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A STUDY OF THE SERVICEABILITY OF SELECTED DRESS FABRICS UTILIZING THE NEWER SYNTHETIC FIBER BLENDS

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5003

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CHAPTER I

INTRODUCTION

Within the past few years a number of new synthetic fibers have been developed and are rapidly finding their way into use for clothing fabrics. Fiber names such as nylon, Orlon, Dacron, Dynel, Acrilan, Vicara and Vinyon are new words to the consumer. The new fibers present new problems to the manufacturer, the merchant, the consumer and the dry cleaner.

The use of new fibers makes it possible to have a greater variety of fabrics than ever before. New fabrics with varied characteristics result from combining natural and man-made fibers by different methods and in varying amounts. When combined with each other or with the natural fibers and rayons, it is possible to make fabrics of unusual appearance with property changes that make them more satisfactory in consumer use.

I. THE PROBLEM

Statement of the problem. The purpose of this study was: (1) to compare the construction of selected fabrics of synthetic blends, (2) to test the performance of these fabrics under controlled conditions of laundering and dry cleaning, (3) to study their adaptability to basic techniques of construction used in home sewing.

Importance of the study. The manufacturer is making outstanding claims for the unusual properties of the fabrics made from man-made fibers. Advertising of all kinds is attempting to arouse public interest in the new fibers and in fiber mixtures. Many newspapers and magazines are publishing articles describing the unusual properties to be found in fabrics made of these "wonder" or "miracle" fibers.

Several of the man-made fibers are advertised as having properties similar to wool, plus additional strength and abrasion resistance. Some fibers are said to be similar to silk but excel in durability. All the new fibers are recommended as being washable and quick drying. It is claimed that greater dimensional stability is obtained by use of synthetic fibers.

The fibers are combined during the manufacturing process in such a way as to utilize the most desirable characteristics. In this manner the specific qualities desired in a fabric for a particular end use can be controlled to a large extent. The synthetic fibers in blends with natural fibers are said to counteract the weaknesses of the natural fibers.

The quantity of promotional material presenting unbelievable features has raised many questions in the minds of consumers. They wonder whether it is possible for such novelty fabrics to resist soiling, resist moisture, resist creasing, retain pleats, be washable, show shrinkage stability and give strength properties which will increase their serviceability.

The consumer who sews for herself and her family faces problems that are not answered by the promotional material. Are the new fabrics being sold in local stores? What types of thread should be used in making the garments? What seam finishes are most satisfactory for use in garments made from these fabrics? How do the fabrics respond to pleating and gathering? Is unnecessary fullness easily eliminated? What pressing techniques are most satisfactory? What other problems might be noticed in making the garment?

The consumer is interested also in the wearability of the fabrics. Even though fabrics of nylon, the best known of the newer fibers, are liked for the permanent crispness, quick drying properties and the ease in caring for garments made from them, many people find that they are hot and uncomfortable, especially when worn in warm weather. What can be expected of these newer fabrics? Do the potentialities of the properties which make them miracle fibers offset any lack of comfort? Can they be laundered or dry cleaned and restored to their original appearance as well as the promotional claims would lead one to believe?

As production of man-made fibers increases in volume during the coming years, unbiased research is needed to acquaint the consumer with the true character and serviceability of the fabrics as they become available.

II. LIMITATIONS

According to the reports of the manufacturers, new fibers are going into fabrics for all types of end use. Since the qualities desired in a fabric are determined by the intended end use, the present study was limited to dress and light weight suit fabrics. The fabrics have been further limited to blends or combinations found on yard goods counters of retail stores. Since all the newer fibers could not be included, the study was limited to blends of nylon, Orlon, Dacron and Acrilan. Since the study was made in spring and summer, the fabrics and garment designs were limited to those suitable for wear in spring and summer of 1953.

The fabrics available were a limiting factor. In spite of voluminous promotional material, the amount of yard goods available was by no means extensive. In attempting to determine the reason for this limitation, it was found that only 3 per cent of the total textile production of 1952 was devoted to fabrics of newer synthetics.[1] The greater portion of these fabrics was allocated to the garment manufacturer rather than to the retail store.

The construction techniques used for wear testing were limited to those thought by the author to be the most common problems of the home sewer. Although the wear period was limited to spring and summer of 1953 for this study, recommendations have been made for the wear study to be continued as long as the garments are wearable.

III. ORGANIZATION OF THE STUDY

Chapter II presents a review of literature dealing with development, manufacture and use of new synthetic fibers. Chapter III presents the methods used in securing the test fabrics, procedures for laboratory anyalyses, serviceability tests of fabrics and the laboratory laundering and dry cleaning formulas. The methods used in selecting garment styles, constructing the garments and plans for the wear study are given. Data from the laboratory tests and wear tests are presented and discussed in Chapter IV. A summary of the findings, conclusions, and recommendations for further study are included in Chapter V. All record and report forms related to the wear study are included in the appendix.

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1 "Design Fabrics for End Uses AATT Symposium Advocates," American Textile Reporter, 117:15. February 12, 1953.

CHAPTER II

REVIEW OF LITERATURE

I. DEVELOPMENT OF SYNTHETIC FIBERS

Count Hilaire de Chardonnet proposed the first synthetic fibers of commercial value in 1884 from pulp of mulberry leaves.[1] Profits were realized and his process has been developed and modified since that time.

The first man-made fiber was called "artificial silk" until 1924 when it became known as Rayon.[2] Rayon is produced from cellulose or its derivative, made soluble by chemical modification, extruded through the fine holes of a spinnerette, and coagulated.[3]

Rayon, in its varied forms, has become an accepted and popular fiber throughout its years of use. The fabrics on the market vary in chemical composition and physical properties.[4] Their characteristics as fabrics for clothing are now understood by most consumers.

The successful development of the rayons has provided the incentive for the development of other man-made fibers.

During the last decade several fibers of fully synthetic origin have been developed. These fibers are all obtained by chemical synthesis

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1 Katharine P. Hess, Textile Fibers and Their Use. New York: J. B. Lippincott Company, 1948. P. 348.

2 L. E. Parsons and John K. Stearns, Textile Fibers, International Textbook Company, 1951, Part III, p. 4.

3 Hess, op. cit., pp. 349-351.

4 Ibid., p. 351.

and controlled polymerization.[5] The newer synthetics, therefore, are different in origin from fibers such as rayon, which is developed from a natural polymer, cellulose.[6]

Four of the most popular types of the fully synthetic fibers for clothing on the market at the present time are nylon, Orlon, Dacron and Acrilan.

Nylon

In 1928 the first and most publicized type of fully synthetic fiber was produced. Nylon, a generic name, was coined by the E. I. du Pont de Nemours and Company.[7]

It was not until 1937 that nylon was put on the market for practical use as clothing fabrics.[8]

> Manufacture of Nylon. "Nylon is a thermoplastic polymer which may be made to have quite a wide variation in physical properties, depending on the conditions under which it is produced. . . . It has been found that nylon can be made from mixtures of about 15 different diamines and 15 different acids."[9]

Nylon is produced from two chemicals called hexamethylene diamine and adipic acid. The two chemicals are combined to form a nylon salt. The salt is dissolved in water and this solution forced through spinerettes forming filaments.[10]

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5 Henry C. Speel, Textile Chemicals and Auxilaries, Reinhold Publishing Corporation, New York, 1952, p. 18.

6 Loc. cit.

7 Bruce E. Hartsuch, Introduction to Textile Chemistry, John Wiley and Sons, Inc., New York, 1950, p. 308.

8 Ibid., p. 310.

9 Loc. cit.

10 Ibid., pp. 310-320.

The nylon filaments are twisted into filament yarns or cut into short lengths and twisted into spun yarns.

Physical and Chemical Properties. The physical properties depend on the amount and kind of treatment given the fiber during the orientation period. The size of fiber, strength, weight, elasticity and luster can be controlled with scientific precision.[11]

Nylon produces many desirable qualities which have made it acceptable for clothing fabrics.

Some of the outstanding characteristics of the nylon fiber for producing fabrics are: (1) low density, (2) high strength and elasticity, (3) resistance to abrasion, (4) uniformity in shrinkage, (5) low absorption of moisture resulting in quick drying, (6) melting point above normal ironing temperature, (7) nonflammable, (8) no loss of strength when wet, (9) resists oxidizing agents well, (10) not attacked by moths or fungi, (11) good heat resistance, (12) can be permanently set, (13) can be dyed permanently, (14) causes no skin irritations.[12]

Although nylon is the oldest of the fully synthetic fibers there are still undesirable characteristics which the producer and the consumer desire to remove. Chornyei[13] states that acetate dyes are still the best dyes for nylon. The acetate colors are quite permanent in fastness to light but are lacking in fastness to washing and perspiration. Acid colors

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11 Ibid., pp. 316-320.

12 Ibid., pp. 321-331.

13 Ernest J. Chornyei, "Present Day Synthetic Fibers and Blends," American Dyestuff Reporter, 41:662, October 13, 1952.

and acid baths have been used to give better permanency to the colors in washing and perspiration.

Another problem which affects both the producer and consumer is static electricity. The problem has not been solved although antistatic products have been introduced.[14]

Use with Other Fibers. Following the nylon continuous filament yarn, the nylon staple was produced for use in spun structure. The same properties listed above apply to the staple form fibers. Staple nylon is being used in blends with the natural fibers or other synthetic fibers. The outstanding characteristics of the nylon fibers are being used as a blending component to complement certain properties of the other fibers.[15]

Mills are producing and cutters buying fabrics in blends of nylon-cotton, nylon-Orlon, nylon-rayon, nylon-acetate, nylon-silk and nylon-Dacron.[16]

Hess states that 10 to 20 per cent of nylon blended with other fibers adds strength far out of proportion to the amount of nylon used.[17]

Beryl Schutte[18] found that a blend of 85 per cent wool and 15 per cent nylon had poor dimensional stability to dry cleaning, wet cleaning

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14 J. H. Dillon, "The Textile Rainbow," American Dyestuff Reporter, 41:68, February 4, 1952.

15 J. B. Quig, "Why Five Fibers," Textile Forum, 9:34, October, 1952.

16 Jerone Campbell, "Where Are We Going With Blends," Modern Textiles, 33:31, November, 1952.

17 Hess, op. cit., p. 384.

18 Beryl Schutte, "A Survey of Availability of Fabric Mixtures for Suits and Coats with Laboratory Testing of a Selected Group." Unpublished thesis, Ohio State University, pp. 73-75, 1952.

and laundering. The laundered fabric showed 11.1 per cent shrinkage in warp and 5.5 per cent in filling after ten treatments. The tenth wet cleaning showed 6.9 per cent shrinkage in warp as compared with 5.5 per cent shrinkage after ten dry cleanings. Shrinkage in filling showed less than 1.1 per cent in all cases.

The study showed a high crease recovery in both warp and filling directions. It also showed good colorfastness to crocking, gas fumes, perspiration, and to dry and wet cleaning. There was considerable fading to light as shown in the Fade-Ometer.

Schutte felt that the amount of nylon was too low to stabilize the fabric.

Orlon

In 1948 Du Pont[19] produced a new fiber technically called an acrylic resin. This acrylic fiber is sold under the trade name of Orlon. Research on Orlon began in the early 1940's with the desire of using polyacrylonitrile as a fiber and film forming polymer.[20] The experimental stage has passed into development and Orlon is found in many textile fabrics and textile products.

> Manufacture. "The acrylonitrile polymers are made from monomeric acrylonitrile, a fairly volatile liquid, derived in part from ethylene, from natural gases and petroleum. Ethylene oxide and hydrocyanic acid are reacted to form acrylonitrile. In the presence of a catalyst, ethylene cyanohydrine is formed. This is broken down to acrylonitrile and water. Orlon is produced by polymerizing acrylonitrile, and extruding it throu a spinnerette."[21]

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19 Parsons and Starnes, op. cit., Part III, p. 63.

20 Leonard Moour and Harry Wechsler, "Modern Textiles Handbook - Part 5, Acrylics," Modern Textiles, 34:44. February, 1953.

21 Loc. cit.

Orlon acrylic staple is known as type 41 and is cut in lengths ranging from 1½ inches to 4½ inches. The continuous filament is known as type 81 and is produced in deniers ranging from 75 to 400.[22]

Physical and Chemical Properties. Orlon has many properties which make it desirable for clothing uses. The continuous filament is more like silk than any other manufactured textile filament. It has a warm, dry, luxurious feel and the dimensional stability of silk even at high humidity. Due to its high thermal insulating characteristics, bulking property, and recovery from wrinkles it is much like wool. It has almost perfect resistance to the damaging effect of sunlight and to mold, mildew, and insects. It has low shrinkage and high tensile strength, even when wet. Orlon has good abrasion quality, low moisture absorbency and fair degree of resistance to alkalies as well as low density and good elasticity. Orlon is easily washed and is outstanding for its wrinkle resistant quality.[23]

Dyeing of Orlon 41 and Orlon 81 has been successful under controlled conditions.[24]

One undesirable characteristic is its static quality when used as the only fiber in the fabric.

Use with Other Fibers. Orlon staple is being used in blends with other fibers. The wrinkle resistance property of Orlon is outstanding in blends with cotton, wool, silk and rayon. Spun Orlon has been combined with other spun fibers to produce warm and bulky fabrics without excess weight. Orlon improves fabric durability resulting from increased strength

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22 *Ibid.*, pp. 44, 48.

23 Hartsuch, *op. cit.*, pp. 353-359.

24 E. Szlosberg, "Dyeing Orlon," *American Dyestuff Reporter*, 41:516, August 18, 1952.

and abrasion resistance when blended with rayon. Added stylability results from the addition of Orlon to other fibers because three color effects are obtained in a single dyeing. Orlon staple has made possible garments that are warm, though light in weight, durable, launderable and easily ironed.[25]

Lyle found that blends of Orlon and wool have established themselves in pleated skirts that retain their pleats through washing and dry cleaning, although tests showed that touch-up ironing was necessary.[26]

Dacron

"Terylene" was developed by British research and is an outgrowth of earlier research work, by W. H. Carothers in the United States, which had led to the development of nylon by Du Pont.[27]

In 1946 the Du Pont Company purchased the patents for the fiber under the trade name of Dacron.[28] Full production of Dacron is expected in 1953.

Manufacture. Dacron is made in manner similar to that used in the manufacture of nylon. It is based on the condensation product of terephthalic acid and ethylene glycol, which is subsequently polymerized. The polymer is spun from the melt and the filaments stretched several times their original length, depending on the end use.[29]

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25 J. R. Bonner, "Part II - Mixed Fiber Symposium," American Dyestuff Reporter, 41:263-264, April 28, 1952.

26 Dorothy S. Lyle, "How Permanent Are Permanent Pleats." National Institute of Cleaning and Dyeing Bulletin, C-17, October, 1952.

27 Leonard Mauer and Harry Wechsler, "Modern Textiles Handbook, Part 6, Dacron," Modern Textiles, 34:82, March, 1953.

28 Loc. cit.

29 Loc. cit.

Dacron is made into continuous filament and staple lengths, each having different percentages of elongation and varying tenacities.[30]

Physical and Chemical Properties. Dacron is becoming popular as a fiber for clothing fabric and as a blend with other fibers in fabrics for clothing.

Dacron is desirable for its (1) low moisture absorption, (2) good heat resistance, (3) good sunlight resistance, (4) excellent electrical properties, (5) ease of washing and cleaning, (6) excellent shape retention property, (7) colorfastness, (8) high stretch resistance, (9) resistance to degradation by bleaches, (10) general resistance to chemicals.[31]

Use with Other Fibers. Dacron staples are similar to wool in appearance and feel and can be blended with wool and all other natural fibers.[32] The excellent wrinkle recovery property adds to the weak points of the natural fibers.

The addition of wool or other natural **fibers** gives greater resistance to static and greater moisture absorption. Blends of wool and Dacron, for their weight, give outstanding performance to the consumer in resiliency, shape retention and freedom from puckering under any climatic conditions.[33]

Blending of Dacron has been found to be the best way to utilize and minimize its shortcomings.[34]

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30 Loc. cit.

31 Ibid., pp. 82-83.

32 Speel, op. cit., p. 19

33 J. R. Bonner, "Part I - Mixed Fibers Symposium," American Dyestuff Reporter, 41:246, April 14, 1952.

34 G.M.Gantz, "Fibers, Fabrics and Finishes of the Future," American Dyestuff Reporter, 41:452, July 21, 1952.

"Factors which determine the amount of Dacron polyester fiber that should be used in a blend with wool are such fabric properties as degree of wet, as well as dry wrinkle resistance, dimensional stability in wearing and cleaning, durability, hand of fabric, etc. In general, one may say that, for winter-weight fabric, blends of 30 to 65 per cent Dacron represent an excellent operating range. For summer-weight fabric, blends containing 55 per cent and more of Dacron should be used to obtain the optimum functional performance."[35]

Acrilan

Acrilan is an acrylic staple fiber produced by the Chemstrand Corporation. The first fibers were produced in pilot plants for research in 1951.[36] The first showing of clothing for men, women and children was in August 1952 after nearly 12 years of research.[37]

Manufacture. Acrilan is produced from acrylonitrile, a product of natural gas and air, by chemical reactions. The spinning solution is extruded through a spinnerette to form a filament. The filaments are processed and cut into staple length for textile use.[38]

Acrilan is produced in 3 to 5 denier sizes with staple lengths ranging from $1\frac{1}{2}$ to 5 inches. The fiber is produced in both bright and dull forms.[39]

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35 Bonner, op. cit., p. 262.

36 Woodruff, J. A., "Introduction to Dyeing of Chemstrand Acrylic Fiber," American Dyestuff Reporter, 40:402, June 25, 1951.

37 "Acrilan Debut," Bulletin, Chemstrand Corporation, August 27, 1952.

38 Loc. cit.

39 Kahn, M. I. Jr., "A is for Acrilan," Textile Forum, 10:12, April, 1953.

Physical and Chemical Properties. Acrilan is being introduced with many properties similar to other synthetic and natural fibers.

The fibers are thermoplastic, can be heated, pleats can be set in. It has good resilience which produces wrinkle-shedding characteristics. It affords warmth, although it has the lowest specific gravity of any textile fiber. Like other synthetic fibers it is not attacked by moth, mildew or mold.

Acrilan is washable and quick drying; has good dimensional stability and is durable. It has good resistance to chemicals and greases. It has certain properties which give it a wool-like hand but in some respects is superior to wool.

Acrilan is the easiest of the newer synthetics to dye.

A wide range of uses as a textile fiber are found in Acrilan due to its bulk without weight, high strength and low stretch.[40]

Use with Other Fibers. As a fabric, Acrilan is being offered in spun yarns with or without addition of other fibers.

Blends of Acrilan-wool, Acrilan-rayon and Acrilan-cotton are being used for suit weight fabrics.[41]

The degree to which the Acrilan properties can be claimed for a particular fabric is determined by the percentage of content and the type of fiber with which it is blended.

The wool-like hand, warmth, stability and bulking power give Acrilan characteristics of wool when blended with rayon.

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[40] Ibid., pp. 12, 13, 37.

[41] Loc. cit.

Wrinkles come out when a garment is hung up for a while due to high resistance to creasing in the Acrilan blend.

Very little material has been published giving the results of consumer use of Acrilan blends.

II. SUMMARIZATION OF OUTSTANDING PROPERTIES

Research shows that synthetic fibers except nylon, are so limited in production and use that no definite conclusions as to the end use can be drawn.

Each synthetic fiber has unique features along with certain undesirable features.

Nylon is outstanding for its abrasion resistance.

Orlon has the greatest resistance to sunlight and outdoor exposure.

Dacron is outstanding for its crease recovery, particularly at high humidity.

Acrilan, in certain respects, has an advantage of better dyeability.

In general, each fiber has good strength, elongation, elasticity recovery, low moisture absorbency, good soil resistance, washes well and dries quickly.

All the fibers have certain electrostatic properties which may or may not be objectionable, depending on the humidity and individual's reactions to static.

Studies show that each fiber can be made in filament or staple yarns and blended with other fibers. Blending of fibers makes possible characteristics not found in each fiber alone.

CHAPTER III

METHOD OF PROCEDURE

I. SELECTION OF FABRIC

Twelve fabrics containing newer synthetics, of quality suitable for spring and summer wear, were selected for this study. Fabrics suitable for spring and summer use were selected because the wear tests were to be made in spring and summer of 1953. The fabrics, collected over a period of five months, beginning December 1952, were purchased in several communities. They represented the blends and combinations which could be purchased by consumers in retail stores.

Two yards of each fabric were purchased for laboratory testing. Enough additional yardage of eight of the fabrics was purchased for constructing the garments to be used for wear tests.

Four fabrics selected were of a weight and construction suitable for spring suits or heavy dresses. Six fabrics were of a weight and construction suitable for general blouse and dress wear. Two sheer fabrics were of a weight and construction suitable for summer wear in warm climates.

II. ANALYSIS OF FABRIC CONSTRUCTION

Fiber content. The percentage of fiber content was determined by qualitative procedures as given by The American Association of Textile Chemists and Colorists.[1]

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[1] American Association of Textile Chemists and Colorists, 1952 Technical Manual and Yearbook of the A. A. T. C. C., XXVIII, pp. 107-111. New York: Howes Publishing Company, 1952.

Weave. The weave was determined by visual examination and verified with the pick glass.

Weight per square yard. The procedure followed was based on the test method recommended by Skinkle.[2]

The weight in ounces per square yard was determined by the following formula: $S = \frac{36 \times 36}{A} \times \frac{G}{28.35}$, where S is the ounces per square yard, A is the area of the sample in square inches, G is the weight of the sample in grams. The mean weight of the test pieces was recorded as the weight per square yard in ounces.

Thread count. The test method used was that established by The American Society for Testing Materials.[3]

With the Suter counter, the number of warp yarns in one linear inch was counted at five different places in the fabric. The number of threads per inch was calculated from the total of the five counts.

The number of filling yarns per linear inch was counted and calculated in the same manner.

Fabric thickness. The procedure followed was that recommended by The American Society for Testing Materials.[4]

A compressometer calibrated to measure in thousandths of an inch was used. An average of five readings made in different sections of the fabric was recorded as the fabric thickness.

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[2] John Skinkle, Textile Testing, Chemical Publishing Company, Inc., Brooklyn, New York, 1949, pp. 77-80.

[3] American Society for Testing Materials Committee D-13, American Society for Testing Materials Standards on Textile Materials, Published in Philadelphia by American Society for Testing Materials, 1952, p. 142.

[4] Loc. cit.

Staple length. The procedure for determining the staple length was based upon the test procedure for hand stapling of cotton fibers recommended by Skinkle[5] and modified in order that yarns could be used instead of the unwoven tufts of cotton.

A staple was removed from the untwisted yarn and measured on a slightly oiled ruler. The length of the fiber was recorded and the staple length determined by averaging five individual fiber lengths.

Filament count. The procedure for determining the filament count was based on recommendation of Skinkle.[6]

A yarn was removed from the fabric and untwisted at the cut end as much as possible, forming a fan-shaped arrangement of the filaments. The untwisted filaments were mounted, then counted microscopically. The filament count was determined by averaging five counts.

Yarn number and denier. The yarn number of the staple yarn and the denier of the filament yarn were determined, according to Skinkle,[7] by weighing five 36 inch yarns on the analytical balance.

The number of the cotton and rayon staple yarn was calculated by the following formula: $N = \frac{I}{M} \times \frac{12,600}{H}$, where N is the number, I is the length of the yarn in inches, M is the weight of the yarn in milligrams, and H is the length of a standard hank, 840 yards.

The number of wool yarn was calculated by the same formula with a substitution of 300 being made for H, the length of a standard wool hank.

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5 Skinkle, op. cit., pp. 35-36.

6 Ibid., p. 55.

7 Ibid., pp. 51-53.

The denier of the filament yarn was determined by the above method of procedure with the calculation being made by the following formula: $D = \frac{M}{I} \times 354$, where D is the denier, M is the weight of the yarn in milligrams, and I is the length of the yarn in inches.

The yarn number size in count system and the denier were converted to the TYPP system (1000 yards per pound) prepared by The American Society for Testing Materials.[8]

Twist. The number and direction of spiral turns given to a yarn in order to hold the fibers together were measured according to test methods prepared by Skinkle.[9]

The method followed used a twist counter which untwisted a given length of yarn and measured the number of turns necessary to untwist the yarns.

Two methods were used, (1) to determine twists of staple yarns, (2) to determine twists of filament yarns.

III. SERVICEABILITY TESTS

Tests to determine dimensional change, tensile strength, bursting strength and colorfastness were used to indicate the durability of the fabric.

The prediction of serviceability in consumer use was determined by tests made after the fabric had been laundered and dry cleaned.

Preparation of test pieces. Three pieces were cut 14 inches long and the full width of fabric for use in serviceability testing after

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8 American Society for Testing Materials, op, cit., pp. 543-549.

9 Skinkle, op. cit., pp. 58-66.

laundering, dry cleaning and one used as a control. Two pieces, 12 inches square, were cut and marked for determining dimensional change after laundering and dry cleaning.

After the tenth laundering and dry cleaning and the determination of dimensional change, the swatches were cut and used for bursting and breaking strengths.

The remaining fabric was reserved for constructing garments for wear tests and for illustrative material.

Laundering procedure. The procedure used followed directions set up by The American Association of Textile Chemists and Colorists for testing fabrics other than cotton and linen.[10] Modifications, set up by Parker,[11] in amount of soap used and the temperature maintained in the water bath were made to make the washing procedure more nearly approximate the laundering action fabrics would undergo in the home.

The laundering tests were done in a cylindrical reversing wash wheel under controlled conditions. The specimens to be tested, plus additional cloth to make an eight pound load, were laundered ten times.

The machine was flushed with six inches of warm water to remove any foreign matter which might have been in the machine.

The specimens, placed in a net laundry bag, plus additional load were placed in the machine. The machine was then filled to the six inch level with cold water. The temperature was raised with live steam to 120° F.

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10 American Association of Textile Chemists and Colorists, op. cit., pp. 132-133.

11 Ruth Parker, "A Study of the Effect of Resin Finishes for Crease Resistance Upon the Serviceability of Certain Cotton Fabrics," (unpublished Master's thesis, The Woman's College of University of North Carolina, Greensboro, 1952) pp. 33-34.

A neutral flaked soap of the type manufactured for home laundering was added and the fabric washed for fifteen minutes.

Following sudsing, eight inches of cold water were added and the temperature raised to 100° F. for each rinse. Two rinses, five and ten minutes in length of time, were used.

The test specimens were removed from the machine and placed in an extractor for seven minutes.

The fabrics were then placed flat on an automatically controlled laundry press for six seconds.

Dry cleaning. Test swatches were prepared for dry cleaning in the same way as for laundering.

The swatches, plus additional garments to make a 30 pound load, were cleaned in an automatic dry cleaning machine using a synthetic solvent and 200 c.c. of a concentrated liquid dry cleaning soap.

The swatches were pressed on a flat steam press before measurements were taken.

Breaking strength. Dry breaking strength was determined by the raveled strip method given by The American Society for Testing Materials.[12]

One set of test pieces was cut for warp breaking strength with the longer dimension parallel to the warp yarn. A second set was cut for filling breaking strength with the longer dimension parallel to the filling yarn.

The specimens used to determine dry strength were tested under standard conditions of temperature and humidity. Such conditions are 70° F.

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12 American Society for Testing Materials, *op. cit.*, pp. 143-144.

temperature and 65 per cent relative humidity within a tolerance of two degrees and two per cent humidity.

Wet strength determination was made on five strips that had been immersed in tap water for at least two hours.

Warp and filling wet and dry tests were taken on the laundered and the dry cleaned fabrics after the first, fifth and tenth treatments.

The tests were made on a Scott tester and the average strength calculated.

Bursting strength. The Mullen tester, an approved type of diaphragm bursting tester, and the procedure recommended by The American Society for Testing Materials were used.[13]

The dry specimens were tested under standard atmospheric conditions as used in the breaking strength tests.

Five tests were taken from a six inch square of test fabric. The number of pounds pressure required to break the fabric was recorded after each reading. The average bursting strength of the five tests was calculated.

A second test square was soaked in water for two hours and the same testing procedure followed with the wet fabric.

Wet and dry bursting strengths were taken after the first, fifth and tenth laundering and dry cleaning.

Dimensional change. Two test pieces with 10 inch squares indicated by a basting thread in a contrasting color were used to measure the shrinkage or stretch in the fabric. One test piece was used to indicate the changes during laundering; the other, the change during dry cleaning.

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13 Ibid., pp. 150-151.

After the first, second, fifth and tenth laundering and dry cleaning, the pressed specimens were laid without tension on a flat surface. Five measurements in the warp direction and five in the filling direction were recorded.

The percentage of shrinkage or stretch was calculated from the average of the measurements by the following formula: $\frac{A - B}{A} \times 100 = C$, where A is the original size of the square, B is the size of the square after laundering or dry cleaning, and C is the percentage of stretch or shrinkage.

Light fastness test. The test was made by use of a FDA—R type Fade-Ometer, according to standards set up by The American Association of Textile Chemists and Colorists,[14] to determine the relative colorfastness to light.

One three inch test specimen was placed in the holder. One third of the fabric was controlled throughout the process. One third was marked for 40 hours of exposure and the other third was marked for 20 hours of exposure.

At the end of exposure periods the color changes were rated by the rating scale devised for consumer use in laboratory tests conducted at the Ellen H. Richards Institute[15] as follows:

Class I . . . . . No color change.

Class II . . . . Little change from the original.

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14 American Association of Textile Chemists and Colorists, op. cit., pp. 100-103.

15 Helen Borton and Mina Butz, et al., "Colorfastness of Women's and Children's Wearing Apparel Fabrics," Journal of Home Economics, 34:539, October, 1942.

Class III . . . . Definite change from the original but could still be worn.

Class IV . . . . Very evident color change, could not be used again.

This method was used for the evaluation of all colorfastness tests.

Colorfastness to laundering. The procedure set up by The American Association of Textile Chemists and Colorists[16] for testing color loss similar to that produced by the commercial and domestic washing of cotton, linen and organic fiber mixtures was used.

The standard Launder-Ometer with a thermostatically controlled water bath was used. Temperature was set at 105° F. (40° C.). A test specimen approximately six inches square, with a swatch of multifiber test cloth attached, was used for each fabric to be tested.

Each test specimen was placed in a glass jar containing approximately 0.5 per cent neutral flaked soap, 500 milligrams of water and ten steel balls. The jar was closed and placed in the Launder-Ometer bath and the machine run for 30 minutes. After the sudsing period the specimen was rinsed twice and placed on a flat surface to dry.

When dry, the test specimen was evaluated for both fading of color and staining of the test cloth after the first, fifth and tenth laundering.

Color changes were rated according to the method described in the preceding discussion.

Colorfastness to dry cleaning. The test for colorfastness in laundering was modified slightly to test the colorfastness to dry cleaning.

Each test specimen, with attached multifiber test cloth, was placed in a glass jar containing 500 milligrams of synthetic cleaning solvent.

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16 American Association of Textile Chemists and Colorists, *op. cit.*, pp. 83-84.

3 c.c. of dry cleaning soap and ten steel balls. The jar was sealed and placed in the Launder-Ometer and washed for 30 minutes at 105° F. The jar was emptied and the test specimen rinsed in clean solvent then placed on a flat surface to dry.

The test specimens were evaluated after the first, fifth and tenth treatment as in the test for colorfastness to laundering.

Rubbing (Crocking). To determine whether or not color might be transferred from the surface of the dyed fabric, the rubbing test, set up by The American Association of Textile Chemists and Colorists,[17] was used.

Each test specimen, fastened to the base of a Crockmeter, was rubbed with standard cloth used for testing crocking. The color transferred to the white cloth and remaining on the cloth after light washing was rated by the scale used in previous color tests.

For wet crocking test, the white cloth was wet and used in the same manner as for dry testing. Evaluation was made by the same scale.

IV. CONSTRUCTION OF GARMENTS

Eight of the fabrics selected were made into garments for wear testing. These consisted of two fabrics from the group suitable for suits or heavy dresses, two chambray type fabrics, two shantung type fabrics and two sheer fabrics.

Each of the fabrics made into garments was recommended by the manufacturer as being washable. The type garments constructed included three blouses, four dresses and one bolero suit. All garments were constructed and worn by two members of the research staff. It was thought that a better

17 Ibid., p. 106.

record would be made if kept by the same two persons interested in the technical aspects of the study.

Varied garment designs were selected to suit the fabric and the wearer as well as incorporating the details desired for testing.

Simple construction techniques recommended for home sewing were used. Construction features of particular interest were: (1) gathering to determine the ease with which the excess fullness could be removed, (2) one or more pleats to determine the permanency of the crease retention properties, (3) durability of seam finishes.

A standard sewing machine was used with the tension set for sewing on medium weight cotton fabric. Mercerized cotton thread was used for all stitching. Fourteen stitches per inch were used for under seams and 20 stitches per inch were used for top stitching.

A plain seam 5/8 inch wide was used on all seams. Four plain seam finishes, recommended by Latzke and Quinlan[18] with modifications, were used. The seam finishes used were (1) unfinished, (2) pinked edge, (3) pinked and machine stitched 1/8 inch from edge, (4) self-stitched edge.

Construction report. A report on garment construction was made by the person making the garment. Opinions were requested as to: (1) the suitability of the weight of the fabric for the design selected, (2) the suitability of the hand or "feel" of the fabric, (3) the recognition of the use of synthetic fibers, (4) the response of the fabric to various construction problems.

The opinionnaire used is reproduced as Exhibit A in the appendix.

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18 Alpha Latzke and Beth Quinlan, Clothing, J. B. Lippincott Company, New York, 1949, p. 500.

Procedure for reporting the results of the wear tests. The individuals who wore the garments used the same procedure for laundering or dry cleaning and kept individual records of each garment.

In laundering, the garment was hand washed in luke warm water with mild soap flakes. The garment was rinsed twice and hung to dry without wringing.

A hand iron with temperature control set on "rayon" was used for pressing.

The dry cleaned garments were cleaned in the laboratory in a commercial automatic machine using a synthetic solvent. Garments were finished on a steam press.

An accurate record of the number of hours worn, number of launderings or dry cleanings, and any change in fabric appearance, hand, or fit of garment were to be noted and recorded. The wearer was asked to give an opinion of the following points: (1) changes noted in the fit of the garment, (2) changes in the hand or "feel" of the fabric, (3) changes noted in the appearance of the fabric, (4) comfort during wear, (5) resistance to wrinkles, (6) resistance to soiling, (7) indications of fabric damage or failure in details of construction during wear.

The opinionnaire used is shown in the appendix as Exhibit B.

Procedure for evaluating the wear tests. At end of the wear period the garments were returned to the laboratory and examined by the research staff.

The garments were rated on (1) the maintenance of the original appearance, hand and color, (2) the response to the fabric damage, (3) retention of soil and stains, and (4) the durability of seam finishes.

CHAPTER IV

PRESENTATION OF DATA

I. DESCRIPTION OF FABRICS TESTED

Twelve fabrics of newer synthetic fibers were selected for this study. They were collected over a period of five months, beginning December 1952. Since there were very few fabrics of the newer synthetic fibers found in the retail stores of Greensboro, it was necessary to purchase most of the fabrics elsewhere.

The fabrics used are shown in Illustration I. They have been grouped according to weight and suitability for specific purposes as follows:

Group A - Suit and heavy dress fabrics

Group B - Medium weight dress and blouse fabrics

Group C - Sheer dress fabrics

The prices of the fabrics varied widely with the greatest variation being in Group A. The cost of the heavy weight fabrics ranged from $0.98 to $6.95 per yard.

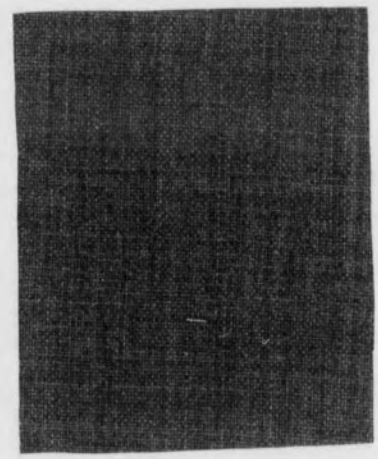
There was not as great a range in the prices of the fabrics for blouse and dress wear. This group ranged from $1.00 to $3.95 per yard. Fabric 7, the lowest in price in this group, was sold by a mill outlet store as a combination of Orlon and cotton. Laboratory tests proved that it was rayon and cotton. It was included in the study because of its similarity in appearance and construction to other fabrics in this group.

ILLUSTRATION I

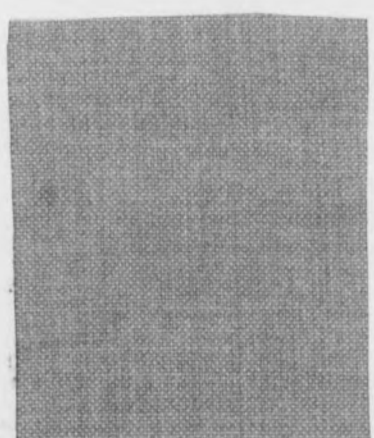
FABRICS USED IN THE STUDY

GROUP A

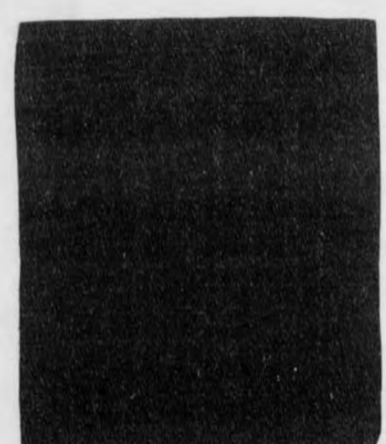
Fabric 1



Fabric 2



Fabric 3

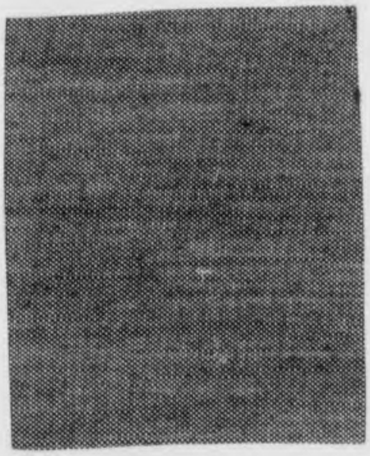


Fabric 4

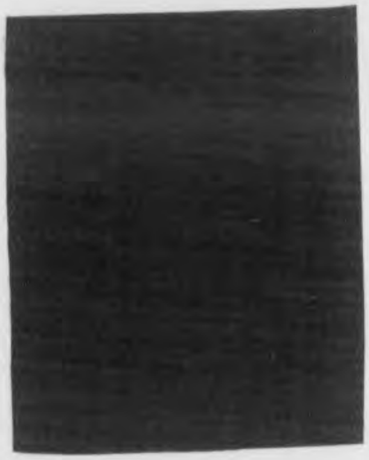
ILLUSTRATION I (Continued)

FABRICS USED IN THE STUDY

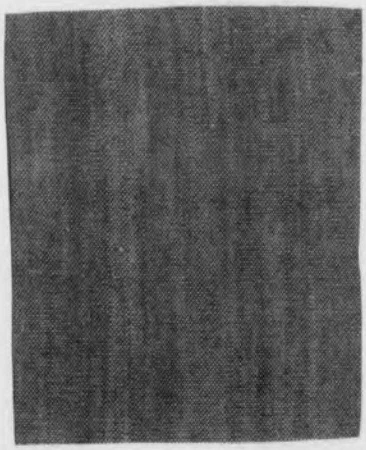
GROUP B



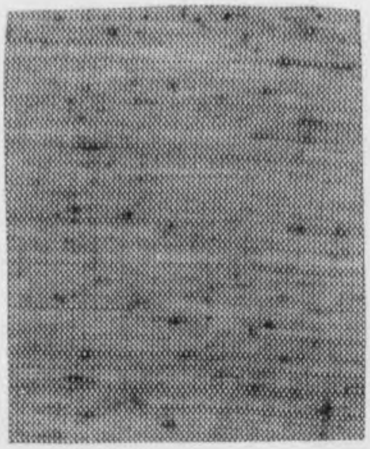
Fabric 5



Fabric 6



Fabric 7

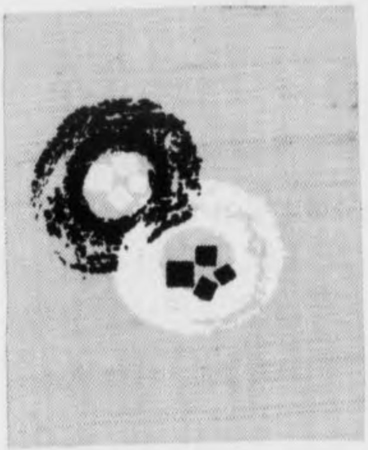


Fabric 8

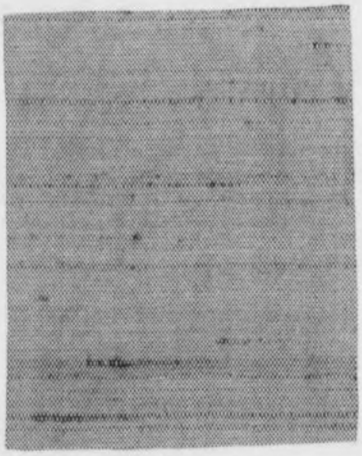
ILLUSTRATION I (Continued)

FABRICS USED IN THE STUDY

GROUP B (Continued)

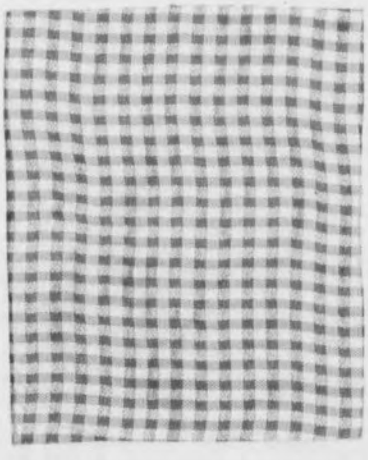


Fabric 9



Fabric 10

GROUP C



Fabric 11

Fabric 12

The two sheer fabrics cost $1.00 and $2.39. The unusual difference in cost was due in part to the fact that fabric 11, the less expensive fabric, was purchased at a mill outlet store.

The cost of each fabric is given in Table I.

II. CONSTRUCTION OF FABRICS

All the fabrics in Group A were woven of yarns made by combining two or more natural and/or synthetic fibers as the yarn was spun. These have been referred to as blended fabrics.

All other fabrics were woven of yarns containing one fiber. The use of such yarns as the warp and/or filling results in a fabric which is a combination of fibers rather than a blend of fibers. The terms "blend" and "combination" have been used to differentiate the two types of fabrics used in this study.

The data pertaining to the construction of the fabrics are shown in Table I and summarized in the following paragraphs.

Weave. All the fabrics were of the plain weave with the exception of fabric 4 which was a crepe weave, and fabric 12, a plain weave combined with an imitation gauze weave to give a novelty effect. A slub yarn was used in the filling of fabrics 8, 9, and 10 to give a slight variation of the weave.

Weight. The heavy dress and suit fabrics ranged from 5.3 to 6.1 ounces per square yard. The medium weight fabrics ranged from 2.0 to 3.9 ounces per square yard. The two sheer fabrics weighed 1.6 and 1.7 ounces per square yard.

	Fabric Number	Fiber	Content (Per cent)	Staple Length (inches) Warp	Staple Length (inches) Filling	Filament Count Warp	Filament Count Filling	Yarn Number (TYPP) Warp	Yarn Number (TYPP) Filling	Denier (TYPP) Warp	Denier (TYPP) Filling	Tw… Wa…
GROUP A	1	Nylon	15.0	2.3	2.3	--	--	7.2	6.6	--	--	13
		Wool	85.0	--	--	--	--	--	--	--	--	-
	2	Dacron	46.0	2.6	2.8	--	--	11.5	13.1	--	--	16
		Wool	54.0	--	--	--	--	--	--	--	--	16
	3	Acrilan	52.5	2.9	2.2	--	--	10.2	10.9	--	--	16
		Rayon	47.5	--	--	--	--	--	--	--	--	-
	4	Rayon	74.2	1.7	2.0	--	--	17.3	14.3	--	--	16
		Acrilan	25.8	--	--	--	--	--	--	--	--	-
GROUP B	5	Orlon	55.0	--	--	76	--	--	--	22.4	--	3
		Cotton	45.0	--	1.10	--	--	--	22.3	--	--	[illegible]
	6	Nylon	55.0	--	--	34	--	--	--	60.4	--	5
		Cotton	45.0	--	1.14	--	--	--	45.0	--	--	[illegible]
	7	Rayon	50.0*	--	--	--	38	--	--	--	25.2	[illegible]
		Cotton	50.0	1.4	--	--	--	28.6	--	--	--	2
	8	Orlon	48.0	--	--	70	--	--	--	21.9	--	6
		Nylon	52.0	--	1.50	--	--	--	17.2	--	--	[illegible]
	9	Silk	43.0	--	--	--	87	--	--	--	44.4	[illegible]
		Orlon	57.0	--	--	40	--	--	--	43.2	--	[illegible]
	10	Silk	64.0	--	--	--	38	--	--	--	58.2	[illegible]
		Orlon	36.0	--	--	38	--	--	--	43.2	--	[illegible]
GROUP C	11	Orlon	66.1	--	--	40	40	--	--	38.5	39.4	[illegible]
		Nylon	33.9	--	--	13	13	--	--	106.2	100.8	[illegible]
	12	Orlon	49.5	--	--	40	40	--	--	41.6	40.8	[illegible]
		Nylon	50.5	--	--	10	10	--	--	148.8	148.8	1

* Could not be determined accurately.

TABLE I

TO THE CONSTRUCTION AND COST OF THE FABRICS

nier (YPP)	Twist Count and Direction of Twist				Thread Count		Weight	Thickness	Weave	Cost
Filling	Warp	(Ply)	Filling	(Ply)	Warp	Filling	(oz/sq.yd.)	(inches)		(per yd.)
--	13.8Z	--	13.5Z	--	32	34	6.1	.030	Plain	$ 3.79
--	--	--	--	--						
--	16.4S	*	16.5Z	--	55	49	5.3	.014	Plain	6.95
--	16.4Z	*	13.2S	--						
--	16.0Z	18.9S	15.0Z	18.9S	51	51	5.5	.014	Plain	1.98
--	--	18.9S	--	18.9S						
--	16.5S	--	24.8S	--	76	83	5.5	.026	Crepe	0.98
--	--	--	--	--						
--	3.0S	--	--	--	62	72	3.0	.010	Plain	1.95
--	--	--	21.7S	--						
--	5.0S	--	--	--	105	90	2.5	.018	Plain	2.00
--	--	--	18.0Z	(24.2S (24.2S						
25.2	--	--	8.0Z	--	69	71	3.5	.009	Plain	1.00
--	23.3Z	--	--	--						
--	6.0S	--	--	--	65	53	3.9	.016	Plain	2.50
--	--	--	24.0S	--					(Slub yarn)	
44.4	--	--	2.0S	--	96	82	2.5	.004	Plain	3.95
--	3.0S	--	--	--					(Slub yarn)	
58.2	--	--	No twist	--	95	69	2.0	.006	Plain	2.98
--	3.0S	--	--	--					(Slub yarn)	
39.4	5.0S	--	6.0S	--	87	86	1.7	.021	Plain	1.00
100.8	9.0S	--	6.0S	--						
40.8	3.0S	--	3.0S	--	86	101	1.6	.023	Plain (with imitation gauze)	2.39
148.8	15.0S*	--	10.0S	--						

Thread count. The thread count differed markedly from fabric to fabric. The thread counts in the suiting fabrics varied from 32 to 76 threads per inch in the warp and from 34 to 83 in the filling. The chambray type fabrics varied from 62 to 105 threads per inch in the warp andfrom 53 to 82 in the filling. The sheer fabrics had warp thread counts of 86 and 87 threads per inch and filling counts of 86 and 101 threads per inch.

Thickness. The fabric thickness was not considered an indication of fabric quality. Due to the fabric and yarn construction there were great variations in thicknesses. The measurements ranged from .004 to .030 of an inch. Fabrics 1 and 4 of Group A were only slightly thicker than the sheer fabrics in Group C.

Yarns. The warp and filling yarns of all fabrics in Group A were blends of staple fibers, the length of staples varying from 1.7 to 2.9 inches in the warp and from 2.0 to 2.8 inches in the filling.

In Group B yarns of staple fibers were found in the warp of fabric 7 (1.4 inches) and in the filling yarns of fabrics 5, 6 and 8, ranging from 1.10 to 1.50 inches.

Filament yarns were used in the warp and filling of fabrics 9 and 10, in the warp of fabrics 5, 6 and 8 and in the filling of fabric 7. The number of filaments used to make each yarn ranged from 34 to 87.

Filament yarns were used in both warp and filling of fabrics 11 and 12. Nylon and Orlon were used in both warp and filling of these fabrics. Forty filaments were used in the Orlon yarns of both fabrics. Thirteen filaments were used in the nylon yarns of fabric 11 and 10 filaments in the yarns of fabric 12.

Further specific data of yarn sizes and the twist of the yarns may be found in Table I.

III. RESULTS OF THE LABORATORY TESTS

Dimensional changes occurring after laundering and dry cleaning. With the exception of fabric 4, all of the fabrics tested were recommended as being washable. No fabric was guaranteed against shrinkage.

According to a study made by Searle and Mack in 1939,[1] the maximum amount of shrinkage or stretch that can take place without causing noticeable change in fabric dimensions is 2.0 per cent. A 1.0 per cent shrinkage or stretch is much more desirable and a shrinkage or stretch of less than 1.0 per cent is preferable as no noticeable change in fabric dimensions which might influence the fit of garments would be produced. From this standpoint, only a few of the fabrics tested were of exceptional stability when laundered or dry cleaned. Fabric 11, a nylon and Orlon crinkled sheer, was the only fabric showing 2.0 per cent or less dimensional change in both warp and filling direction when laundered or dry cleaned ten times. The dimensional stability of the other fabrics varied considerably and tended to increase at each testing period.

In most fabrics there was greater stability in dry cleaning than in laundering. This is not unusual in that the fabric is exposed to less moisture in dry cleaning than in laundering.

Data showing the percentage of dimensional change in laundering and dry cleaning have been shown in Table II. Graphs showing these changes are given in Illustration II.

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[1] A. B. Searle and P. B. Mack, "A Study of the Incidence of Shrinkage in Women's and Children's Wearing Apparel Fabrics," American Dyestuff Reporter, August 7, 1939, pp. 405-409.

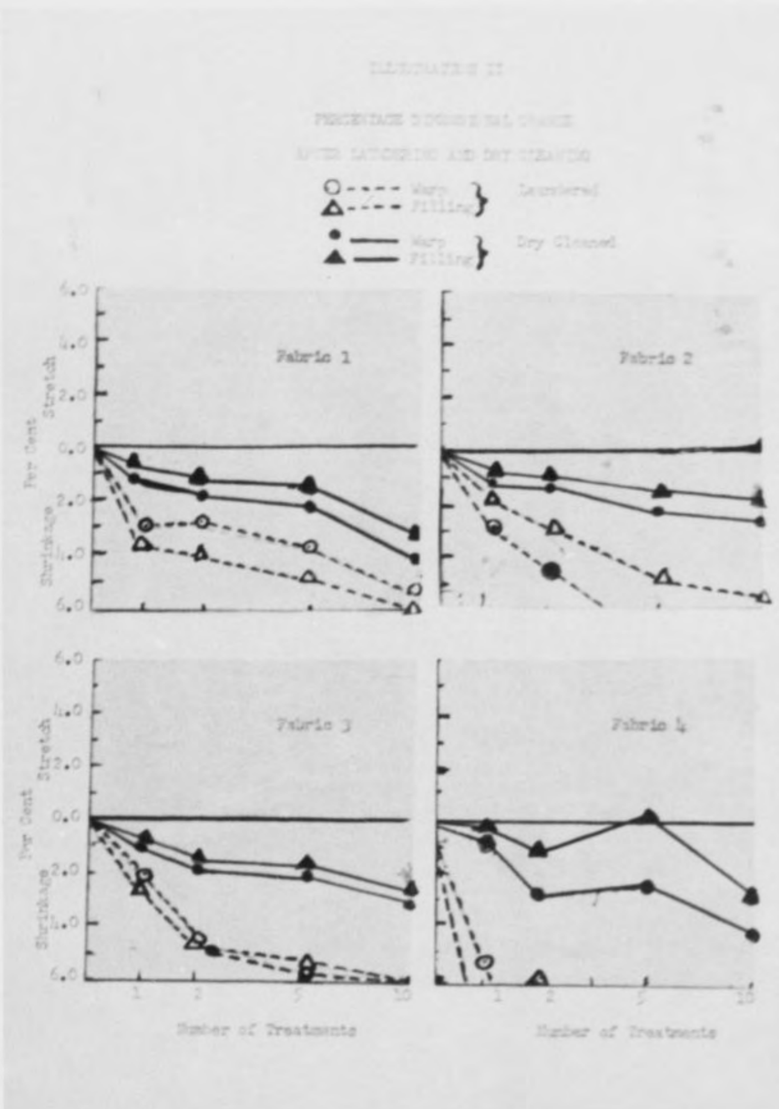
TABLE II

PERCENTAGE DIMENSIONAL CHANGE AFTER LAUNDERING AND DRY CLEANING

	Fabric Number	Number of Times Laundered: One Warp	One Filling	Two Warp	Two Filling	Five Warp	Five Filling	Ten Warp	Ten Filling
GROUP A	1	-3.1	-3.8	-3.0	-4.2	-3.9	-5.0	-5.6	-6.0
	2	-2.8	-1.8	-4.4	-2.9	-7.4	-4.8	-8.2	-5.5
	3	-2.3	-2.4	-4.6	-4.6	-5.8	-5.5	-7.2	-6.6
	4	-5.4	-8.4	-10.4	-5.9	-11.6	-6.7	-14.3	-7.1
GROUP B	5	-1.1	-4.7	-1.4	-5.4	-2.6	-5.7	-2.9	-5.6
	6	+0.4	-2.7	+0.2	-2.3	+0.3	-2.1	+1.0	-2.8
	7	-2.8	+2.6	-2.0	+3.5	-2.4	+2.7	-2.8	+3.2
	8	-2.7	-0.2	-3.8	+0.1	-4.6	+1.0	-5.2	+1.8
	9	-1.4	-2.0	-2.0	-1.8	-3.2	-2.1	-3.0	-2.3
	10	-0.6	-0.5	-1.8	-0.5	-1.7	-0.1	-2.6	-1.3
GROUP C	11	-1.0	-0.8	-0.4	-0.4	-1.2	-0.8	-0.5	-0.2
	12	-2.0	-0.1	-1.8	+0.6	-3.0	-0.4	-2.0	+0.8

	Fabric Number	Number of Times Dry Cleaned: One Warp	One Filling	Two Warp	Two Filling	Five Warp	Five Filling	Ten Warp	Ten Filling
GROUP A	1	-1.2	-0.7	-1.9	-1.2	-2.1	-1.5	-4.1	-3.3
	2	-1.1	-0.8	-1.3	-0.8	-2.4	-1.5	-2.8	-1.8
	3	-1.0	-1.0	-1.8	-1.6	-2.0	-1.7	-3.0	-2.8
	4	-0.7	-0.1	-2.6	-1.1	-2.4	+0.2	-4.2	-3.0
GROUP B	5	-0.6	-2.2	-1.0	-3.0	-0.9	-4.0	-1.8	-5.7
	6	-0.7	-0.8	-1.5	-1.2	-1.0	-1.6	-1.6	-2.5
	7	+0.1	-2.6	+0.6	-0.8	+0.6	-2.1	+0.1	-6.2
	8	-3.1	-1.8	-4.2	-1.8	-4.9	-1.4	-3.7	-1.4
	9	-0.6	-1.1	-0.6	-1.4	-0.8	-1.5	-1.3	-2.4
	10	-1.0	-0.7	-0.7	-0.1	-2.0	+0.7	-3.0	-0.6
GROUP C	11	-0.4	-0.6	-0.5	-0.8	-1.3	-1.5	-1.0	-1.2
	12	-0.4	-0.8	-1.0	-1.0	-1.9	-1.4	-1.3	-0.8

* Stretch is indicated by +; shrinkage is indicated by -.


Warp
Filling
Dry Cleaned
Fabric 1
Fabric 2
Fabric 3
Fabric 4
Per Cent
Stretch
Shrinkage
6.0
4.0
2.0
0.0
2.0
4.0
6.0
1
2
5
10
Number of Treatments
Number of Treatments

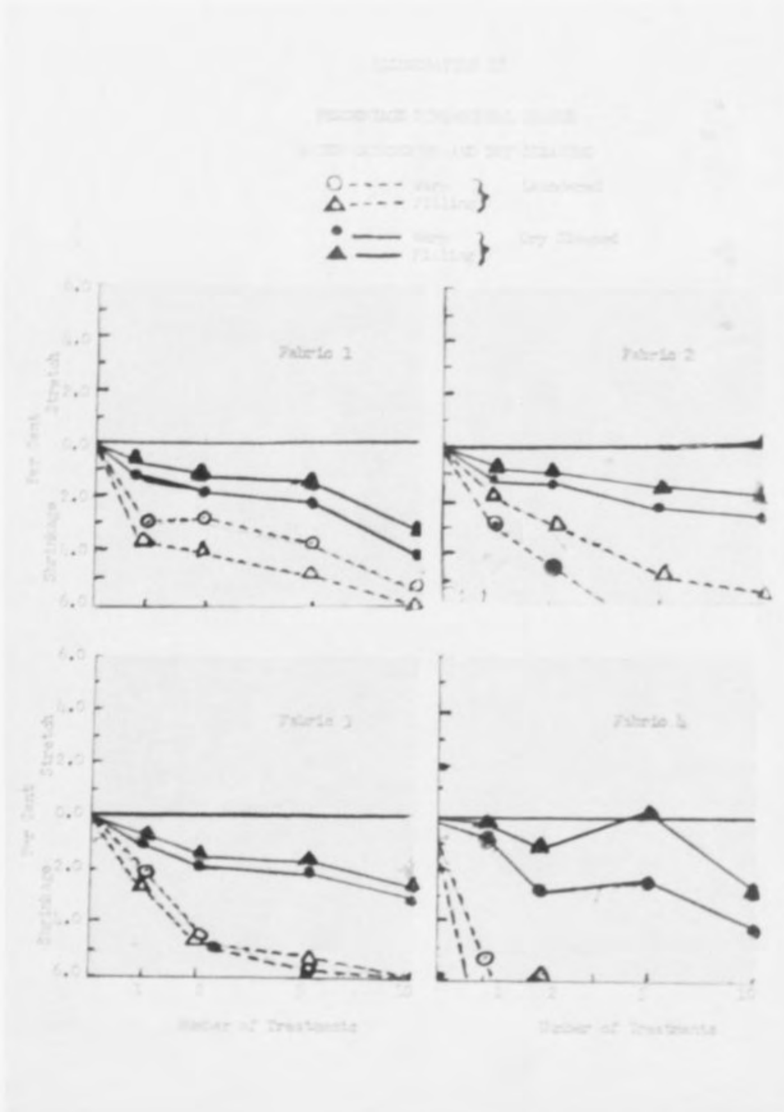
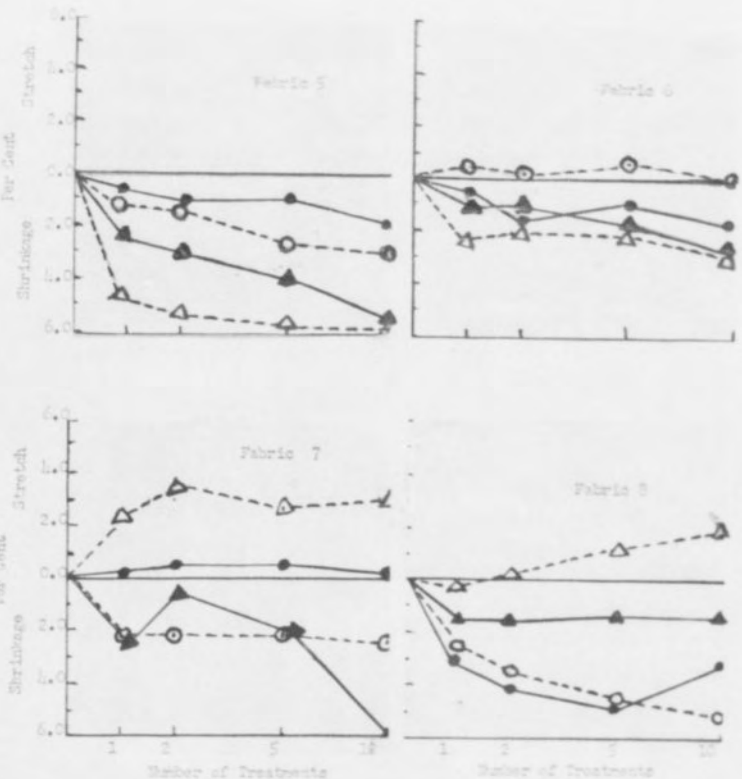
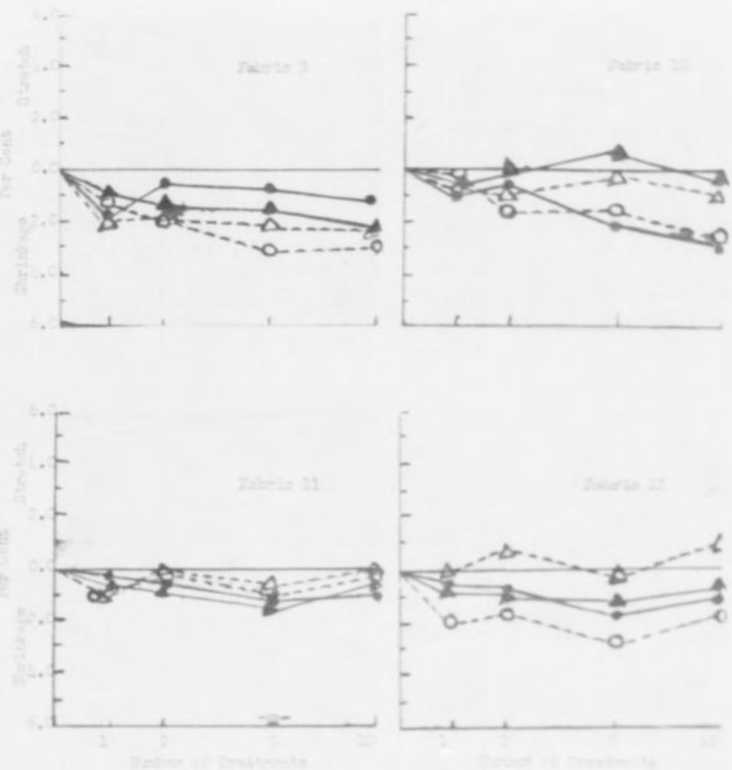

Fabric 1
Fabric 2
Fabric 3
Fabric 4
Per Cent
Stretch
Shrinkage
Number of Treatments
Number of Treatments

ILLUSTRATION II (continued)

PERCENTAGE DIMENSIONAL CHANGE

AFTER LAUNDERING AND DRY CLEANING




Fabric 9
Fabric 11
Per Cent
Stretch

Only one fabric in Group A showed a shrinkage of less than 2.0 per cent after one laundering. This was found in the filling direction of fabric 2, the Dacron and wool suiting. Shrinkage of the other fabrics in this group ranged from 2.3 to 5.4 per cent in the warp direction and from 2.4 to 8.4 per cent in the filling. In terms of linear measurements this would be approximately 7/8 to 1 7/8 inches per yard in the warp and 7/8 to 3 inches per yard in the filling.

In all fabrics of Group A the dimensional changes increased progressively at the second, fifth and tenth testing periods. After the tenth laundering, shrinkage ranged from 5.6 to 14.3 per cent (2 to 5 inches per yard) in the warp direction and from 5.5 to 7.1 per cent (2 to 2½ inches per yard) in the filling.

Regardless of claims for washability, it would not be advisable to launder any garment made from fabrics in this group.

Dry cleaning produced less dimensional change than did laundering in all fabrics in Group A. All fabrics in this group showed good dimensional stability through the second cleaning with the exception of the warp of fabric 4. This showed shrinkage of 2.6 per cent after the second cleaning. After the fifth cleaning the filling of all the fabrics shrank or stretched less than 2.0 per cent. The warp shrinkage of 3 fabrics in this group was slightly more than 2.0 per cent.

After the tenth dry cleaning the warp shrinkage ranged from 2.8 to 4.2 per cent and the filling from 1.8 to 3.3 per cent. Fabrics 1 and 4 showed the greatest changes in both warp and filling directions.

From the tests made it was concluded that the four fabrics in Group A would retain good dimensional stability up to and including the fifth dry cleaning.

No fabric in Group B showed, in all tests, a shrinkage of less than 2.0 per cent in both laundering and dry cleaning. Fabric 10 shrank less than 2.0 per cent in all testing periods with the exception of the warp during the tenth laundering and dry cleaning. Fabric 9 showed less than 2.0 per cent shrinkage through the first and second laundering with a gradual increase during the fifth and tenth.

The greatest percentage changes were found in fabrics 5, 7 and 8. These fabrics showed changes ranging from a shrinkage of 5.6 to a stretch of 3.2 per cent. It would not be advisable to launder these fabrics.

The nylon, Orlon and silk yarns used in these fabrics were similar in dimensional stability. They were more stable than the cotton and rayon yarns used in fabrics 5, 6 and 7.

There was a lower percentage change in dimensions during dry cleaning than during laundering. Fabrics 6 and 9 showed less than 2.0 per cent change during each testing period with the exception of the fillings after the tenth cleaning where shrinkage showed 2.5 and 2.4 per cent respectively. Fabric 10 also showed less than 2.0 per cent up to the tenth cleaning where the warp showed a loss of 3.0 per cent.

The greatest percentage changes were found in fabrics 5, 7 and 8. These fabrics showed shrinkage ranging from 3.7 to 6.2 per cent.

Fabrics in Group C showed shrinkage or stretch of 2.0 per cent or less at every laundering and dry cleaning testing period, with the exception of the warp of fabric 12. The shrinkage in this fabric after the fifth laundering was 3.0 per cent; however, after the tenth laundering it was only 2.0 per cent.

Dimensional stability in both laundering and dry cleaning of fabrics in Group C was considered good. Either fabric could be expected to give excellent stability in consumer use.

Tensile strength. The tests for tensile strength have been used more as a measure of the maintenance of strength during laundering and dry cleaning than as a means of comparing apparel fabrics of these varying constructions.

As an aid in evaluating the strength properties of the fabrics, 10 per cent has been established as a standard of comparison in this study. A fabric with a loss or gain of 10 per cent or less in strength has been considered satisfactory in use.

The determination of tensile strength in pounds per inch showed that losses and gains in strength occurred during both laundering and dry cleaning periods. In some cases these changes were great enough to cause damage in the fabric that would affect the end use. Increased strength would appear to indicate increased durability. However, fabric shrinkage, the effect of heat on synthetic fibers, and other factors known to influence strength gains might produce fabric damage that would affect the end use. Better maintenance of strength was found in dry cleaning than in laundering.

The initial strength of the fabrics was high in most cases. For this reason a small gain or loss in strength would not detract from the durability of the fabric.

Group B, the combination fabrics, showed a higher initial strength in the synthetic yarns than in the natural fiber yarns, both dry and wet. All the initial test pieces were of lower strength when wet than when dry with the exception of the cotton filling yarns of fabrics 5 and 6 and the warp yarns (silk) of fabric 10.

After the tenth laundering and dry cleaning there was no fabric which showed less than 10 per cent change in all tests. In many cases there was less than 10 per cent in one direction, either dry or wet. There were many variations in strength after each treatment, with no two fabrics reacting in the same manner.

From the use of the results of these durability tests, it is concluded that fabrics 3 and 12 would probably give the greatest satisfaction in use.

Data pertaining to changes in tensile strength after laundering and dry cleaning are shown in Tables III and IV. The data is shown graphically in Illustrations III and IV and discussed further in the following paragraphs.

After the first laundering, fabrics 2 and 3 in Group A showed less than 10 per cent change in both dry and wet, warp and filling. The filling of fabric 1 showed the greatest change in the dry test with an increase in strength of 19.2 per cent. The warp of fabric 1 showed the greatest change in the wet test with a loss of 19.8 per cent.

After the fifth laundering no fabric in Group A showed less than 10 per cent change in both dry and wet, warp and filling. The warp and filling dry strengths of fabrics 1 and 2 were below 10 per cent. In most cases, all other changes were gradual progressive increases or decreases of the strength changes found after the first testing period. The greatest change was in the filling of fabric 4. The dry strength showed an increase of 21.8 per cent and the wet strength a decrease of 32.6 per cent.

After the tenth laundering, fabric 3 showed less than 10 per cent change in strength. This was also true of the wet filling of fabric 2 and the warp of fabric 4. The highest percentage changes were found in fabrics 1 and 4.

TABLE II

CHANGES IN BREAKING STREN

(Poun

	Fabric Number	Original				1			
		Dry		Wet		Dry		Wet	
		Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
GROUP A	1	21.7	13.0	19.1	13.6	20.6	15.5	15.3	12.2
	2	57.8	45.9	49.0	43.0	57.1	49.3	46.3	43.4
	3	70.3	65.5	62.4	56.9	71.2	71.3	58.5	62.3
	4	59.9	38.6	38.3	22.4	59.4	44.8	36.2	26.7
GROUP B	5	82.9	25.7	80.9	35.2	92.3	25.8	87.5	35.0
	6	79.5	39.2	65.6	40.0	71.5	31.4	56.2	41.7
	7	24.2	37.6	21.7	15.4	20.3	32.6	19.2	18.3
	8	101.0	64.2	95.3	55.2	83.5	62.4	73.7	51.7
	9	67.2	68.8	52.3	52.0	67.9	61.6	57.0	45.1
	10	71.6	43.7	74.2	33.3	60.7	40.7	56.7	32.8
GROUP C	11	41.4	39.4	38.6	32.3	39.0	35.7	38.3	30.7
	12	31.6	23.0	24.0	21.4	26.0	20.9	24.1	19.2
GROUP A	1					- 5.1	+19.2	-19.8	-10.3
	2					- 1.2	+ 7.4	- 5.5	+ 0.9
	3					+ 1.3	+ 8.9	- 6.3	+ 9.5
	4					- 0.8	+16.1	- 5.3	-19.2
GROUP B	5					+10.2	+ 0.4	+ 8.2	- 5.7
	6					-10.0	-19.9	-14.3	+ 4.2
	7					-16.1	-13.3	-11.5	-18.8
	8					-19.3	- 2.5	-22.6	- 6.3
	9					+ 1.0	- 1.3	+ 9.0	-13.3
	10					-15.2	- 6.9	-23.6	- 1.5
GROUP C	11					- 5.8	- 9.4	- 0.8	- 5.0
	12					-17.7	- 9.2	- 0.5	-10.3

* Gain is indicated by +; loss is indicated by -.

TABLE III

IN BREAKING STRENGTH AFTER LAUNDERING

(Pounds)

Number of Times Laundered									
1		5				10			
Wet		Dry		Wet		Dry		Wet	
Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
15.3	12.2	19.7	12.7	17.4	11.0	15.7	10.0	16.0	10.1
46.3	43.4	53.0	43.8	42.6	36.1	48.0	41.0	40.0	39.7
58.5	62.3	77.9	74.6	51.0	65.0	67.7	70.2	67.0	62.0
36.2	26.7	56.7	47.0	36.7	29.7	48.5	47.5	35.0	27.0
87.5	35.0	95.0	26.2	93.3	41.6	80.2	24.2	88.5	37.5
56.2	41.7	75.4	34.1	61.1	46.1	65.5	29.4	53.0	34.5
19.2	18.3	20.2	35.8	17.8	17.9	15.8	33.1	15.5	14.2
73.7	51.7	82.2	57.5	70.8	47.5	85.2	54.0	78.8	46.2
57.0	45.1	62.5	54.1	57.0	41.0	62.2	53.6	58.7	39.7
56.7	32.8	55.6	36.0	43.0	25.8	48.5	37.0	49.8	30.5
38.3	30.7	36.9	35.3	32.2	23.1	25.4	33.2	36.9	29.0
24.1	19.2	26.3	21.3	25.1	19.4	26.2	22.9	24.6	18.0
Percentage Change in Strength									
-19.8	-10.3	- 9.2	- 2.3	- 9.9	-19.1	-27.6	-23.0	-16.2	-25.7
- 5.5	+ 0.9	- 8.3	- 4.6	-13.0	-16.0	-17.0	-10.7	-18.3	- 7.2
- 6.3	+ 9.5	+10.8	+13.9	- 2.3	+14.2	- 3.7	+ 7.2	+ 7.4	+ 9.0
- 5.3	-19.2	- 5.4	+21.8	- 4.2	-32.6	-19.1	+23.0	- 8.6	-20.5
+ 8.2	- 5.7	+13.1	+ 1.9	+15.4	+18.1	- 2.9	- 5.8	+ 9.4	+ 6.5
-14.3	+ 4.2	- 5.2	-13.0	- 6.9	+15.2	-21.4	-25.0	-19.2	-13.5
-11.5	-18.8	-16.5	- 4.8	-18.0	-16.2	-34.7	-12.0	-28.6	- 8.5
-22.6	- 6.3	-18.6	-10.4	-25.7	-13.9	-15.6	-15.9	-17.3	-16.3
+ 9.0	-13.3	- 7.0	-21.4	+ 9.0	-21.1	- 7.5	-22.1	+10.3	-23.7
-23.6	- 1.5	-22.3	-17.6	-42.0	-22.5	-32.2	-15.3	-32.8	- 8.4
- 0.8	- 5.0	-10.9	-10.4	-16.6	-28.5	-38.7	-16.7	- 4.4	-10.2
- 0.5	-10.3	-16.8	- 7.4	- 4.6	- 9.3	-15.8	- 0.5	- 2.5	-13.1

ILLUSTRATION III

PERCENTAGE CHANGE IN BREAKING STRENGTH

AFTER LAUNDERING

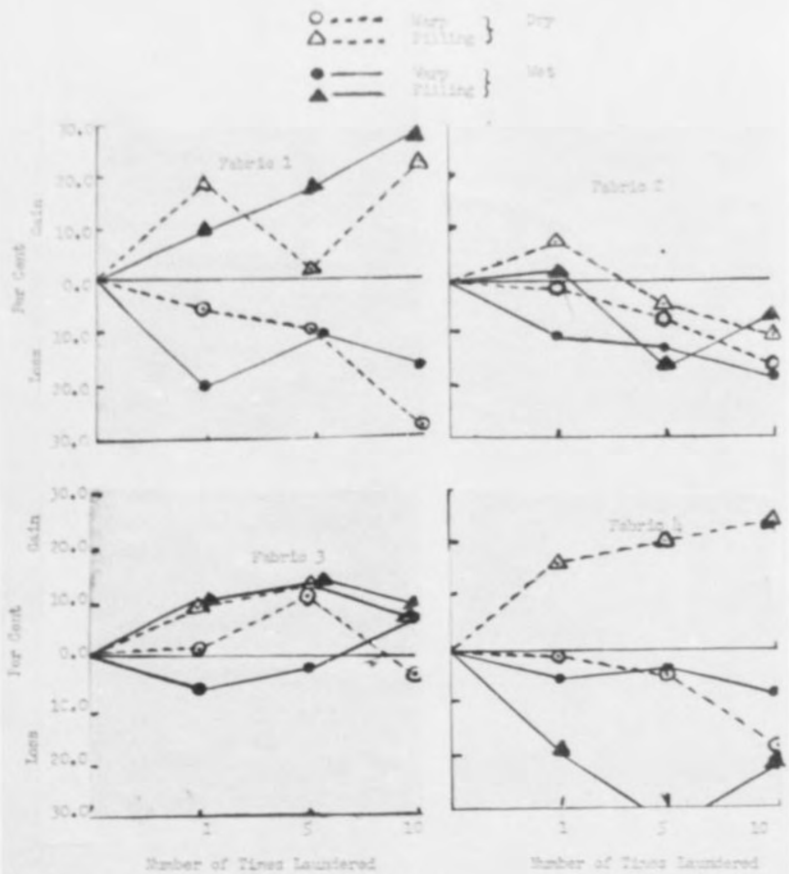


ILLUSTRATION III (continued)

PERCENTAGE CHANGE IN [illegible]

AFTER LAUNDERING

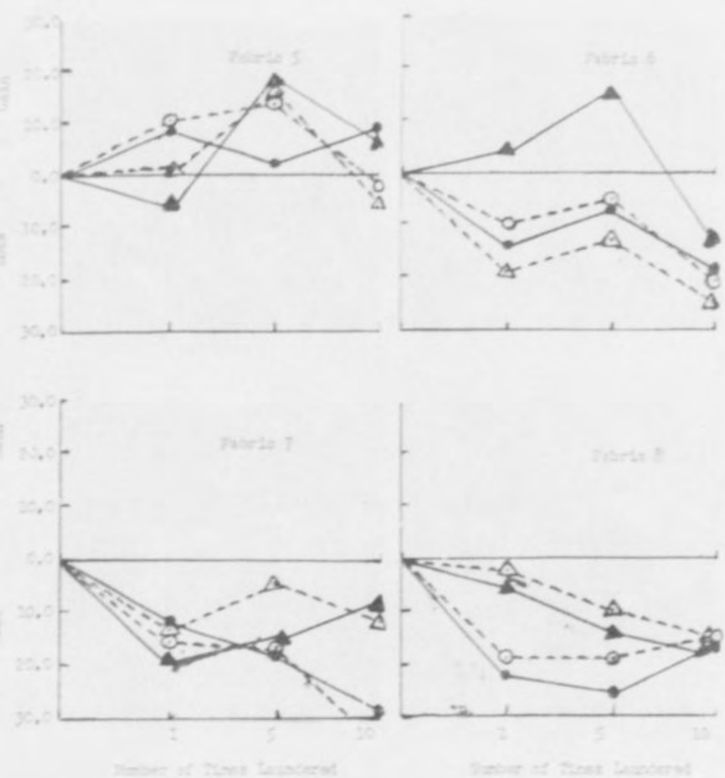


TABLE IV

CHANGES IN BREAKING STRENGT

(Pounds)

	Fabric Number	Original				1			
		Dry		Wet		Dry		Wet	
		Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
GROUP A	1	21.7	13.0	19.1	13.6	14.7	16.5	12.1	15.0
	2	57.8	45.9	49.0	43.0	61.0	49.4	49.6	42.1
	3	70.3	65.5	62.4	56.9	70.0	63.0	62.8	59.7
	4	59.9	38.6	38.3	22.4	53.3	38.3	35.5	23.0
GROUP B	5	82.9	25.7	80.9	35.2	74.2	30.3	92.7	43.0
	6	79.5	39.2	65.6	40.0	65.0	34.7	62.0	52.3
	7	24.2	37.6	21.7	15.4	23.6	35.0	17.5	16.9
	8	101.0	64.2	95.9	55.2	87.4	62.0	82.5	47.3
	9	67.2	68.8	52.3	52.0	59.2	70.2	77.9	56.0
	10	71.6	43.7	74.2	33.3	56.1	41.1	61.2	36.0
GROUP C	11	41.4	39.4	38.6	32.3	39.4	36.4	29.6	33.9
	12	31.6	23.0	24.0	21.4	25.2	23.8	23.3	20.3
GROUP A	1					-32.3	+26.8	-36.7	+10.5
	2					+ 5.5	+ 7.7	+12.2	- 2.0
	3					- 0.4	- 3.8	+0.6	+ 4.9
	4					- 9.4	- 0.8	- 7.3	+ 2.6
GROUP B	5					-10.5	+17.9	+14.6	+22.2
	6					-18.3	-11.5	- 5.5	+31.0
	7					- 2.5	- 6.9	-19.4	+ 9.7
	8					-13.5	- 3.4	-12.6	-14.3
	9					-11.3	+ 2.3	+49.0	+ 7.7
	10					-21.6	- 5.9	-17.5	+ 8.1
GROUP C	11					- 4.8	- 7.6	-23.2	+ 4.9
	12					-20.0	+ 3.5	- 2.9	- 5.2

* Gain is indicated by +; loss is indicated by -.

TABLE IV

N BREAKING STRENGTH AFTER DRY CLEANING

(Pounds)

		Number of Times Dry Cleaned							
		5				10			
Wet		Dry		Wet		Dry		Wet	
Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
12.1	15.0	26.0	15.6	19.6	11.4	22.8	16.3	22.3	13.4
49.6	42.1	61.2	47.2	49.5	43.9	61.9	46.8	47.2	43.3
62.8	59.7	76.1	69.8	66.1	63.2	76.1	58.2	66.3	61.9
35.5	23.0	58.9	44.6	36.7	23.6	64.4	41.1	35.8	21.6
92.7	43.0	95.7	36.6	95.5	39.9	90.5	25.6	98.7	38.0
62.0	52.3	76.6	40.0	63.8	49.0	74.8	35.9	62.5	51.7
17.5	16.9	25.4	34.6	20.6	16.6	21.8	30.0	19.2	15.4
82.5	47.3	78.3	60.4	89.1	57.2	83.4	56.2	72.1	51.8
77.9	56.0	58.6	70.7	72.4	57.6	68.9	57.3	73.0	46.7
61.2	36.0	51.0	45.0	59.3	28.8	48.6	44.9	43.1	30.9
29.6	33.9	40.0	37.4	34.1	27.4	37.3	35.3	34.2	31.6
23.3	20.3	23.3	21.2	22.8	21.0	23.7	21.8	24.6	19.1
		Percentage Change in Strength							
-36.7	+10.5	+ 9.8	+20.0	+23.6	-16.2	+ 4.6	+25.4	+16.7	- 1.5
+12.2	- 2.0	+ 5.8	+ 2.8	+ 1.0	+ 2.0	+ 7.1	+ 2.0	- 3.7	+ 0.7
+0.6	+ 4.9	+ 8.3	+ 4.3	+ 5.9	+11.1	+ 8.3	-11.3	+ 6.3	+ 8.8
- 7.3	+ 2.6	-14.3	+15.5	- 4.2	+ 5.1	+ 7.5	+ 6.5	- 6.3	- 3.6
+14.6	+22.2	+15.5	+42.2	+14.4	+13.4	+19.2	- 3.9	+22.1	+ 8.0
- 5.5	+31.0	- 3.6	- 2.0	- 2.7	+22.5	- 5.9	- 8.4	- 4.7	+29.3
-19.4	+ 9.7	+ 4.9	- 8.0	- 5.1	+ 7.3	- 9.9	-20.2	-11.5	0.0
-12.6	-14.3	-22.5	- 5.9	- 7.1	+ 3.6	-17.4	- 4.7	-24.9	- 6.2
+49.0	+ 7.7	-12.8	+ 2.8	+38.4	+10.7	+ 2.5	-16.7	+29.6	-10.4
-17.5	+ 8.1	-28.8	+ 3.0	-20.1	-13.4	-32.1	+ 2.7	-41.8	-10.3
-23.2	+ 4.9	- 3.4	- 5.1	-11.6	-15.2	- 9.9	-10.4	-11.4	- 2.2
- 2.9	- 5.2	-26.2	- 7.8	- 5.0	- 1.9	-25.0	- 5.2	+ 2.0	-10.7

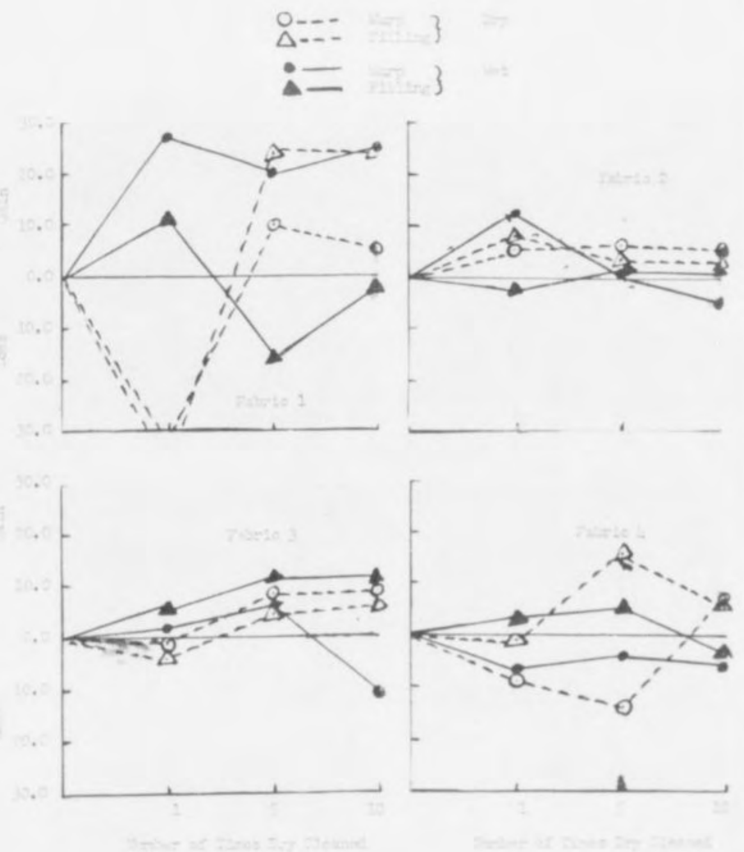

Warp
Filling
Dry
Wet
Fabric 1
Fabric 2
Fabric 3
Fabric 4
Per Cent
Gain
Loss
Number of Times Dry Cleaned
Number of Times Dry Cleaned

ILLUSTRATION IV (continued)

PERCENTAGE CHANGE IN BREAKING STRENGTH

AFTER DRY CLEANING

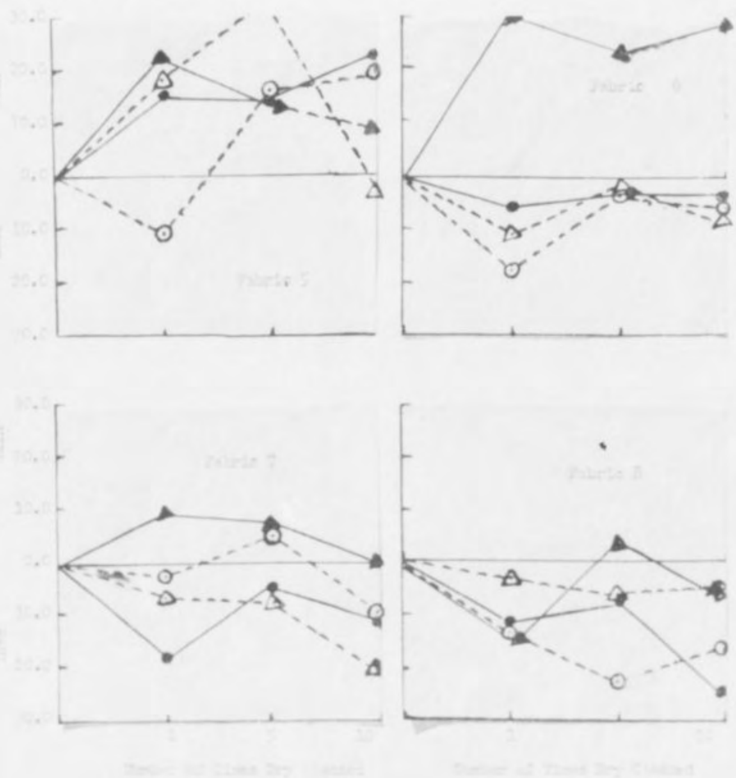


ILLUSTRATION IV (Continued)

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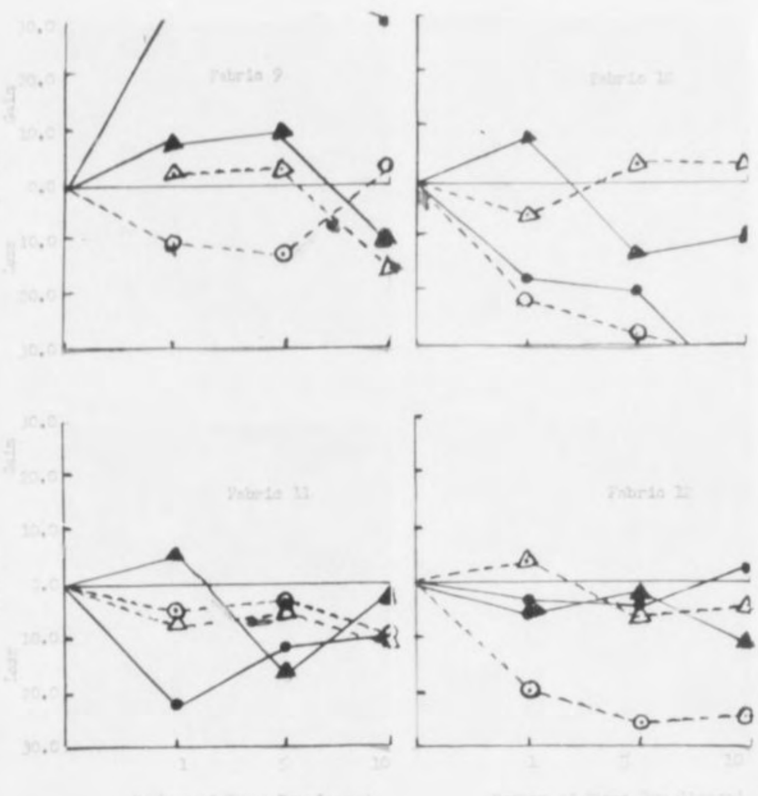

After the first dry cleaning, fabrics 3 and 4 of Group A showed excellent maintenance of strength. Fabric 2 changed less than 10 per cent in all tests except the wet warp strength which showed a slight gain of 12.2 per cent. Fabric 1 showed the greatest percentage changes in both dry and wet warp and filling strengths.

Fabric 2 in Group A showed less than 10 per cent change in dry and wet, warp and filling strengths after the fifth dry cleaning. The wet warp strength of fabric 3 and the wet warp and filling strengths of fabric 4 were also within this amount.

After the tenth dry cleaning fabrics 2 and 4 of Group A showed less than 10 per cent change in all strength tests.

There was no fabric in Group B that showed less than 10 per cent change in wet and dry, warp and filling, after the first laundering. However, the dry strengths, warp and filling, of fabric 9 and the wet strengths, warp and filling, of fabric 5 showed less than 10 per cent change.

No fabric in Group B showed less than 10 per cent change in all tests after the fifth laundering. The dry filling of fabrics 5, 7 and 9 showed excellent strength retention. This was also true of the wet warp strength of fabrics 6 and 9. The greatest change was found in fabric 10 where there was a 42.0 per cent loss in the warp strength when wet.

After 10 launderings fabric 5 showed less than 10 per cent change. The dry warp strength of fabric 9 and the wet filling strengths of fabrics 7 and 10 showed less than 10 per cent change. The greatest change was a loss of 34.7 per cent found in the dry warp strength of fabric 7.

As in laundering, there was no fabric in Group B which had less than 10 per cent change in all tests after each dry cleaning period. After the first dry cleaning, the dry tests for both warp and filling of fabric 7 and the dry filling strengths of fabrics 8, 9 and 10 showed less than 10 per cent. The wet tests showed less than 10 per cent in the warp direction of fabric 6 and in the filling direction of fabrics 7, 9 and 10.

Fabric 7 in Group B showed less than 10 per cent change in all tests after the fifth cleaning. The dry strength of fabric 6 and the wet strength of fabric 8 were less than 10 per cent. The dry filling of fabrics 8, 9 and 10 and the wet warp strength of fabric 6 maintained less than 10 per cent change. The greatest change in dry strength was found in the filling of fabric 5 with an increase of 42.2 per cent. The greatest change in wet strength was found in the warp of fabric 9 with an increase of 38.4 per cent.

All fabrics in Group B showed more than 10 per cent change after 10 dry cleanings. Less than 10 per cent change in dry strength was found in the warp and filling of fabric 6, the warp of fabrics 7 and 9 and in the filling of fabrics 5, 8, and 10. Less than 10 per cent in wet strength was found in the warp of fabric 6 and in the filling of fabrics 5, 7 and 8. The greatest changes in Group B, after 10 dry cleanings, were found in the warp of fabric 10 with a loss of 32.1 per cent dry and 41.8 per cent wet.

After the first laundering, fabric 11 in Group C showed excellent maintenance of strength in both wet and dry tests. The dry filling and the wet warp of fabric 12 showed less than 10 per cent change.

Neither fabric in Group C showed less than 10 per cent change in all tests after the fifth or tenth laundering period.

After the first dry cleaning, neither fabric in Group C showed less than 10 per cent change in all tests. The greatest change was found in the wet warp strength of fabric 11 with a loss of 23.2 per cent.

After five dry cleaning periods, the dry strength of fabric 11 showed less than 10 per cent change. With the exception of the dry warp strength, fabric 12 showed less than 10 per cent change.

Neither fabric in Group C showed less than 10 per cent change in all tests after 10 dry cleanings. The dry warp strength of fabric 11 and the dry filling strength of fabric 12 showed less than 10 per cent change. The wet filling of fabric 11 and the wet warp strength of fabric 12 were also less than 10 per cent.

Bursting strength. The bursting strength tests were better indications of fabric strength than the tensile strength tests. This is thought to be due to the fact that a square inch of fabric is tested by this method. The test shows the combined strengths of both warp and filling yarns. The 10 per cent standard used in tensile strength has been used in comparison of bursting strengths of the fabrics used in the study.

As in tensile strength tests, dry cleaned fabrics showed better maintenance of strength than laundered fabrics. No laundered fabric showed less than 10 per cent change in both dry and wet tests after all testing periods.

After ten cleanings, all four fabrics in Group A showed less than 10 per cent change in all tests. Each fabric in this group was rated as having excellent maintenance of strength. After the tenth cleaning the greatest change in Group A was found to be the wet strength of fabric 1 with a loss of 6.6 per cent. No fabric in Group B showed less than 10 per cent change in all testing periods, while two showed the desired amount in all dry tests and one in all wet tests. Fabric 11 in Group C showed less than 10 per cent change in all dry cleaning tests.

After the tenth testing period there were 6 fabrics showing less than 10 per cent change in laundering as compared with 7 fabrics after dry cleaning. The changes in all tests showed dry cleaning to have slightly better effect on the maintenance of strength than laundering. Twenty-three of the 36 tests (wet and dry) made on the dry cleaned fabrics showed less than 10 per cent change as compared with 11 tests after laundering.

The number of tests showing increase in strength was greater than the number showing decrease.

Data pertaining to the bursting strength of the fabrics in pounds and the percentage changes at each laundering and dry cleaning period are shown in Tables V and VI and in Illustration V. Trends in bursting strength are described in the following paragraphs.

Fabric 3 in Group A showed the lowest percentage of change in strength during all laundering tests. After 10 launderings the dry strength test showed no loss or gain and the wet test showed only 0.6 per cent gain. Fabric 1 also showed less than 10 per cent change after ten laundering periods.

Fabric 4 showed the greatest changes in all testing periods. After the first laundering period the wet test showed a loss of 13.8 per cent. The dry test showed an increase of 8.6 per cent. Tests, after 10 launderings, showed the dry strength had increased 15.4 per cent and the wet had increased 9.7 per cent. This increase was probably due to high shrinkage caused by weave and high rayon percentage content.

All tests of Group A showed less than 10 per cent change after dry cleaning. The greatest changes were found in fabrics 1 and 4 with changes ranging from a loss of 6.6 per cent to an increase of 6.2 per cent.

TABLE V

CHANGES IN BURSTING STRENGTH AFTER LAUNDERING

(Pounds)

	Fabric Number	Number of Times Laundered: Original		1		5		10	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
GROUP A	1	96	77	89	69	89	64	88	70
	2	160	140	161	139	140	126	150	123
	3	200+	172	198	175	200+	191	200+	173
	4	130	93	112	101	159	102	150	102
GROUP B	5	145	149	148	169	160	170	147	176
	6	125	156	110	152	137	162	126	146
	7	55	52	60	51	70	54	60	51
	8	152	141	174	170	183	179	190	179
	9	172	156	200	169	192	170	184	149
	10	153	142	156	125	148	140	160	135
GROUP C	11	112	114	124	104	135	117	124	113
	12	93	98	107	94	108	101	105	97
				Percentage Change					
GROUP A	1			- 7.3	-10.4	- 7.3	-16.8	- 8.3	- 9.1
	2			+ 0.6	- 0.7	-12.5	-10.0	- 6.3	-12.2
	3			- 1.0	+ 1.7	0.0	+11.0	0.0	+ 0.6
	4			-13.8	+ 8.6	+22.3	+ 9.7	+15.4	+ 9.7
GROUP B	5			- 2.7	+13.4	+10.3	+14.1	+ 1.4	+18.1
	6			-12.0	- 2.5	+ 9.6	+ 2.5	+ 0.8	- 6.4
	7			+ 9.1	- 1.9	+27.4	+ 3.8	+ 9.1	- 1.9
	8			+14.5	+20.3	+20.2	+27.7	+27.6	+27.7
	9			+16.3	+ 8.4	+11.6	+ 9.0	+ 7.0	- 4.5
	10			+ 2.0	-11.9	- 3.3	- 1.4	+ 4.6	- 4.9
GROUP C	11			+10.7	- 8.8	+20.5	+ 2.6	+10.7	- 0.9
	12			+15.1	- 4.1	+16.1	+ 3.1	+12.9	- 1.0

* Gain is indicated by +; loss is indicated by -.

ILLUSTRATION V

PERCENTAGE CHANGE IN BREAKING STRENGTH

AFTER LAUNDERING AND DRY CLEANING

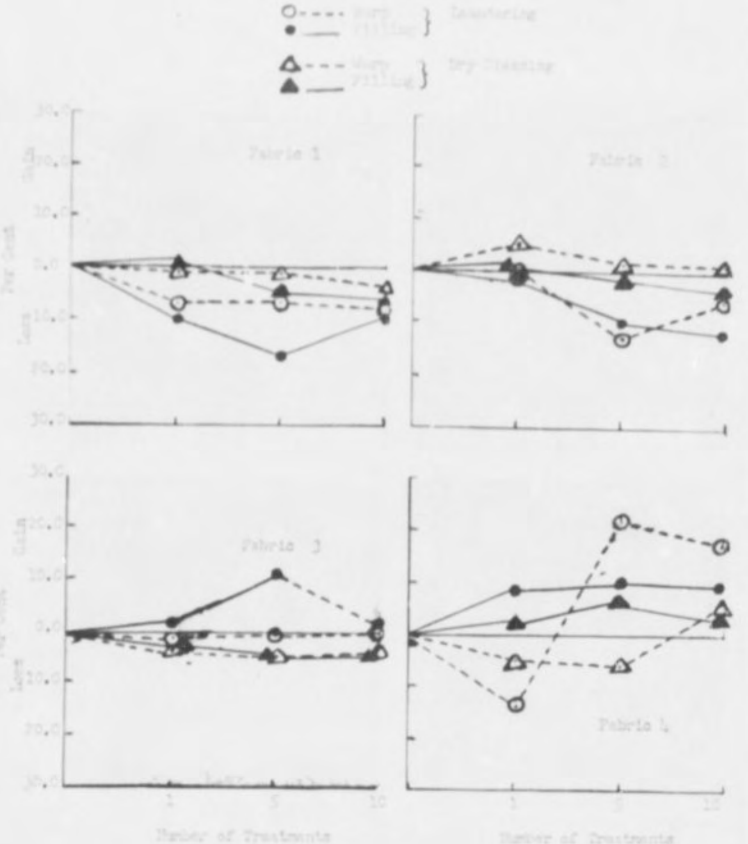

ILLUSTRATION V (continued)

PERCENTAGE CHANGE IN BURSTING STRENGTH

AFTER LAUNDERING AND DRY CLEANING

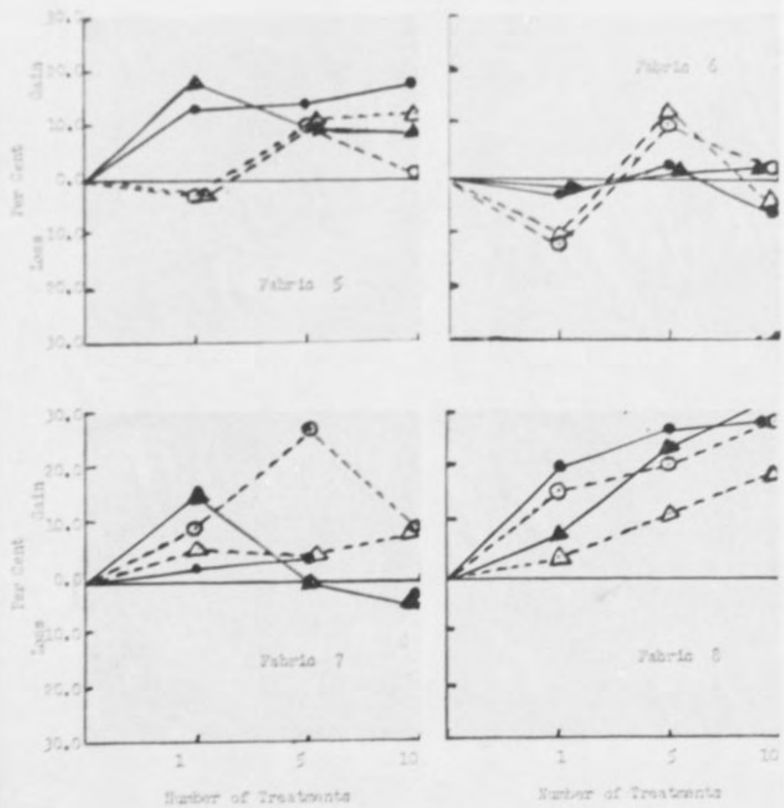

ILLUSTRATION V (continued)

PERCENTAGE CHANGE IN BURSTING STRENGTH

AFTER LAUNDERING AND DRY CLEANING

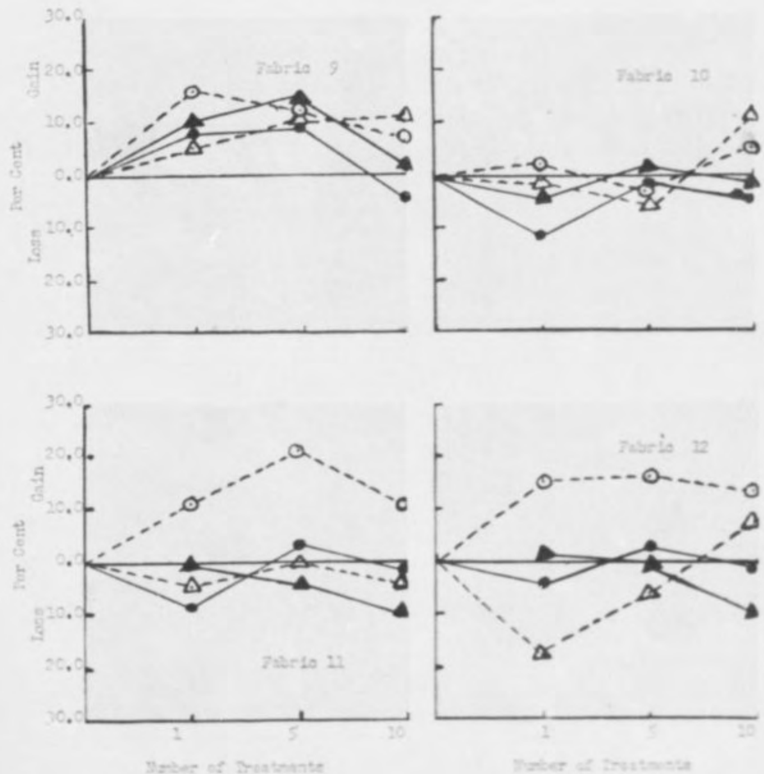

TABLE VI

CHANGES IN BURSTING STRENGTH AFTER DRY CLEANING

(Pounds)

	Fabric Number	Number of Times Dry Cleaned: Original		1		5		10	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
GROUP A	1	96	77	95	77	95	73	91	72
	2	160	140	169	139	161	138	162	134
	3	200+	172	194	167	190	164	192	164
	4	130	93	123	94	122	99	138	96
GROUP B	5	145	149	142	176	161	164	162	162
	6	125	156	113	153	140	158	119	159
	7	55	52	59	60	56	52	60	51
	8	152	141	158	153	168	173	170	187
	9	172	156	182	172	190	178	191	159
	10	153	142	152	136	144	143	152	159
GROUP C	11	112	114	106	114	112	109	110	104
	12	93	98	76	99	88	98	100	88
				Percentage Change					
GROUP A	1			- 1.0	0.0	- 1.0	- 5.5	- 4.2	- 6.6
	2			+ 5.6	- 0.7	+ 0.6	- 1.4	+ 1.2	- 4.3
	3			- 3.0	- 2.9	- 5.0	- 4.7	- 4.0	- 4.7
	4			- 5.4	+ 1.8	- 6.2	+ 6.5	+ 6.2	+ 3.2
GROUP B	5			- 2.3	+18.1	+11.0	+10.1	+11.7	+ 8.7
	6			- 9.6	- 1.9	+12.0	+ 1.3	- 4.8	+ 1.9
	7			+ 7.3	+15.4	+ 1.8	0.0	+ 9.1	- 1.9
	8			+ 3.8	+ 8.5	+10.5	+22.7	+18.4	+32.6
	9			+ 5.8	+10.3	+10.5	+14.1	+11.1	+ 1.9
	10			- 0.7	- 4.2	- 5.9	+ 0.7	- 0.7	+11.9
GROUP C	11			- 5.4	0.0	0.0	- 4.4	- 1.8	- 8.7
	12			-18.3	+ 1.0	- 5.5	0.0	+ 7.5	-10.2

* Gain is indicated by +; loss is indicated by -.

Greater changes were found in Group B in both the laundered and dry cleaned fabrics. No fabric showed less than 10 per cent change in all laundering tests. With the exception of either the wet or dry test after the first laundering, fabrics 6, 9 and 10 showed less than 10 per cent change in all tests. Fabric 7 showed less than 10 per cent change with the exception of the dry test after the fifth laundering which showed an increase of 27.4 per cent.

Fabric 8 showed the greatest change in all tests with an increase after each testing. After 10 launderings, fabric 8 showed an increase of 27.6 per cent dry and 27.7 per cent wet. All other fabrics, with the exception of the wet test of fabric 5, showed less than 10 per cent change after the tenth laundering period.

The strength changes of the laundered fabrics and the dry cleaned fabrics of Group B were similar. Dry cleaned fabrics showed the same general trend as did the laundered fabrics in Group B. No fabric showed less than 10 per cent change at all testing periods. Fabrics 6, 7 and 10 exceeded the desired 10 per cent in only one test each. After 10 cleanings fabrics 6 and 7 showed less than 10 per cent change. Fabrics 5, 9 and 10 showed only slightly more than 10 per cent change in either the dry or wet tests after 10 cleaning periods.

Fabric 8 showed the greatest change with an increase of 18.4 per cent in dry strength and 32.6 in wet strength.

Neither fabric in Group C showed less than 10 per cent change after any laundering period. After 10 tests fabric 11 showed an increase of 10.7 per cent dry and a loss of 0.9 per cent wet.

Fabric 11 showed less than 10 per cent change in all dry cleaning tests. Fabric 12 showed a loss of 18.3 per cent in dry strength after the first cleaning and 10.2 per cent loss in wet strength after the tenth cleaning. All other tests showed less than 10 per cent change.

Results of colorfastness tests. All colorfastness results were rated by the following classification:

- Class I - No color change
- Class II - Little change from the original
- Class III - Definite change from the original but could still be worn
- Class IV - Very evident color change, could not be used again.

Colorfastness to light. All fabrics were tested in the Fade-Ometer for 20 and 40 hour periods. Textiles which show no appreciable change in color after exposure to light for 20 hours are considered satisfactory for use where moderate fastness to light is desirable. Fabrics which show no appreciable change after 40 hours of exposure may be expected to give satisfactory performance where good fastness to light is essential.[2] The classifications of colorfastness to light are presented in Table VII.

After 20 hours of exposure, fabric 1 showed slight change in color and was rated as Class II. All other fabrics in Group A were rated as Class I.

After 40 hours of exposure, fabric 1 was rated as Class III and fabric 3 as Class II. All other fabrics in Group A were rated as Class I.

Fabric 8 in Group B was rated as Class II after 20 hours of exposure. All other fabrics in Group B were rated as Class I.

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2 U. S. Department of Commerce, "Textiles - Testing and Reporting, Commercial Standard C559-44," U. S. Department of Commerce, Washington, D. C., 1944, pp. 22-23.

TABLE VII

CLASSIFICATION OF COLORFASTNESS TO LIGHT

	Fabric Number	Time Exposed to Light: 20 hours (Class)	40 hours (Class)
GROUP A	1	II	III
	2	I	I
	3	I	II
	4	I	I
GROUP B	5	I	II
	6	I	II
	7	I	I
	8	II	II
	9	I	I
	10	I	II
GROUP C	11	I	I
	12	I	I

TABLE VIII

CLASSIFICATION OF COLORFASTNESS TO CROCKING

	Fabric Number	Dry (Class)	Wet (Class)
GROUP A	1	I	I
	2	I	II
	3	I	II
	4	I	III
GROUP B	5	I	III
	6	I	III
	7	I	II
	8	I	II
	9	I	II
	10	I	I
GROUP C	11	I	I
	12	I	I

After 40 hours of exposure fabrics 5, 6, 8 and 10 were rated as Class II. Fabrics 7 and 9 were rated as Class I.

Both fabrics in Group C were rated as Class I in both tests.

Colorfastness to crocking. Each fabric was tested for colorfastness to crocking both dry and wet. The importance of this test as applied to wearing apparel is questioned. However, permanency of the dyes applied to fabrics of these types were of interest. The results of each test are included in Table VIII.

All fabrics tested were rated as Class I after the dry tests.

After the wet tests, fabric 1 in Group A was given a Class I rating. Fabrics 2 and 3 were rated Class II and fabric 4 was rated Class III. Only one fabric, number 10, in Group B was rated as Class I in the wet tests. Fabrics 7, 8 and 9 were rated as Class II and fabrics 5 and 6 as Class III. Both fabrics in Group C were rated as Class I.

Colorfastness to laundering. Colorfastness to both fading and bleeding are of importance to the consumer. It is assumed that garments made of these fabrics would be laundered individually. However, it is quite possible that the garment could be trimmed or combined with fabrics of other fibers. It is often true that an even fading of a garment is not as objectionable as a loss of color that is transferred to another part of the garment. The classifications of fading and bleeding during laundering after the first, fifth and tenth testing periods are presented in Table IX.

Class I and II fading would be considered satisfactory in use. In most cases, the fabrics tested were in these classes. The most noticeable changes were noted after the tenth laundering period.

All fabrics except fabric 6 were classified as having Class I fading after the first laundering. Class I ratings were maintained through ten

TABLE IX

CLASSIFICATION OF FADING AND BLEE

Fabric Number	1			2			3			4			5			6			7	
Times Laundered	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5
Fading Class	I	I	I	I	II	II	I	I	II	I	III	IV	I	I	I	II	II	III	I	I
Bleeding Class																				
Wool	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	III	II	II	I	I
Viscose	I	I	I	I	I	I	I	I	I	II	II	I	IV	IV	IV	II	II	II	I	I
Silk	I	I	I	I	I	I	I	I	I	I	I	I	II	IV	III	IV	III	II	I	I
Cotton	I	I	I	I	I	I	I	I	I	III	II	I	IV	IV	IV	II	I	I	I	I
Acetate	I	I	I	I	I	I	I	I	I	I	I	I	I	II	II	IV	IV	IV	I	I
Nylon	I	I	I	I	I	I	I	I	I	I	I	I	III	IV	III	IV	IV	IV	I	I

TABLE IX

IFICATION OF FADING AND BLEEDING AFTER LAUNDERING

5			6			7			8			9			10			11			12		
1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10
I	I	I	II	II	III	I	I	I	I	I	II	I	II	III	I	II	III	I	II	III	I	I	I
I	I	I	III	II	II	I	I	I	I	I	I	I	I	I	II	I	I	II	III	IV	I	I	I
IV	IV	IV	II	II	II	I	I	I	I	I	I	III	II	I	II	I	I	II	III	III	I	I	II
II	IV	III	IV	III	II	I	I	I	I	I	I	I	I	I	III	I	I	III	IV	IV	I	I	I
IV	IV	IV	II	I	I	I	I	I	I	I	I	IV	IV	II	III	II	II	II	III	III	I	I	II
I	II	II	IV	IV	IV	I	I	I	I	I	I	I	I	I	I	I	I	III	IV	IV	I	I	I
II	IV	III	IV	IV	IV	I	I	I	I	I	I	I	I	I	II	II	I	III	IV	IV	I	I	I

TABLE IX

IFICATION OF FADING AND BLEEDING AFTER LAUNDERING

5			6			7			8			9			10			11			12		
1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10
I	I	I	II	II	III	I	I	I	I	I	II	I	II	III	I	II	III	I	II	III	I	I	I
I	I	I	III	II	II	I	I	I	I	I	I	I	I	I	II	I	I	II	III	IV	I	I	I
IV	IV	IV	II	II	II	I	I	I	I	I	I	III	II	I	II	I	I	II	III	III	I	I	II
II	IV	III	IV	III	II	I	I	I	I	I	I	I	I	I	III	I	I	III	IV	IV	I	I	I
IV	IV	IV	II	I	I	I	I	I	I	I	I	IV	IV	II	III	II	II	II	III	III	I	I	II
I	II	II	IV	IV	IV	I	I	I	I	I	I	I	I	I	I	I	I	III	IV	IV	I	I	I
II	IV	III	IV	IV	IV	I	I	I	I	I	I	I	I	I	II	II	I	III	IV	IV	I	I	I

launderings by fabrics 1, 5, 7 and 12. Fabrics 2, 3 and 8 were rated no lower than Class II after ten launderings. Fabrics 6, 9, 10 and 11 were rated as Class III after ten launderings and fabric 4 was rated Class IV after ten launderings.

The fabrics in Group A showed excellent resistance to bleeding. Class I ratings were given on all yarns in the composite cloth attached to fabrics 1, 2 and 3. Fabric 4 showed traces of color in the cotton and viscose yarns after the first and fifth launderings. The color disappeared after the tenth laundering.

Of the fabrics in Group B, only fabrics 7 and 8 maintained a Class I rating on all fibers in the composite cloth through ten launderings. All other fabrics in this group showed bleeding that would be unsatisfactory in consumer use.

Fabric 11 in Group C showed unsatisfactory bleeding in all laundering tests. After the tenth laundering, fabric 12 showed slight traces of color on the viscose and cotton yarns of the composite cloth. Fabric 12, however, would be expected to give satisfaction in consumer use.

Results of colorfastness to dry cleaning. Results of colorfastness to dry cleaning are presented in Table X.

All fabrics were rated as Class I in resistance to fading after the first dry cleaning. After ten dry cleanings fabrics 1, 5, 6, 7 and 12 were rated as Class I. This would indicate excellent performance. After five cleanings fabrics 2, 9, 10 and 11 were rated as Class II and fabric 4 as Class III. Fabrics 3, 8 and 10 were rated as Class II after ten cleanings and fabrics 2, 9 and 11 as Class III. After ten cleanings fabric 4 was rated as Class IV.

TABLE X

CLASSIFICATION OF FADING AND BLEED

Fabric Number	1			2			3			4			5			6			7		
Times Laundered	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	1
Fading Class	I	I	I	I	II	III	I	I	II	I	III	IV	I	I	I	I	I	I	I	I	
Bleeding Class																					
Wool	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
Viscose	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
Silk	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
Cotton	I	I	I	I	I	I	I	I	I	I	II	II	I	I	II	I	I	I	I	I	
Acetate	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
Nylon	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	

TABLE X

ON OF FADING AND BLEEDING AFTER DRY CLEANING

	6			7			8			9			10			11			12		
0	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10	1	5	10
I	I	I	I	I	I	I	I	I	II	I	II	III	I	II	II	I	II	III	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

There was very little bleeding during dry cleaning. Fabric 4 was rated as Class II after the fifth and tenth cleaning. Fabric 5 was rated as Class II after the tenth cleaning. All other tests were rated as Class I.

All fabrics would be expected to give satisfaction to fading in consumer use up to the fifth cleaning. Fabrics 2, 4, 9 and 11 would not be satisfactory to fading after five cleanings. All fabrics would give satisfaction in colorfastness to bleeding.

IV. RESULTS OF GARMENT STUDY

Adaptability of the fabric to garment construction. The adaptability of the fabrics to garment construction was determined from information supplied by the persons who made the garments. An evaluation of the adaptability to garment construction is given in Table XI.

All the fabrics were of suitable weight for the style of garment selected. Various descriptions were given on the hand of the fabrics. Two fabrics were described as being harsh. Coarse, scratchy, and soft were other terms used to describe a fabric. Three fabrics were described as smooth and six were described as stiff.

It was visibly apparent in four of the combination fabrics that synthetic fibers had been used in the construction, but it was not possible to determine visually which synthetic fiber had been used. It was not apparent in either of the suiting fabrics that a synthetic was used. The Orlon in three fabrics produced a sheen similar to that found in early rayon fabrics.

There were various responses to typical methods used in garment construction. The elimination of excess fullness produced the greatest problem. It was necessary to recut the sleeve of two garments in order to

TABLE XI

ADAPTABILITY TO GARMENT CONSTRUCTION

	Garments Made from Fabrics							
Fabric Number	2	3	5	6	9	10	11	12
Suitability of Material:								
Too heavy								
Satisfactory	x	x	x	x	x	x	x	x
Too light								
Description of Hand:								
Harsh						x	x	
Coarse					x			
Soft				x				
Fine								x
Smooth		x	x	x				
Scratchy	x							
Stiff		x	x		x	x	x	x
Flimsy								
Apparent Synthetic Used:								
Yes			x		x		x	x
No	x	x		x		x		
Response to Garment Construction:*								
Cutting	G	G	G	G	S	G	S	G
Control during work	G	G	S	G	G	G	S	S
Hand sewing	G	P	S	G	S	P	S	S
Resistance to fraying	G	P	S	G	S	S	S	S
Machine stitching	G	G	G	G	G	G	S	P
Gathering	S	S	G	G	S	P	G	G
Elimination of excess fullness	P	P	S	P	P	P	P	P
Pleating or creasing	S	G	G	S	S	G	P	S
Pressing:								
Dry	P	P	S	S	S	S	P	P
Moist	S	S	G	G	G	G	S	S

* G - Good
S - Satisfactory
P - Poor

produce a satisfactory finish to the sleeve cap. No fabric was rated as good in elimination of excess fullness.

It was found that all fabrics were easily cut with sharp shears. In some fabrics it was difficult to pass the needle through the fabric and produce the desired size of hand stitch. Fabrics 3 and 10 showed the greatest problem in hand sewing. Fabrics 5, 9, 11 and 12 produced some difficulties in hand sewing but they were not considered serious problems. Pin basting was possible in all fabrics but required careful handling to prevent the pins slipping out of the fabrics.

Fabric 2 and 6 showed good resistance to fraying, while fabric 3 showed the greatest fraying problem during construction.

All machine stitching was done with mercerized cotton thread. The original plan included the use of silk or synthetic thread. Nylon thread was the only synthetic thread available in the local stores. It was impossible to match the colors of the fabrics with either nylon or silk thread. There was no difficulty encountered in using the mercerized thread. Fabric 12 was the only fabric which required adjustment of the machine tension. It was thought that this was due to the open weave in the fabric construction rather than to the presence of a synthetic fiber.

The stiff, harsh hand caused fabric 10 to produce the greatest problem in gathering. Fabrics 2, 3 and 9 presented slight difficulties in gathering because of the stiffness of the fabric finish. Fabrics 11 and 12 were rated lowest in response to pleating. This difficult pleating problem was considered due to the crepe construction of the fabric and not to the fiber used.

Even though all the fabrics were recommended as requiring only light pressing, it was found that moisture was needed to give the desired finish to fabrics 2, 3, 11 and 12. All other fabrics responded satisfactorily to light, dry pressing.

It was concluded that fabrics 2, 5 and 6 gave the best response to garment construction. When consumers are informed of the problems likely to arise in the handling of these fabrics, techniques and procedures that will minimize these problems should be recommended.

Serviceability of garments in wear. At the end of the wear period the garments were returned to the laboratory and evaluated by the research staff. Results of the evaluation are given in Table XII.

The number of hours each garment was worn ranged from 135 to 292 hours. The number of times each garment was laundered or dry cleaned ranged from two to seven treatments. Garments made from fabrics 2 and 3 were dry cleaned at each cleaning period because of the high shrinkage found in the laboratory testing of these fabrics. Even though the fabrics were recommended as being washable, it was felt that too much money had been invested in the fabrics to risk excessive shrinkage in laundering.

Fabric 6 showed the poorest maintenance of original qualities. After five laundering periods the garment was not desirable for use by the wearer. Fading was very noticeable and perspiration stains across the back and under the arms caused a complete color change. The surface appearance was roughened to the point of appearing napped, making the fabric undesirable. Fabric 3 showed slight change in appearance, color and hand, but this was not objectionable for further wear. Fabrics 3, 6, 10 and 12 became softer after each treatment. This softness was not objectionable to the wearers although it would be objectionable in garments where permanent stiffness is a consideration. Fabric 9 showed the greatest problem

TABLE XII

SERVICEABILITY IN WEAR

	Garments Made from Fabrics							
	2	3	5	6	9	10	11	12
Hours Worn*	167	135	219	227	167	257	223	292
Times Laundered	--	--	6	5	2	7	6	5
Times Dry Cleaned	2	3	--	--	--	--	--	--
Maintenance of Original Qualities								
a. Appearance	G	S	G	P	G	G	G	G
b. Color	G	S	G	P	G	G	S	G
c. Hand	G	S	S	S	G	S	G	S
Resistance to Indications of Wear								
a. Seam slippage	G	G	G	G	G	G	G	G
b. Breaking of machine stitch	G	S	G	G	G	G	G	S
c. Spots and stains	G	G	P	P	G	G	G	G
d. Fabric damage	G	P	S	S	G	S	S	G
e. Seam finishes								
(1). Unfinished	P	P	P	P	P	P	S	P
(2). Pinked	S	P	S	G	G	P	S	P
(3). Pinked and stitched	S	S	S	G	G	P	G	P
(4). Self-hemmed	G	G	S	G	G	S	G	S

* Reported as the nearest full hour of wear.

G - Good
S - Satisfactory
P - Poor

in pressing after each laundering period. It was found that a great deal of moisture was necessary in pressing to give the desired finish to the garment.

There were very few indications of wear on any garment. There was no seam slippage and only two garments showed breakage of machine stitching. These faults were found under one arm each in garments made of fabrics 3 and 12. Fabrics 5 and 6 showed spots of grease which could not be removed in laundering. There were several indications of fabric damages in the garments. Fabric 3 showed holes and thread pulls, therefore was rated as poor. Fabric 5 showed holes caused by acid, and fabric 11 showed fusing which resulted from too high a temperature in pressing. Indications of slippage were apparent in the handworked buttonholes of the garments made from fabric 10 and in the bound buttonholes of the garment made from fabric 6.

The wearing qualities of seam finishes varied greatly. No fabric showed good results in all four finishes. Representative portions of the seam finishes of each garment are shown in Illustrations VI - XIII.

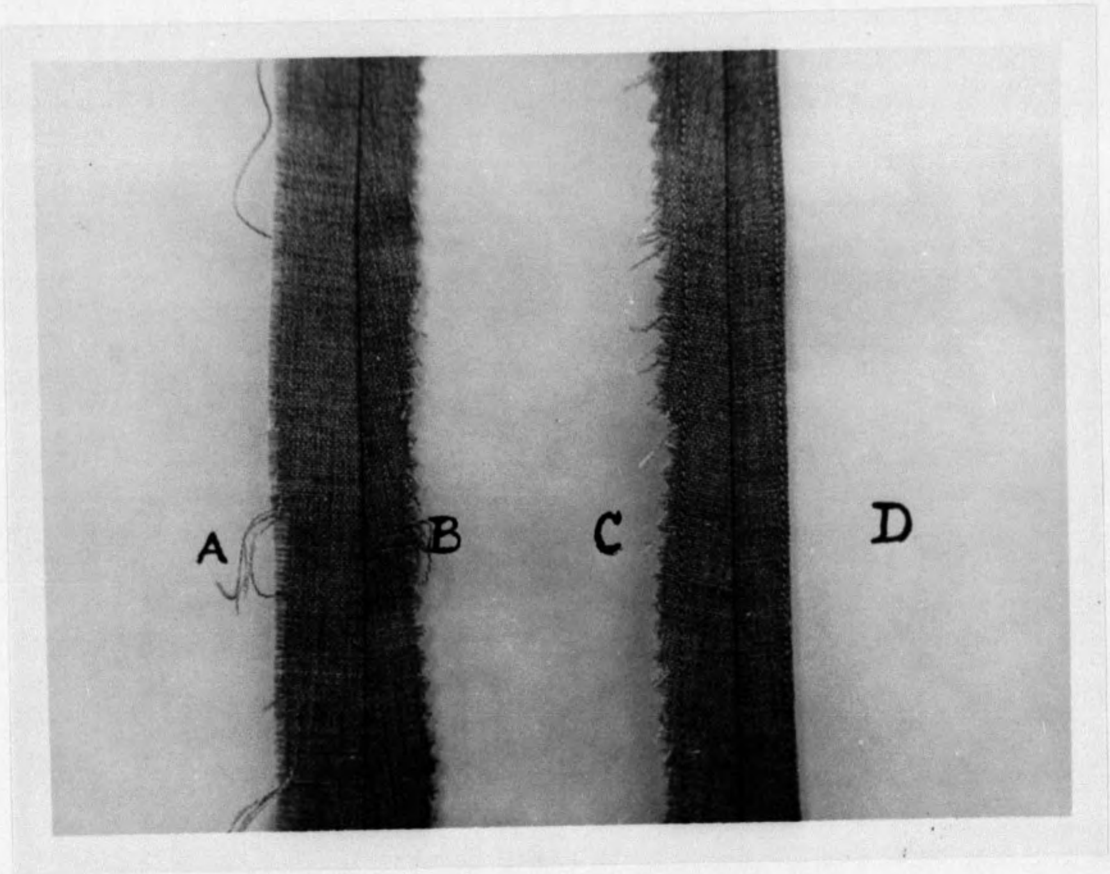
The unfinished seam was classified as a poor finish for all fabrics except fabric 11 which was rated as satisfactory. The pinked seam finish was rated as good in fabrics 6 and 9; satisfactory in fabrics 2, 5 and 11, and poor in fabrics 3, 10 and 12. The pinked and stitched seam finish was rated good in fabrics 6, 9 and 11; satisfactory in fabrics 2, 3 and 5, and poor in fabric 12. The self-hemmed finish was good in all garments except those made from fabrics 5, 10 and 12 which were satisfactory.

The unfinished seam, as often used in the manufacture of lower cost garments, would not be recommended for any of the fabrics studied. The self-hemmed seam finish was most satisfactory, although this showed raveling of

ILLUSTRATION VI

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 2

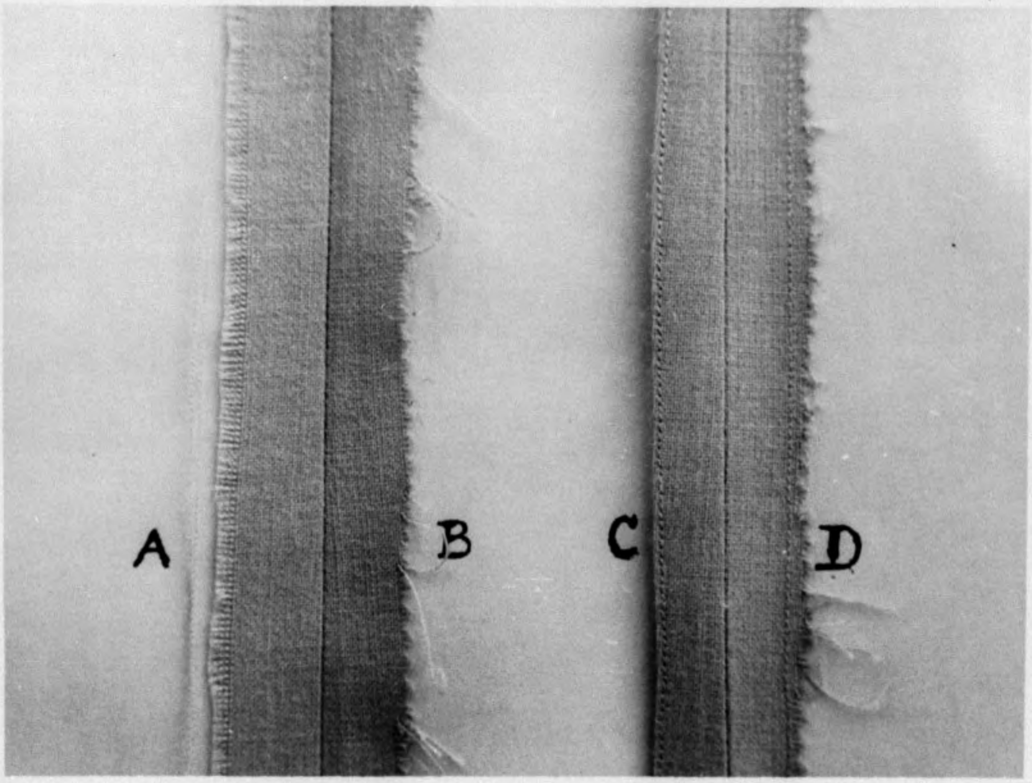


A - Unfinished
B - Pinked
C - Pinked and machine stitched
D - Self-hemmed

ILLUSTRATION VII

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 3

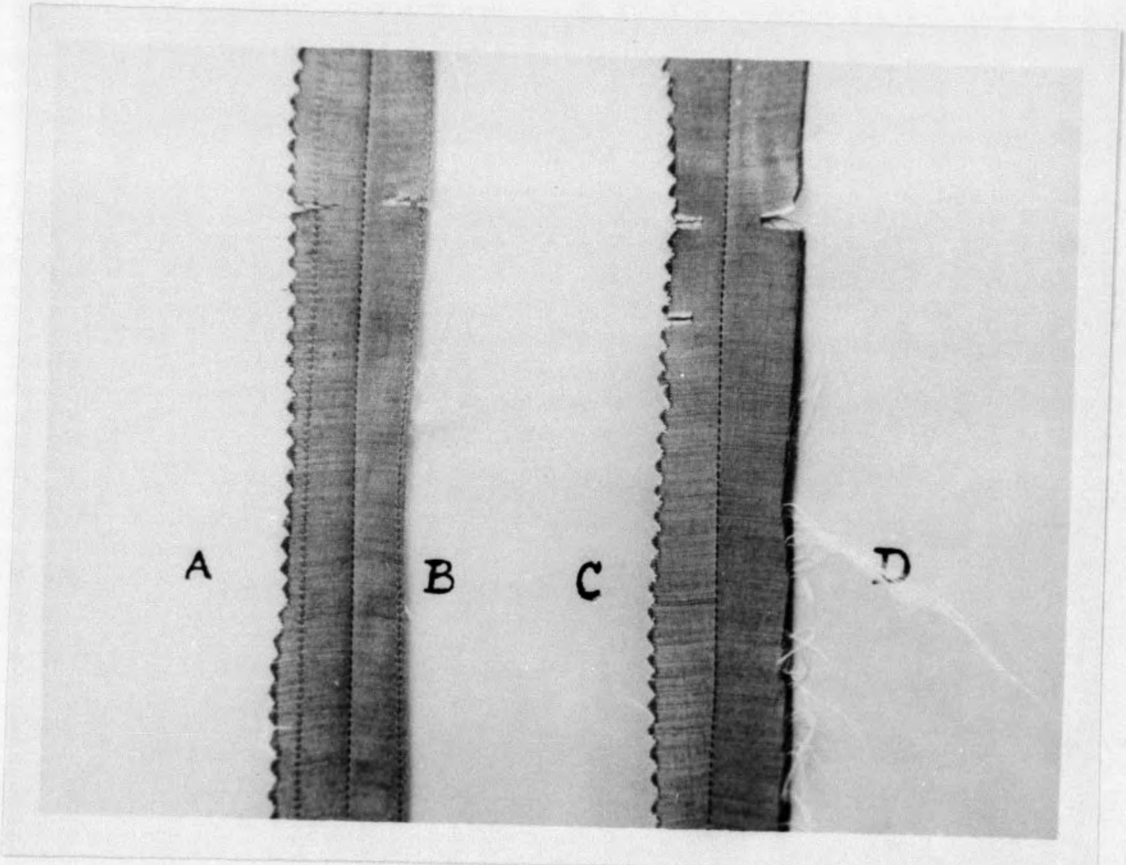


A - Unfinished
B - Pinked
C - Self-hemmed
D - Pinked and machine stitched

ILLUSTRATION VIII

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 5

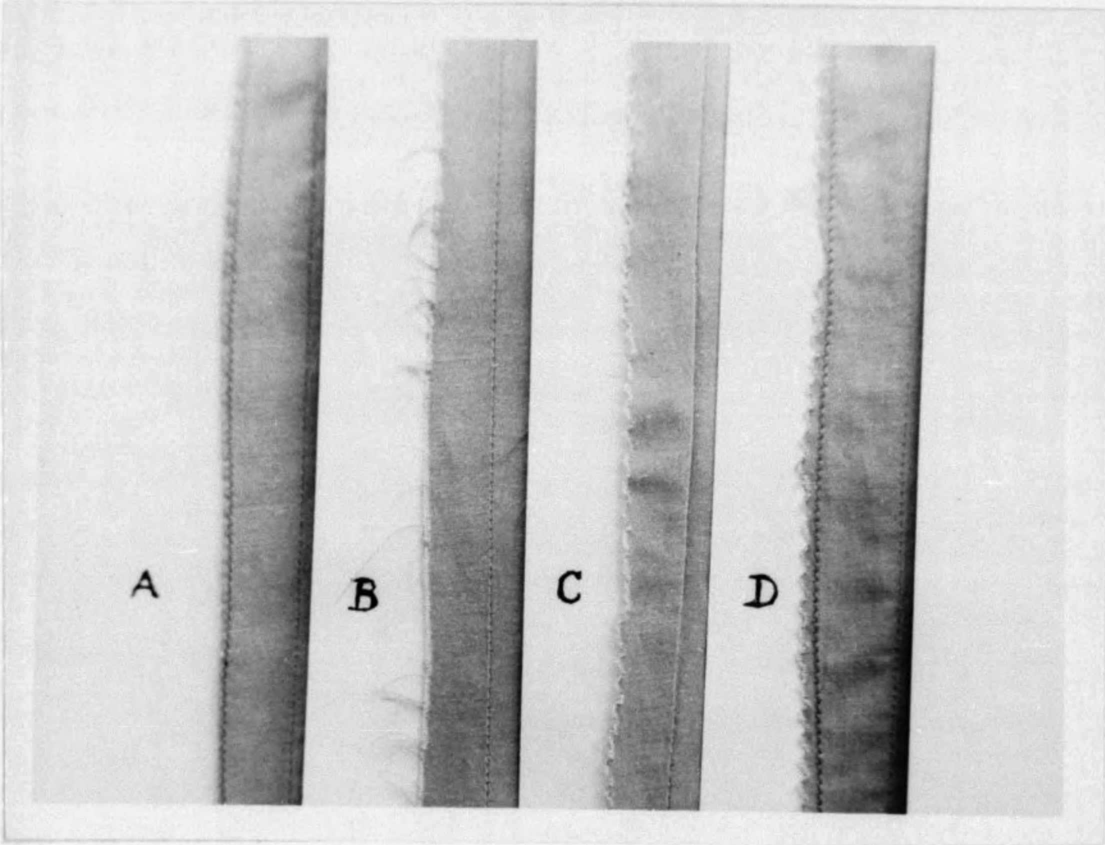


A - Pinked and machine stitched
B - Self-hemmed
C - Pinked
D - Unfinished

ILLUSTRATION IX

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 6

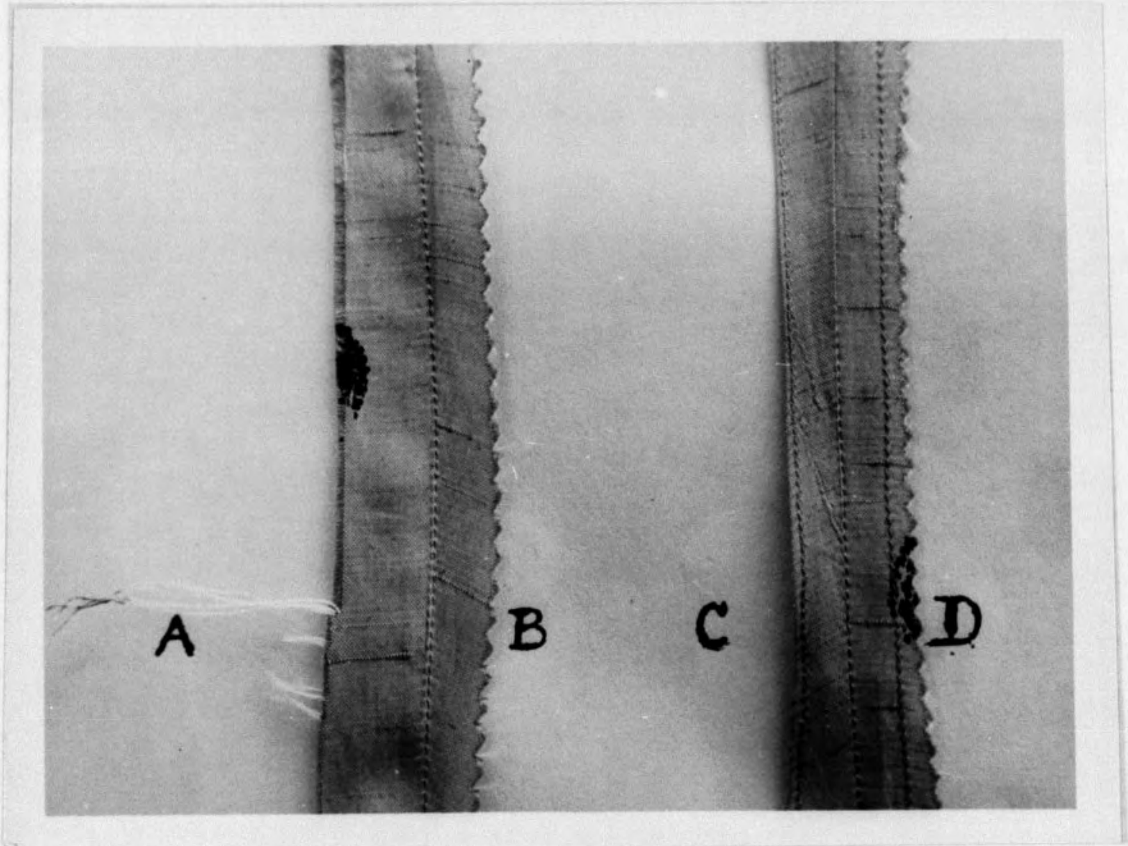


A - Self-hemmed
B - Unfinished
C - Pinked
D - Pinked and machine stitched

ILLUSTRATION X

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 9

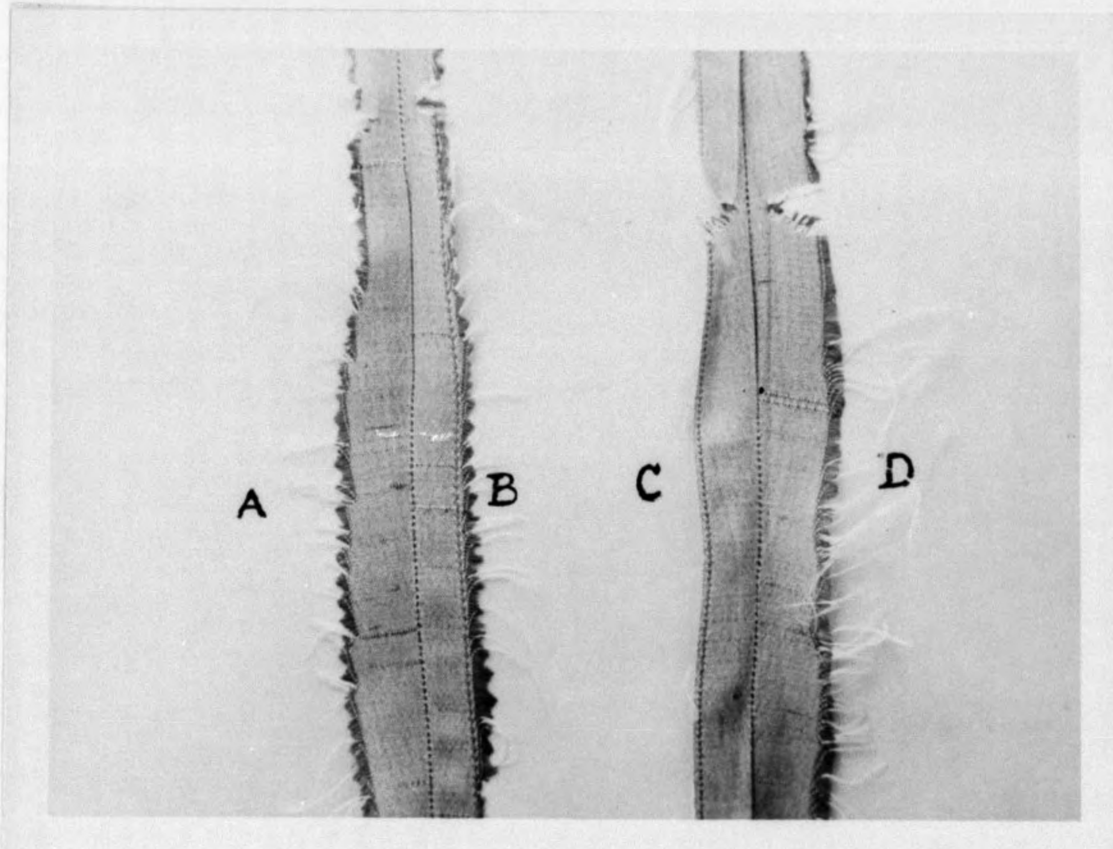


A - Unfinished
B - Pinked
C - Self-hemmed
D - Pinked and machine stitched

ILLUSTRATION XI

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 10

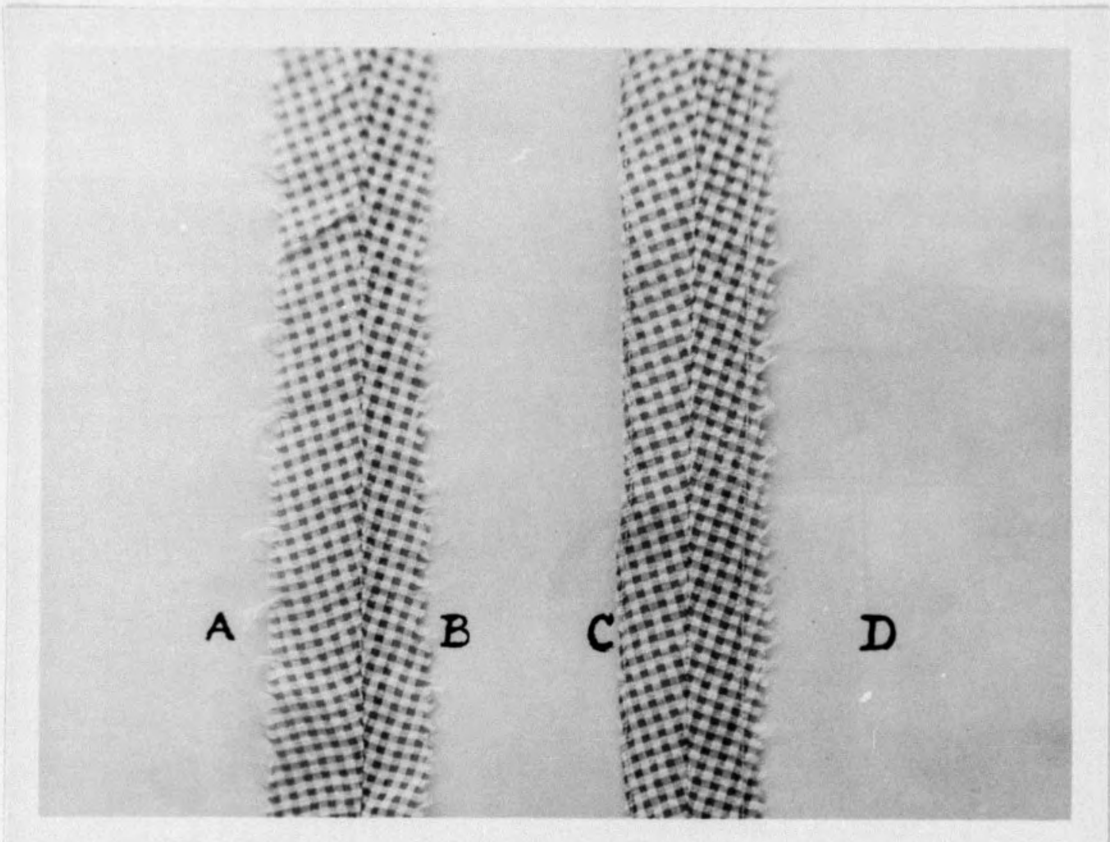


A - Pinked
B - Pinked and machine stitched
C - Self-hemmed
D - Unfinished

ILLUSTRATION XII

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 11

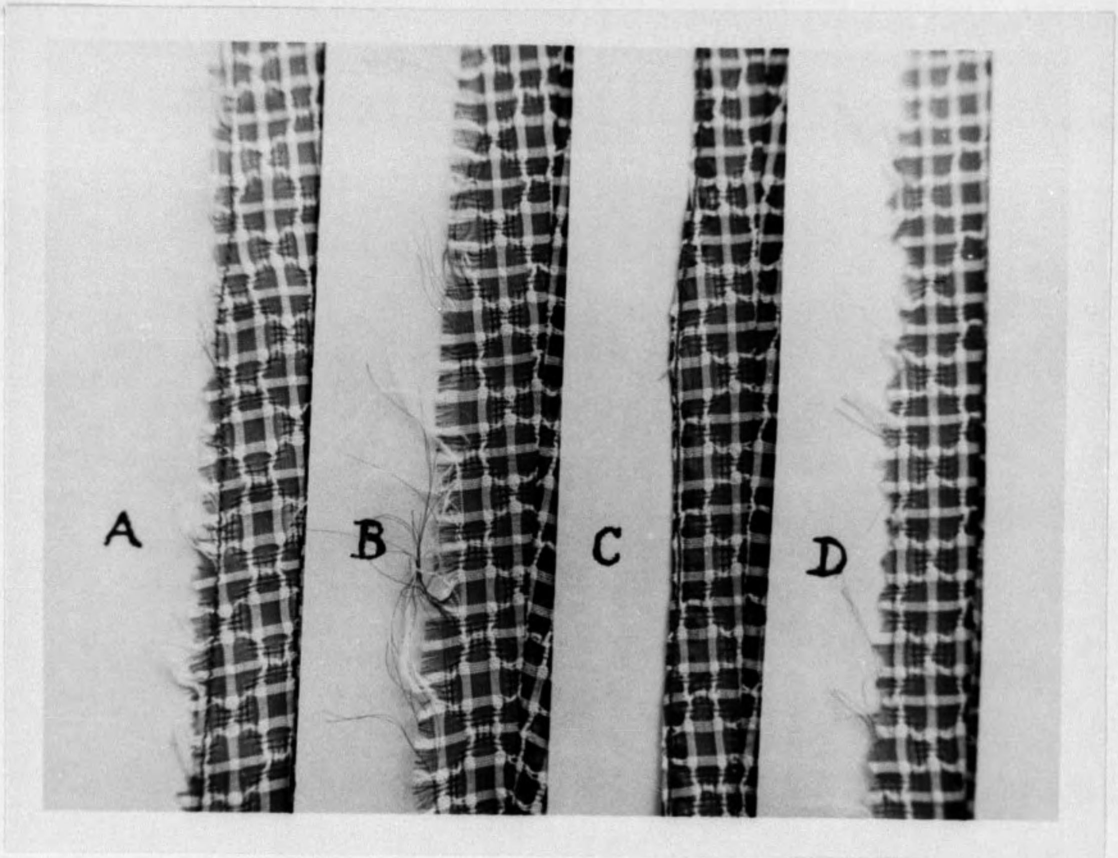


A - Unfinished
B - Pinked
C - Self-hemmed
D - Pinked and machine stitched

ILLUSTRATION XIII

SERVICEABILITY OF GARMENT SEAM

FINISHES MADE FROM FABRIC 12



A - Pinked and machine stitched
B - Unfinished
C - Self-hemmed
D - Pinked

the under edges. Fabrics 10 and 12 presented the greatest problems in seam finishes. The self-hemmed seams were the only ones that could be considered satisfactory for fabrics 10 and 12.

Most consumers would expect a garment to be usable more than one season. The fraying of seams, indications of fabric damage, and color changes noted in the garment made from fabric 6 would make this fabric unsatisfactory in use. All other fabrics gave satisfactory performance during the wearing period. It is quite probable that they would be satisfactory for more than one season of wear.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Manufacturers are producing many new fibers for use in clothing fabrics both as individual fibers and in combination with natural fibers. Various claims for the unusual properties of the "wonder" or "miracle" fibers are being made. The synthetic fibers resemble natural fibers and in many respects exceed certain properties of the natural fibers.

The purpose of this study was to compare a selected number of fabrics of synthetic blends and combinations of fibers. Their construction, performance in laboratory testing and their adaptability to garment construction techniques used in home sewing were tested.

Twelve fabrics were selected for laboratory testing and eight of the selected fabrics were made into garments for wear tests. Attempts were made to determine answers to some of the questions in the minds of the consumer and home sewer.

I. SUMMARY OF RESULTS

It was found that there were very few fabrics of the newer synthetic fibers in the retail stores. The amount of yardage and the variety of fabrics on the counters was not as great as the promotional material would lead the consumer to expect. Blends or combinations of four synthetic fibers, nylon, Dacron, Orlon and Acrilan, were found in small amounts in various stores.

It was apparent that each fabric mixture must be evaluated individually and that the present laboratory testing methods are not entirely satisfactory as a measure of performance in use. The properties manifested by each fabric mixture will vary with the kind and percentage of fibers used and the yarn and fabric structure. The laboratory study showed that there were differences in the construction and durability of each fabric. Some of the changes in fabric properties were of sufficient amounts to be of great concern to the consumer in end use.

The laboratory analysis of the selected fabrics showed that no two fabrics were of the same fiber content or fabric construction. The differences in fiber content or fabric construction were in some cases part of the reason for the great differences in the results of serviceability tests.

Changes in dimensions occurred in all fabrics after laundering and dry cleaning. Fabric 11 was the only one showing less than 10 per cent change after ten laundering and dry cleaning tests. The dimensional stability of all the other fabrics varied greatly. The percentage of dimensional changes tended to increase after each treatment. Dry cleaning proved to give better stability than laundering.

The heavy dress weight fabrics, Group A, which were constructed of blends of staple fibers showed the greatest dimensional changes after laundering, however fabrics in this group retained good dimensional stability up to and including the fifth dry cleaning. Regardless of claims for washability, it would not be advisable to launder any garment made from fabrics of this group.

Percentage dimensional changes of fabrics 5, 7 and 8 of Group B were high. It was concluded that garments made from these three fabrics would not give satisfactory dimensional stability through ten laundering periods.

The similarity of the all nylon, Orlon and silk yarns in Group B was of interest. Tests proved the dimensional stability of the man-made, nylon and Orlon, and the natural fiber, silk, to be very similar. Group B showed better stability in dry cleaning than in laundering. However, there were cases in which the change exceeded the desired 2.0 per cent and would not be satisfactory in consumer use.

The two fabrics in Group C proved to retain good dimensional stability after both laundering and dry cleaning. The use of two synthetic yarns of similar dimensional stability produced fabrics which would be satisfactory in consumer use.

The laboratory tests of tensile strength revealed that losses and gains in strength occurred during both laundering and dry cleaning periods. More cases showed gains in strength than losses in strength. In some cases the changes were great enough to be of concern to the consumer in end use. These variations could have been caused by dimensional changes and fusion of the synthetic yarns during the cleaning processes. Dry cleaned fabrics showed better maintenance of strength than those that were laundered. Variations in strength were found after each treatment, and no two fabrics reacted in the same manner. In most cases synthetic yarns showed a higher strength than the natural fibers, both dry and wet.

Bursting strength tests showed that better maintenance of strength was obtained in dry cleaning than in laundering. There was no fabric which showed less than 10 per cent change in both wet and dry tests after ten laundering periods. All fabrics in Group A showed less than 10 per cent change after ten dry cleanings. Fabric 11 in Group C also showed less than 10 per cent change after ten dry cleanings. There were many fluctuations in strength during the testing periods. It was thought that these fluctuations might be influenced by heat, used in cleaning, which may have caused some melting and fusing of the fibers.

After ten testing periods there were more fabrics with less than 10 per cent change in strength than after the first testing period. This fact would indicate that even though there were fluctuations in strengths during each cleaning period, there was a tendency for the fabrics to become better stabilized as the cleaning periods increased.

Colorfastness to light was good with the exception of one fabric which showed definite change in color. None of the fabrics were rated as objectionable for garment use because of poor light fastness. All fabrics were rated as excellent in colorfastness to dry cleaning. Two fabrics showed definite color changes in wet crocking but would not be objectionable in use. After the tenth laundering three fabrics showed definite fading and one was rated as undesirable for use. The difference between fading during laundering and dry cleaning was negligible.

Bleeding was the greatest problem found in the colorfastness tests. It was much more evident during laundering than during dry cleaning. Fabrics showing noticeable bleeding of colors would not be satisfactory in consumer use when a different fabric is used as trimming for a garment.

The adaptability of the fabrics to garment construction was considered good in most cases. The synthetic staple yarns were not visibly apparent while the synthetic filament yarns were apparent in three fabrics. The greatest problem encountered in the garment construction process was the elimination of excess fullness. This difficulty could be avoided by the use of patterns designed with little excess fullness. Hand sewing was more difficult on these blended or combined fabrics than in fabrics of similar construction using natural fibers. Skillful handling was required in hand sewing and pin basting. All the fabrics responded satisfactorily to machine sewing and no difficulties were encountered in using cotton or mercerized thread. Although some of the fabrics were recommended as requiring no pressing, it was found that light pressing was desirable and moisture was required in some cases.

Only one fabric showed poor maintenance of original qualities after the first wear period. Fading, produced by laundering and perspiration, caused fabric 6 to be undesirable for use after five laundering periods and 227 hours of wear. The garments showed few indications of wear and would be very satisfactory to the abrasion encountered in consumer use. One fabric was damaged by acid and one by fusion resulting from too high a temperature used in pressing.

The unfinished seam would not be recommended for any of the fabrics studied. Any of the other finishes would give satisfactory service in the heavy or medium weight fabrics. The self-hemmed seam finish was most satisfactory in all fabrics. Fabrics 10 and 12 showed the greatest problem in seam finishes. This was thought to be caused by the yarn and weave used in constructing the fabric.

The fabrics included in this study were of great interest in that they represented new and unusual fabrics. Attempts are being made to produce fabrics that look attractive and wear well. Great progress has been made and the synthetic or "miracle" fibers have proved to add many desirable qualities to the properties of the natural fibers.

It is probable that many of the fabrics studied were still in the experimental stage and were sold before being perfected. While laboratory tests showed that each fabric did not live up to all the claims, the majority responded quite satisfactorily to basic sewing techniques and to wear.

Consumers will continue to desire fabrics that look attractive and wear well. It is to be expected that steady improvements in synthetic fabrics will be seen in the next few years and fewer dramatic claims will be emphasized by the manufacturer. The consumer may then have the assurance that the less practical fabrics will be discontinued. Those that remain on the market will be perfected or "engineered" to suit the specific needs of the consumer.

II. CONCLUSIONS

From this study the following conclusions were drawn:

1. The fabrics containing newer synthetic fibers were not as available as promotional material implied.

2. Greater dimensional changes occurred during laundering than during dry cleaning. The use of moisture increased shrinkage and all fibers were affected to some degree even though several were hydrophobic fibers.

3. Regardless of claims for washability, the amounts of dimensional change indicated in end use testing would make it inadvisable to launder any garments made from fabrics in Group A and some of the fabrics in Group B.

4. In a majority of the fabrics the strength changes were not sufficient to affect the serviceability of the fabric.

5. Bleeding during laundering was the greatest problem encountered in the colorfastness tests. Although all fabrics were sold as washable, not all dyes were completely fast to laundering.

6. The home sewer should be well informed of the problems likely to be encountered in producing satisfactory construction techniques and finishes of garments containing synthetic fibers.

7. Although fabrics of synthetic fibers are often recommended as requiring no pressing, attractive finishes on many of the fabrics required light pressing; and, in some cases, the application of moisture was necessary. Proper temperatures for pressing should be given.

III. RECOMMENDATIONS FOR FURTHER STUDY

The following recommendations are suggested for further study:

1. To continue research in order to record the results of improvements made in future fabrics of these synthetic fibers.

2. To determine the crease resistance of Orlon blended fabrics.

3. To compare the serviceability of fabrics made of blends or combinations of a selected synthetic with fabrics of the same construction using natural fibers.

4. To compare laboratory dry cleaned fabrics with the same fabrics cleaned by commercial establishments.

5. To compare the abrasion of fabrics of synthetic blends or combinations with similar fabrics made of natural fibers.

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APPENDIX

EXHIBIT A

REPORT ON GARMENT CONSTRUCTION

Garment Number______________ Date of Report____________________

Name of Person Reporting_____________________________________

1. How did you like the weight of this material for the type of garment selected?

   Too heavy_______ Satisfactory__________ Too light___________

2. What is your opinion of the hand or "feel" of the material? (Underline the adjective which might describe your opinion.)

   Harsh, coarse, soft, fine, smooth, scratchy, stiff, flimsy.

3. Is it easily apparent that a synthetic fiber has been used in this fabric?

   Yes________________________ No__________________________

4. Explain the reason for your answer to question 3.

   ____

   ____

   ____

5. How did the fabric respond to these construction problems?

	Good	Satisfactory	Poor
a. Cutting of garment	___	______	___
b. Control of fabric during work	___	______	___
c. Hand sewing	___	______	___
d. Resistance to fraying	___	______	___
e. Machine stitching	___	______	___
f. Gathering	___	______	___
g. Elimination of excess fullness	___	______	___
h. Pleating (or creasing)	___	______	___
i. Pressing			
Dry	___	______	___
Moist	___	______	___

6. Explain in detail any unusual problems encountered during construction.

   ____

   ____

   ____

   ____

EXHIBIT B

REPORT ON GARMENTS AFTER WEAR AND LAUNDERING

1. Were any changes noted in the fit of the garment?

   Yes____________________ No____________________

   Explain. ____

   ____

2. Were there any changes in the hand or "feel" of the fabric?

   Yes____________________ No____________________

   Explain____

   ____

3. Were any changes noted in the appearance of the fabric?

   Yes____________________ No____________________

   Explain.____

4. Evaluate the responses to the following factors:
   a. Comfort during wear ________________________

   b. Resistance to wrinkles ________________________

   c. Resistance to soiling ________________________

5. Note indications of fabric damage or failure in details of construction during wear. (i.e., seam slippage, fabric weakness, breaking of machine stitching, fraying of seams, or other objectionable weaknesses.)

   ____

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