgings and to experiment with hem without encountering technical difficulties. Using appliqués with raw edges which were attached to the blouse with embroidery stitches and using embroidery threads in a free design added aesthetic values to the design.

Design 7

Design 7: The outcome is re-engineered, timeless garments that are suitable for wear, made using nonwovens which bring new and exciting properties to fashion design. The blouse is decorated by using trimming tape and beads in slated lines under the bust line and repeated it in zigzag lines around the neck line and at the sleeves' hem.

Design 8

Design 8: The blouse focuses on modern femininity look. Womanliness is further reflected in the color choices of the nonwoven fabrics and in the design pattern. The stiffness of the nonwoven fabric enabled shapes to fit together to achieve a strong silhouette. Other beneficial properties include high tear strength, which was vital in allowing the effective joining of the shapes of the top and belt together using metal rings. The aesthetic touch was achieved by using the contrast between the printed rectangles and colored ones. This idea is repeated in the belt and halter neckline.

Design 9

Design 9: This research enabled students to develop an exciting interaction between the modern and futuristic features of nonwovens contrasting with the 'classic' appearance of the design. Embroidery stitches (cross and running stitches) are used to improve the aesthetic appearance of the design.

Design 10

Design 10: Nonwovens, by their very nature, do not fray; this essential property has allowed the incorporation of elaborate laser cut designs within the blouse as well as the benefits offered by the sonic bonding process. nonwoven fabric has enabled a garment to be produced that is modern, striking and completely wearable. Using the shape of flowers in a sculptural form adds a sexy feel to the girlish theme to create a modern mixture of innocence and sexuality.

Design 11

Design 11: The fact that the nonwoven fabric was resistant to fraying provides a distinct advantage over many woven fabrics traditionally used in fashion garments. This gave creative freedom to choose detailed hem edgings without encountering technical difficulties. The contrast between the vertical and horizontal lines results from the running stitches with velvet tape adds aesthetic look to the design.

Design 12

Design 12: The incorporation of a nonwoven fabric enabled the hem to be left raw as the fabric resisted fraying, thus giving the garment an irregular and deconstructed feel. The fabric is durable and has a soft handle which is comfortable against the skin; it is available in different basis weights and has good draping properties. The zip and the bust dart in vertical seams give the bodice support in the way that boning gives aid to corsets. Using an open-ended zip means that the blouse can also be worn as outerwear.

Referee Comparison

Table (1) the average results of a questionnaire for evaluating designs

Referee	Designs' numbers											
	D 1	D 2	D 3	D 4	D 5	D 6	D 7	D 8	D 9	D 10	D 11	D 12
Ref 1	48	39	40	46	16	28	28	50	34	48	35	39
Ref 2	47	33	43	46	20	20	29	50	29	47	41	40
Ref 3	47	35	43	43	16	22	27	50	29	46	42	39
Ref 4	48	35	44	44	18	24	30	48	30	49	38	39
Ref 5	50	37	45	45	19	18	29	49	30	50	38	40
Ref 6	48	35	43	45	17	20	33	50	34	48	39	39
Ref 7	48	35	45	44	20	17	29	49	35	47	41	41
Ref 8	48	37	45	44	24	19	26	50	36	46	37	37
Ref 9	46	34	46	46	20	19	30	49	33	48	41	39
Ref 10	46	35	47	46	21	21	31	47	28	48	42	39
average	47.6	35.5	44.1	44.9	19.1	20.8	29.2	49.2	31.8	47.7	39.4	39.2

It is evident from Table (1) that the eighth design came first with an average of 49.2, followed by the tenth design in the second with an average 47.7, then the first design came third with an average 47.6, the fourth design came in the fourth position with an average 44.9, the third design came in the fifth position with an average 44.1, the eleventh design in the sixth position with an average 39.4, then the twelfth design came in the seventh position with an average 39.2, the second design came in the eighth position with an average 35.5, the ninth design came in the ninth position with an average 31.8, the seventh design came in the tenth position with an average 29.2, then the sixth design came in the eleventh position with an average 20.8, finally the fifth design came in the last position with an average 19.1.

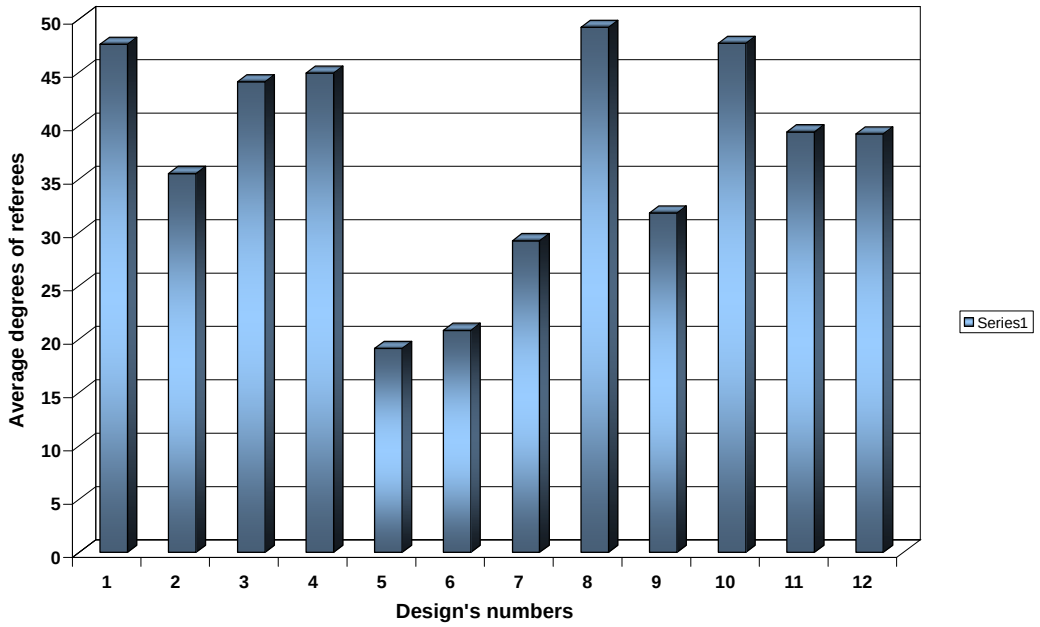


Figure (7) the average degrees of the referees for each design

Table (2) significant differences between the Designs produced

Designs produced	Mean "m"	Standard Deviation "SD"	Number of Sample "n"	Confidence Level (95.0%)
D1	47.6	1.173	10	0.839
D2	35.5	1.715	10	1.227
D3	44.1	1.969	10	1.408
D4	44.9	1.101	10	0.787
D5	19.1	2.469	10	1.766
D6	20.8	3.224	10	2.306
D7	29.2	1.988	10	1.422
D8	49.2	1.032	10	0.738
D9	31.8	2.898	10	2.073
D10	47.7	1.251	10	0.895
D11	39.4	2.366	10	1.692
D12	39.2	1.032	10	0.738

Table (2) shows the average degrees of the referees for each design (Mean), the standard deviation (SD) between the average degrees of the referees, which ranged from 1.032% as the lowest value and 3.224% as the highest value, and the confidence level (95.0%) which shows that the moral calculated is greater than 0.05 and this indicates that there is no significant difference between the results of the referees for each design, which indicates that the representation and judgment on these results correctly according to the statistical analysis.

4. Discussion

To get idea about designs that best or worth indications we review the next:

Design (8): focuses on modern femininity look. Womanliness is further reflected in the color choices of the nonwoven fabrics and in the design pattern. The stiffness of the nonwoven fabric enabled shapes to fit together to achieve a strong silhouette. Other beneficial properties include high tear strength, which was vital in allowing the effective joining of the shapes of the top and belt together using metal rings. The aesthetic touch was achieved by using the contrast between the printed rectangles and colored ones. This idea is repeated in the belt and halter neckline.

Design (10): Nonwovens, by their very nature, do not fray; this essential property has allowed the incorporation of elaborate laser cut designs within the blouse as well as the benefits offered by the sonic bonding process. Nonwoven fabric has enabled a garment to be produced that is modern, striking and completely wearable. Using the shape of flowers in a sculptural form adds a sexy feel to the girlish theme to create a modern mixture of innocence and sexuality.

Design (1): The blouse was embraced some of the original design aspects, it has been re-engineered, adding new elements (decorative beads) in order to create an innovative and original garment. Patterning with curved lines gave the blouse a soft, pretty, feminine look. Nonwoven materials provide an exciting balance between aesthetic appeal, and physical properties, a balance which is difficult to reach with existing woven and knitted fabrics.

From the above it is clear the cause of achieving the higher scoured in evaluating, specially in the possibility of the production and marketing the design, Implementation techniques achieved advanced levels in the field of designing and implementation, The nonwoven fabrics properties are compatible with techniques used in the implementation, Decorative design enriches the essential design, and The general shape of the design.

Design (5): The design and construction of the vest, composed entirely of nonwoven fabrics, provided the opportunity to explore new techniques and implement new finishes. Aesthetic values achieved by using trimming tape in the out line of the pattern and appliqué which decorated with running stitches and beads**.**

Design (6): Due to the non-fray properties of the fabrics, reduced seam allowances and hem finishes were required during the pattern drafting process. This gave creative freedom to choose

detailed neck edgings and to experiment with hem without encountering technical difficulties. Using appliqués with raw edges which were attached to the blouse with embroidery stitches and using embroidery threads in a free design added aesthetic values to the design.

The reduced can be clearly seen in evaluation values in designs (5,6) from questionnaires opinion may be due to the designs didn't compile with the properties of nonwoven fabrics. Implementation techniques didn't achieve advanced levels in the field of designing and implementation, the color of materials used in embroidery, appliqué, and patchwork didn't compatible with the design colors, and decorative design didn't enrich the essential design.

There are researches based on using nonwoven fabrics in fashion apparel as follows:

Research (1): An innovative collection of garments constructed from nonwoven fabrics researched, designed and produced by Fashion students and Staff in the School of Design, University of Leeds, UK. This collection exhibited for the first time at INDEX 08 is based on high performance durable and single-use nonwoven fabrics supplied by the nonwovens industry and incorporates developments in elastic film composites, thermo-active PCM's, masterbatch additives, thermochromic finishes, electroconductive fabrics, high temperature protective fabrics, metallised and multi-layer spunbond laminates. (Backhouse & Webster, 2008)

|Research (2): During spring 2005 North Carolina State University (NCSU) College of Textiles demonstrated that nonwoven fabrics can produce aesthetics that are as good as traditional textiles. Under the guidance of Dr. Istook, students designed a variety of fashion outfits and accessories, constructed with at least 95% nonwoven fabric. Automatic cutters and industrial sewing machines were used for this work. The drape of the garments was found to be fairly good and improved after finishing. (Dhange, Webester, & Govekar, 2012)

The present research differ from the bravious researches because it based on using the traditional sewing tools (tailor scissor and industrial sewing machine) in producing the designs by applying technical requirenents of nonwoven fabrics. Traditional decoration (handmade embroidery, applique, patchwork) are used to add aesthetic values to the designs. According to the properties of nonwoven fabrics; no need for conventional seams, over locking or hemming. The finished designs cost are low because students based on traditional techniques in the production process and some finishing stages are canceled like hemming and overlocking.

5. Conclusions

- Nonwoven fabric can be used in designing and producing the women's blouse at low costs.
- Traditional techniques can be used in designing and producing the women's blouse by using the nonwoven fabrics.
- According to the evaluation of designs, most designs achieved the success.
- According to the evaluation of designs, the best designs that have been produced using nonwoven fabrics were designs no. (8, 10 and 1). They took the higher scoured in evaluating, specialy in the possibility of the production and marketing the design, Implementation techniques achieved advanced levels in the field of designing and implementation, The nonwoven fabrics properties are compatible with techniques used in the implementation, Decorative design enriches the essential design, and The general shape of the design.

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