A STUDY TO EVALUATE THE DURABILITY AND CARE OF THE COTTON UNIFORMS OF WHITNEY VOCATIONAL HIGH SCHOOL, TOLEDO, OHIO

Thesis for the Degree of M. A.
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Bertha Knapp Robertson

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This is to certify that the

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A STUDY TO EVALUATE THE DURABILITY AND CARE OF THE COTTON UNIFORMS OF WHITNEY VOCATIONAL HIGH SCHOOL, TOLEDO, OHIO

by

Bertha Knapp Robertson

A Thesis

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Introduction

The cotton fabrics used for the uniforms at the Whitney Vocational High School, Toledo, Ohio, were not giving satisfactory service. These fabrics, made into uniforms by the students in clothing in the Power Machine Shop, shrunk, did not wear equally well under various service conditions, nor did they retain their color or crisp appearance after laundering.

This study was undertaken to evaluate the durability of and to devise improved methods for the care of the cotton uniforms worn by the girls in the Clothing, Cosmetology, Foods and Household Management Shops at Whitney Vocational High School. From this study it was hoped to determine whether or not the dissatisfaction with the uniforms was due to:

1. causes inherent within the fabric
2. improper laundering methods
3. variability of wear in the different shops
4. structural design and workmanship of the uniforms
5. a combination of these factors

From an analysis of these variables it seemed possible that recommendations could be made concerning future selection of materials for uniforms best suited to the needs of the school.

The findings of this study should be of interest and significance to the purchasers of uniforms for hotels, restaurants, hospitals, beauty parlors and similar business concerns. In as much as the fabric used in the uniforms in this study is typical of that used by a uniform rental

agency serving such groups in Toledo, Ohio, the findings should be pertinent.

Review of Literature

Since uniforms are used so extensively it is surprising that there is relatively little literature reporting experimental work on the type of fabric from which they are made.

In the available literature reviewed no published study on any fabric of identical or similar construction to Kolor Kloth for use as school uniforms was found. However, there were numerous studies relating to cotton fabrics for use as apparel, household textiles, and home furnishing textiles. Many experimental studies, related to this problem, have been made by government agencies such as the Bureau of Human Nutrition and Home Economics of the United States Department of Agriculture, college experiment stations, college textile laboratories and private testing organizations. These studies followed test procedures set up by the American Society for Testing Materials (2), the American Association of Textile Chemists and Colorists (1), and the National Bureau of Standards (14). The tests were made to determine the relationship between the physical characteristics of fabrics and their reliability of prediction for intended use; to set up standard specifications for certain fabrics; to study the effect of wear and laundry upon fabrics; or similar problems. While there was found to be wide variation in cotton fabrics in breaking strength, shrinkage, colorfastness, thread count, and sizing determinations it was generally agreed that the performance of fabrics in use was very closely related to

these factors.

Hays and Frankenberg (7) in their analysis of eight-four qualities of cotton dress prints found that in general breaking strength was directly related to count; that grab values were usually higher than the strip method; and that the values of the two were correlated. Hays (8) in an analysis of six types of plain weave cotton dress fabrics stated that filling strength tests were the critical values in durability, and that any fabric with a filling value for the grab method below twenty pounds should not be expected to be serviceable for purposes requiring a higher breaking strength. Skinkle (17) cited that any change in strength of a textile material was always due to some change in its physical or chemical properties. He, also, cautioned that strength was a determination of the result of several variables namely: quality of fiber, twist and ply of yarn, weave and finish. These factors need to be carefully considered in the interpretation and comparison of strength tests.

Davison (3) reported that cotton fabrics subjected to laundry and to body wear could be expected to shrink lengthwise until worn out, and that 3 percent of the shrinkage occurred after the first laundry. Hays' (8) later experiments on poplins, shantungs, and ginghams showed shrinkage of 3 percent or more in the warp. In the same study on lightweight lawns, dimity and swiss the shrinkage was greater in the filling than in the warp. The range was

from 4.0 to 11.5 percent in the filling and 1.3 to 5.4 percent in the warp. In the shrinkage tests on sheets made from selected mill types of cotton, Rogers, Hays, Wigington (15) noted that all sheets shrank lengthwise and all sheets increased in width with wear and with laundry.

Since colorfastness to light and to laundry is very important, Hays and Frankenberg (7) proposed that cotton dress prints should be class 3 or higher to light and 3 or higher to washing. The recommendations were based on Commercial Standard CS59-41 (14) rating for colorfastness to light and to laundry. They deducted, from their data, that a consumer buying unlabelled merchandise stood about one chance in three in obtaining material with satisfactory colorfastness to light. Sixty-four of the eighty-four cotton prints tested showed excellent colorfastness to laundering Test No. 4 Commercial Standard CS59-41 (14). This rating does not imply protection against the excessive use of chlorine in washing or drying repeatedly in the direct sunlight. Morrison (13), in her study on the serviceability of slip-cover fabrics, concluded that the information on labels concerning colorfastness to washing was more reliable than that given concerning colorfastness to sun.

The studies reviewed revealed a wide range in weight per square yard and the sizing per square yard for cotton fabrics. The loss in weight on desizing in general decreased as the count increased. Elongation results on cotton sheets as re-

ported by Rogers, Hays, and Wigington (15) showed that warp elongation increased at 25 washes and then gradually decreased, and that after 125 washes values remained essentially the same. The filling elongation decreased with service to values between six and eight percent.

While many studies have been made on cotton fabrics used as apparel, household textiles and home furnishings, apparently relatively few kinds of fabrics suitable for uniforms have been investigated. The studies that have been made on cotton fabrics show a close relationship between the physical characteristics of the fabrics and their performance in service.

Materials and Methods

Fifty-five girls were chosen at random from the Clothing, Cosmetology, Foods, and Household Management Shops at Whitney Vocational High School in Toledo, Ohio, to participate in this experimental study. They were divided in two groups, thirty-one in the controlled group and twenty-four in the non-controlled group. The uniforms in the controlled group were laundered at school, by the writer, under carefully controlled conditions that could be repeated in the home. The uniforms in the non-controlled group were laundered at home by the girls in their regular home laundry. No instructions were given to this group. Each girl purchased two uniforms, which had been made by the Clothing girls in the Power Machine Shop, from the school store. The uniforms ranged in size from 12 to 18. These sizes were representative of the entire school of over 600 girls. The students in the above named shops wore their uniforms daily to classes. Some wore them to their after school work in restaurants, beauty shops, or in the Clothing trades.

Fabrics: The fabric from which the uniforms were made was sold under the trade name 'Sno Flake Kolor Kloth'. It was purchased by the school from a wholesale establishment in Toledo, Ohio, in the summer of 1942 and was made into uniforms during the school year of 1942-43. No specifications concerning the physical properties or the care of the material was obtainable from the label. Inquiry at the wholesale firm revealed that the fabric was preshrunk. The

same quality Kolor Kloth was secured for all the uniforms, the only difference being the color. The Clothing uniforms were blue, the Cosmetology uniforms were white, the Foods uniforms were peach, and the Household Management uniforms were green. As nearly as could be ascertained the fabric corresponded more closely to the specifications given by Smenner (16) for cotton suiting number 15 than to any other specifications found. The specifications are:

Thread count	Warp	52.8	Filling	54.1
Strip tensile strength	"	63.55	"	59.70
Elongation	"	7.73	"	13.83
Weight per sq. yd.	5.2275 ounces			

(See Appendix A--Swatches p.52).

Measurements: Three special charts were devised for keeping the necessary data on the uniforms throughout the school year. The 'Fit of Uniforms' Chart B (Appendix p. 53) was designed as a means for recording linear measurements and width measurements at the bust, back of shoulders, and hips. Pertinent comments on the general appearance and color change of the uniform throughout the study were noted in the spaces provided for these purposes. A record was made of the weight and height of each girl at the beginning and at the end of the study by the school nurse. (The girl's weight and height were taken in her gymnasium suit.) (See Appendix Chart B p. 53) A second chart 'Wearer's Record of Care of Uniforms' Chart C (Appendix p. 54) provided a sheet for keeping specific data on the method of laundry, stains, tears or breaks in

fabric, when and where they occurred, if they were mended, and the length of time between launderings. A third chart (on the back of the second one) consisted of a calendar of the school year. Each time the uniform was laundered it was checked opposite the correct date of laundry. (See Appendix Chart C p. 54). These two charts were stapled together and all recordings were made by the writer.

To insure uniformity in measuring each new uniform was laid out smoothly on a horizontal surface, without tension in any direction, and measured with a steel tape to the nearest 1/16 of an inch. Points were carefully marked with indelible ink in the following places on the right and left side of the garment:

Linear Measurements:

I. Shirtwaist style uniform
   a. Entire length taken at the center back of the garment.

II. Princess style uniform
   a. Line dropped vertically from the shoulder seam at the intersection of the front and side-front panel.

(In each instance indelible ink marks were made at the hem line and at the center back, and center front shoulder seam for re-measurements at identical points.)

Width Measurements:

I. Shirtwaist style uniform
   a. Shoulder back--width measurement taken at the base of the yoke line.
   b. Bust--line dropped vertically 2" from the armscye on the underarm seam. Width measurements taken between these points.
   c. Hips--line dropped vertically 7" below the waistline on the side seams. Width measurements taken between these points.

II. Princess style uniform
   a. Shoulder back--line dropped vertically 4½" from shoulder seam to armscye. Width measurements taken between these points.
   b. Bust--line dropped 2" on underarm seam. Width measurements taken between these points.
   c. Hips--line dropped vertically 14" from the base of armscye on the side seams. Width measurements taken at these points.

(See Appendix uniform sketches D-E-F-G pp.56-9.

Re-measurements were taken at these points after the first, tenth, twentieth, and twenty-fifth launderings. Uniforms from the controlled and the non-controlled groups were withdrawn for yarn count, tensile strength, and elongation tests as follows:

Controlled group uniforms

Number	Laundry Interval
2	1
2	10
3	20
5	25

Non-controlled group uniforms

3	1
2	10
3	20
2	25

A total of twenty-two uniforms were withdrawn. New uniforms were purchased, by the writer, to replace the ones taken from the girls. All uniforms were measured for shrinkage or stretchage at each designated interval.

Laundry Methods: The laundry procedure was devised by the writer and could be easily duplicated by the girls at home. An electric spinner type 9 pound capacity washer was

filled to the water line with 115-118° F. water; 4 standard sized measuring cups of mild stock soap solution (14) were added to the water; the machine was operated until there was a full running suds; the white and green uniforms were placed in the water and agitated for 12-15 minutes depending upon the amount of soil in the garments. After wringing they were placed in an electric spinner type washer in a clear water at a temperature of 115-118° F. and agitated for 3 minutes. They were put into the spinnerette for the removal of excess water. Then they were taken through a second clear tub of rinse water at a temperature of 110° F. Each uniform was dipped up and down ten times and passed through the wringer. This procedure was repeated in a third tub of clear rinse water at a temperature of 100° F. After a thin starch dressing they were passed through the wringer and hung up to dry at room temperature 70°/ - 2° F. The blue and peach uniforms were treated in the same way except the initial washing and rinsing water temperature was lowered to 110-112° F. It was found through experimentation in the laboratory on swatch pieces (L Figure I p. 15) that higher temperatures of water caused these two colors to bleed. The same mild soap solution was used throughout the entire experiment.

Methods of Sampling: In an endeavor to study the characteristics of the new fabric two yards of fabric of each color were donated by the school for experimental laboratory procedures. Figure I p. 15 is a sampling diagram of the test pieces which were taken from each specimen for yarn

count, breaking strength, elongation, weight per square yard and sizing determinations.

Sampling Diagram of Test Pieces
for Each Color Specimen

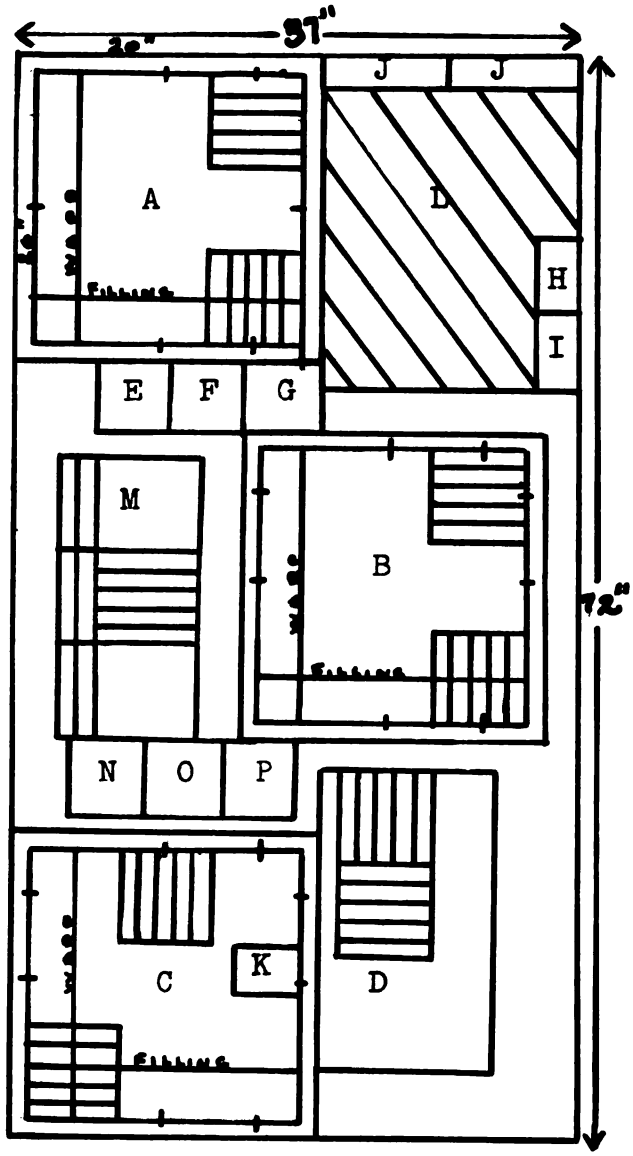


Figure I

A-B-C	Shrinkage Yarn Count Breaking Strength
D	Breaking Strength (First Laundering)
E-F-G	Sizing
H-I	Acid, Alkaline Perspiration Test
J	Colorfastness to light
K	Colorfastness to Laundering (Composite test cloth)
L	Temperature Color Tests
M	Breaking Strength (New Fabric)
N-O-P	Weight per Square Yard
	Scale .2"-1"

Shrinkage: A modified Commercial Standard CS59-41 (14) shrinkage procedure was followed to determine the percentage of shrinkage in the new fabric. Twelve 20" squares (three of each of the four colors represented by the uniforms) were used as control specimens for shrinkage determinations. (See Figure I Squares A-B-C p. 15.) An 18" square was marked off on the 20" square with a colored basting thread. Care was taken to have the thread follow the warp and the filling yarns. On this basting line three 18" lengths 6" apart were marked off with indelible ink. This procedure was repeated for each of the twelve squares which were laundered each week in the school controlled laundry. The specimens were handled with extreme care, the excess water was squeezed out by hand, so as not to distort yarns. The squares were placed horizontally on a flat surface and allowed to dry at room temperature 70° - 2° F. When dry they were laid out smoothly, without stretching, dampened, and allowed to lie for 5 minutes. They were laid on a padded ironing board and pressed by raising and lowering the iron. The iron temperature was between 275-300° F. The specimens were then conditioned on a flat surface for 2 hours at room temperature. The 3 marked distances in each direction on the squares were measured to the nearest 1/16 inch after the 1, 2, 3, 4, 5, 10, 20, and 25th launderings. The average changes in dimensions in the warp and filling for each specimen was calculated. Square A, of each color, was removed after the tenth laundering for breaking strength,

elongation, yarn count tests. Square B was removed after the twentieth and Square C after the twenty-fifth laundering. The breaking strength of these test specimens, which had no body wear, was compared with the breaking strength of the uniforms which had been worn to determine the amount of wear due to body wear and the amount of wear due to laundry wear.

Colorfastness: To determine whether or not the colors were fast to washing conditions that could be duplicated at home, Square C (Figure I p. 15) of each color was laundered throughout the entire test period. A 2" x 4" composite test cloth (K Figure I p. 15) was sewed to each Square C to determine whether or not the dye was fugitive to the various fibers. After each laundry the colorfastness was noted and reported as determined by Test No. 2 Commercial Standard CS59-41 (14).

The colorfastness to perspiration procedure as outlined by Commercial Standard CS59-41 (14) was followed in the laboratory test for this determination. Two specimens (H and I Figure I p. 15) approximately 2" x 4" were prepared for testing. Similar sized pieces of composite test cloth containing fibers of silk, wool, linen, rayon and cotton were prepared. One of the test specimens and a similar sized piece of composite test cloth were thoroughly wet with the acid solution. The two pieces were then rolled together, with the fabric to be tested on the inside. The other test specimen was prepared in a similar manner except that the pieces were thoroughly wet with the alkaline solu-

tion. Each roll was then placed in a labelled glass tube, the end of which was closed, leaving one-third of each roll projecting, the other two-thirds of the roll being protected from evaporation. The tubes were placed in an electric oven maintained at a temperature of 100°/ - 2° F. until dry. No specimen was rinsed after drying. The colorfastness was reported according to Commercial Standard CS59-41 (14). Discoloration, due to perspiration, of the uniforms during actual wear was noted by visual examination.

The colorfastness to light was tested and reported according to Commercial Standard CS59-41 (14). A F D A Fade-Ometer apparatus was used to determine the colorfastness to light. Two specimens 2½" x 8" (J Figure I p. 15) of each colored fabric were prepared. The specimens were placed between opaque masks which shielded them from the light except for an area of 3/4" x 2" which was open to the air on one side. The specimens so protected were exposed in the Fade-Ometer for a period of 20 hours. A second strip of the opaque mask was torn off and the specimen was exposed for another 20 hours, thus the first part of the fabric was exposed for 40 hours. This was repeated until the first section of the fabric had been exposed 100 hours. The amount of fading was judged by comparing the exposed sample, after it had laid in the dark at room temperature for 2 hours, with the original material.

Strip breaking test and elongation: Breaking strength tests on the new fabric were carried out in accordance with

the raveled-strip method Commercial Standard CS59-41 (14). Five test specimens 6" x 1¼" (M Figure I p. 15) were cut in each direction of the fabric where yarns had been pulled. These were raveled to exactly 1" in width and were tested in the dry state after they had lain at room temperature 70° F. for 2 hours. The relative humidity of the room was 40 for every test made. The strips were placed in the jaws of a Scott motor-driven Breaking Strength machine and broken in the standard manner. The results were recorded and an average of the five warp and the five filling strips was taken as the average number of pounds necessary to tear the fabric. Specimen D (Figure I p. 15) was laundered just once. It was removed and breaking strips were prepared in a similar manner and the strength recorded. Specimens A-B-C (Figure I p. 15) were tested after the tenth, twentieth, and twenty-fifth launderings respectively. (See Appendix drawings D-E-F-G pp.56-9 for specimens tested from each of the twenty-two uniforms as they were withdrawn at the stated laundering intervals.) Elongation tests were read from the autographic tensilgram sheets which were recorded simultaneously with the strength tests.

Yarn count: A.S.T.M. Designation: D39-39 (2) procedure was followed to determine the number of yarns per square inch. A micrometer was used to count the actual number of warp yarns in one inch at five different places in the fabric, and the average number per inch was calculated. No count was made nearer than one-tenth the width

of the fabric. The average number of filling yarns per inch was determined in the same way. The procedure was repeated on the fabric squares A-B-C Figure I p. 15 until the yarns ceased to shift. A yarn count was made on each uniform, as it was withdrawn, throughout the entire study.

Water soluble dressing: A modification of the method given by Jacobsen and McCullough (11) was used to determine the percentage of sizing in the test specimens. Three specimens E-F-G Figure I p. 15 exactly 5" x 5" were prepared and an average of the three tests reported as the percentage of sizing. Each 5" x 5" piece was divided into four equal parts. These were placed in an electric oven maintained at a temperature of 221° F. and dried until a constant weight was obtained on an analytical balance. The samples were immersed in a 5 percent oxalic acid solution, squeezed while immersed, removed, and the procedure repeated three times to insure thorough wetting of the fibers by the acid solution. The samples were placed in a 600 ml beaker, covered with 250-300 ml of the 5 percent oxalic acid solution and boiled for 15 minutes. At the end of this time each sample was removed and tested with iodine to determine whether or not any starch remained. The samples were then rinsed 12 times in fresh hot distilled water, squeezed well after each rinse. After rinsing the samples were conditioned at room temperature 70% - 2° F. until dry. They were then replaced in the conditioning oven, dried at a temperature maintained at 221° F. to a constant

weight. The percentage of sizing was calculated by using the following equation:

$$\frac{\text{weight of original sample} - \text{weight of desized sample}}{\text{weight of original sample}} \times 100 = \% \text{ of sizing}$$

Weight per square yard: Jacobsen and McCullough's (11) procedure for the determination of the weight per square yard was used. Three test specimens (N-O-P Figure I p. 15) exactly 5" x 5" were cut, then divided into 4 equal parts. These were dried to a constant weight in an electric oven maintained at a temperature of 221° F. The weight per square yard of the three test specimens was averaged and recorded as the ounces of weight per square yard. This procedure was repeated for each colored fabric. The following equation was used:

$$\frac{1295 \times \text{wt. of known area (5x5)}}{\text{area in inches}} = \text{weight of square yard}$$

Design and workmanship: A study of the design and workmanship of the garments in relation to service was made from data compiled on Chart B "Fit of Uniforms" and Chart C "Wearer's Record of Care of Uniforms" (Appendix pp.53-4). In addition visual observation of the uniforms throughout the school year and critical comments of the girls were noted.

Discussion of Results

Physical properties of the new fabric: An analysis of the physical properties of the new fabric was carried out to determine whether or not there were significant differences within the four colors of the same fabric. Table I p. 23 shows negligible differences in yarn count per inch in either the warp or filling in the four colors. The average warp breaking strength falls within a range of 3 pounds, the average filling falls within a range of 11 pounds. There is relatively little difference in the weight per square yard in the blue, peach and green Kolor Kloth. The white material is approximately 16 percent heavier than the other fabrics. On the basis of sizing the fabrics seem to fall into two groups. The white and green are markedly sized, while the blue and peach have little dressing. To further determine whether or not there are significant differences in the new fabrics an analysis of variance of the breaking strength, elongation and shrinkage of the four colors was carried out. Such an analysis enables one to test the significance of a difference between the averages of two compounds each made up of two or more variables. This procedure reveals no such differences in the fabrics. Therefore, on the basis of these analyses it is assumed that there is no significant difference in the physical properties of the four colors of the fabric.

Breaking strength: After the first laundry, an analysis of variance of the warp breaking strength of the controlled

Table I--Physical Properties of New Fabric

Fabric	Yarn Count Per Inch[1]		Breaking Strength Strip Method Pounds[2]		Elongation Percent[3]		Weight Per Square Yard Ounces[4]	Sizing Percent[5]
	W.	F.	W.	F.	W.	F.		
Blue	54	49	58	47	3.7	21.0	4.60	1.80
White	54	49	57	42	8.3	25.0	5.13	7.20
Peach	54	50	60	52	6.2	19.6	4.30	2.00
Green	55	46	58	41	6.0	23.5	4.64	4.03

1-average of 5 counts each in warp and filling.
2-average of 5 determinations each in warp and filling.
3-average of 5 determinations each in warp and filling.
4-average of 3 determinations for each color.
5-average of 3 determinations for each color.

and non-controlled uniforms, and the fabric squares reveals that the average 55.2 pounds for the fabric squares is not significantly greater than the average 55 pounds for the controlled uniforms and the average 53 pounds for the non-controlled uniforms. There are no significant differences between the filling breaking strength averages at the same period.

Analysis of Variance of the Warp Breaking Strength of the Materials after the Twentieth Laundry

Fabric Squares		Controlled Uniforms		Non-controlled Uniforms		
(t_1)	53*	(t_2)	40*	(t_3)	38*	
	49		37		46	
	48		44		49	
	49					
Total	199		121		133	453
Average	49.7		40		44	45

* pounds

$$\frac{(453)^2}{10} = \frac{205209}{10} = 20521 \text{ C.T.}$$

Sum (of all t's)^2 = 20781

$$\frac{t_1^2}{N_1} + \frac{t_2^2}{N_2} + \frac{t_3^2}{N_3} = \frac{39601}{4} + \frac{14641}{3} + \frac{17689}{3} = 20676$$

Sum (of all t's)^2 -- C.T.$= \frac{t_1^2}{N_1} + \frac{t_2^2}{N_2} + \frac{t_3^2}{N_3}$ -- C.T.

20781 -- 20521 = 20676 -- 20521

260 = 155 plus error

Source	D.F.	Sum of Squares	Mean of Squares	
Total	9	260	---	$F = \frac{77.5}{15} - 5.2$
Group	2	155	77.5	(Significant)
Within	7	105	$\sqrt{15}$	15 = 3.87 S.D.

$$\sigma\sqrt{\frac{1}{N_1} + \frac{1}{N_2}} = 3.87\sqrt{1/4 + 1/3} = 2.18$$

$$t_1 = \frac{M_1 - M_2}{2.18} = \frac{49.7 - 40}{2.18} = \frac{9.7}{2.18} = 4.45$$

Therefore 49.7 pounds is significantly greater than 40 pounds.

$$t_2 = \frac{M_1 -- M_3}{2.18} = \frac{49.7 -- 44}{2.18} = 2.43$$

Therefore 49.7 pounds is significantly greater than 44 pounds.

$$\sigma\sqrt{\frac{1}{N_2} + \frac{1}{N_3}} = \sigma\sqrt{1/3 + 1/3} = 3.87\ \sqrt{67} = 2.11$$

$$t_3 = \frac{M_3 -- M_2}{2.11} = \frac{44 -- 40}{2.11} = \frac{4.0}{2.11} = 1.51$$

Therefore 44 pounds is not significantly greater than 40 pounds.

If two samples are taken and the averages are computed the question arises as to whether the difference between these samples might arise from mere fluctuations in sampling or whether it indicates a real difference between the two larger groups from which the samples were drawn. The average 49.7 pounds for the fabric squares is significantly greater than the average 40 pounds for the controlled uniforms and the average 44 pounds for the non-controlled uniforms and is not due to faulty sampling. Therefore the average of the breaking strength of the unworn fabric squares is significantly greater than the average of the breaking strength of the worn material at the twentieth laundering interval. The fluctuations appear to be due to body wear. At this interval the school controlled laundering method and the home non-controlled laundering method are not sufficiently different to cause a variance in the breaking strength of the fabrics in these groups. A similar mathematical procedure shows that the average 42 pounds for the filling strength of the fabric squares is significantly greater than the average 29.6 pounds for the non-

controlled uniforms and the average 32 pounds for the controlled uniforms. There is no significant difference between the averages for the controlled and the non-controlled uniforms. At the twenty-fifth laundering interval the increase in the average warp breaking strength of the controlled uniform group appears to be due to individual differences in wear and variance in body excretions. Table 2 p. 27. There is not a great enough lapse in time between the twentieth and twenty-fifth laundering interval to show further significant changes in either the warp or the filling breaking strength.

The fabrics, in this study, were by no means worn out at the end of the school year. Each laundering interval approximated 20 hours of body wear. Davison (3) reported the fabrics in her study worn completely out by body wear and laundry wear showed a decrease warpwise in breaking strength of approximately 50 to 60 percent, and 60 to 70 percent decrease fillingwise. The fabrics, in this study, at the end of the 25th laundering show a decrease in strength of approximately 20 to 25 percent warpwise and 30 to 35 percent fillingwise. Table 3 p. 28. On this basis the uniforms, as far as strength indicates, are approximately half worn out. This finding is further borne out in actual usage of a two year school period. Davison (3) stated that wear on a garment from body wear alone caused about one-half of the strength decrease warpwise and slightly less than two-thirds of the decrease fillingwise. In this study the average original warp breaking strength for the fabric squares is

Table 2--Analysis of Variance of Breaking Strength

Mean of Fabrics

Laundry Intervals	Fabric Squares Pounds		Controlled Uniforms Pounds		Non-controlled Uniforms Pounds	
	W.	F.	W.	F.	W.	F.
1	55.2	46.5	55.0	46.5	53.0	43.7
10	50.7	45.2	47.0	39.5	45.0	37.5
20	49.7	42.0	40.0	32.0	44.0	29.6
25	44.5	33.0	44.5	32.0	40.0	25.5

Table 3--Summary of Breaking Strength

Strip Method in Pounds

70° 40% R.H.*

Averages**

Laundry Intervals	Uniforms Withdrawn	Controlled Uniforms Pounds		Uniforms Withdrawn	Non-controlled Uniforms Pounds		Squares Withdrawn	Fabrics Squares Pounds	
		W.	F.		W.	F.		W.	F.
New		58.2	45.5		58.2	45.5		58.2	45.5
First	2	55.0	46.5	3	53.0	43.6	4	56.3	46.5
Tenth	2	47.0	39.0	2	45.0	37.5	4	50.8	43.3
Twentieth	3	40.3	32.0	3	43.3	29.3	4	49.8	42.0
Twenty-fifth	5	44.4	32.0	2	40.0	25.5	4	44.5	33.0

* 40 percent relative humidity
** Averages are of 5 warp and 5 filling strips taken from each of the withdrawn specimens.

58.2 pounds. Table 3 p. 28. The average warp decrease for the fabric squares after the 25th laundering is 13.7 pounds. The average for uniforms is 15.06 pounds. Therefore the decrease due to body wear alone is 1.36 pounds or approximately 9 percent of the total decrease. The original filling breaking strength is 45.5 pounds. The average filling decrease for the fabric squares after the 25th laundering is 12.5 pounds. The average for the uniforms is 15.36 pounds. Therefore the decrease due to body wear alone is 2.86 pounds or approximately 18.6 percent of the total decrease. Table 3 p. 28. Assuming the uniforms to be half worn out, at this interval, the decreases warpwise and fillingwise are less than those of Davison (3). This may be due to the quality of the original fiber, diameter and twist of the yarns, thread count, or to the treatment of the fiber and cloth in the finishing processes, as well as individual differences in wear and in the care of the fabrics. While there appeared to be no significant differences in the breaking strength of the new fabrics they do not show a similarity in decrease in breaking strength at the end of the 25th laundering. Wear, due to laundering alone, shows a variation from the original in the warp strength ranging from 12 to 29 percent and from 16 to 36 percent fillingwise. The blue Kolor Kloth lost 12.1 percent of its original warpwise strength and 36.1 percent fillingwise. In comparison with the peach, green and white fabric the blue lost the least strength warpwise and the most strength fillingwise of any of the colors. It

seems that there are variations in the decrease in the breaking strength of the same fabric under identical laundering procedures. While original breaking strength may be indicative of the durability of a fabric, variability within the same fabric tends to limit its predictive value.

Elongation: At the end of the experiment the warp elongation had increased approximately 4 percent, and the filling had decreased approximately 2 percent. The trends in these findings are similar to those reported by Rogers, Hays, and Wigington (15). An analysis of variance of the warp elongation (Table 4 p. 31) shows that the average 10.87 percent for the fabric squares is not significantly greater than the average 10.65 percent for the non-controlled uniforms or the average 8.76 percent for the controlled uniforms. The controlled uniform group shows the least warpwise elongation (Table 4 p. 31). However, an analysis of variance of the filling elongation shows that the average 22.65 percent for the fabric squares is significantly greater than the average 18.15 percent for the non-controlled uniforms, but is not significantly greater than the average of 20.36 percent for the controlled uniforms. This difference is due to greater stretchage in ironing in the non-controlled group. The warp elongation increased similarly in all three groups, while the filling decrease varied with the method of care. It has been reported by Essam (5) that fabric elongation is directly related to the thread count per inch. Haven (6) stated that elongation and breaking strength are not always directly re-

Table 4--Analysis of Variance of Elongation

Mean of Fabrics

Laundry Intervals	Fabric Squares Percent		Controlled Uniforms Percent		Non-controlled Uniforms Percent	
	W.	F.	W.	F.	W.	F.
1	21.95	28.2	10.15	27.1	13.95	24.3
10	10.4	25.15	7.8	19.5	9.5	17.95
20	10.4	22.2	8.73	17.4	9.63	20.2
25	10.87	22.65	8.76	20.36	10.65	18.15

lated. A brittle fabric may have high tensile strength but little or no stretch; a sleazy fabric will have little or no tensile strength but will stretch a great deal; an intermediate fabric may have considerable strength and stretchage. The Kolor Kloth falls in the last category.

Yarn Count: Essam (5) cited that there is a definite relationship between the breaking strength of a fabric and its structure. Hays and Frankenberg (7) found that in general the breaking strength was related to yarn count. The fabric studied has a very definite closeness of weave. Table I p. 23. The count of cloth is well balanced with consequent shifting of yarns very slight. Appendix Yarn Count p. 60. The range in yarn count before laundering varies from 54 to 55 in the warp and from 46 to 49 in the filling. At the end of the study the count varies from 53 to 55 in the warp and from 49 to 53 in the filling. While there is little or no difference in the number of yarns per inch warpwise or fillingwise, there is a difference in their appearance under the microscope. The white yarns appear to be made from shorter cotton fibers as they are very fuzzy, and they are not as tightly twisted as those of the other colors. In actual usage the white fabric did not retain its original appearance as long as did the other colors.

Colorfastness to light: After exposure for 100 hours in the Fade-Ometer there was no appreciable change in any hue. All fabrics rate as having "Class 5 colorfastness to light" (15). Such fabrics are considered of superlative

Table 5--Rating of Colorfastness According to Commercial Standard CS59-41*

All Colors Fade-Ometer						All Colors Perspiration Tests		
Hours	20	40	60	80	100	Test	Acid	Alkaline
Class	5	5	5	5	5	Class	A	A

Controlled Uniform Group

Launderings	No color change	Slight change	Noticeable change	Appreciable change	Total
1	**31				31
10	27	2			29
20	21	5			26
25	12	11			23

Non-controlled Uniform Group

Launderings	No color change	Slight change	Noticeable change	Appreciable change	Total
1	**21	3			24
10	4	12	4	1	21
20		2	11	4	17
25			8	6	14

*Reference (14)
**Number of uniforms in study.

fastness to sunlight and may be used for any purpose where extreme fastness to light is required. Table 5 p. 33.

Colorfastness to laundering: There are very evident differences in the colorfastness of the colors to the different laundering methods employed. The colors of the uniforms in the controlled group rate as having "Class 2 colorfastness to laundering" (14). Such fabrics are launderable in the home or commercial laundry under careful methods when the temperature does not exceed 120° F., and when no alkali or chlorine is present, and when the material is not dried in the direct sunlight. The uniforms in the controlled group retained their colors with no appreciable change throughout the entire study. This is not true of the non-controlled uniform group. Table 5 p. 33. These uniforms show changes within ten launderings; by the twelfth laundering the peach is appreciably discolored, taking on an orangy hue. There are at least two dye lots in this particular color, the one changing color much more rapidly than the other. The blue and green show appreciable change by twenty launderings.

Colorfastness to perspiration: The test specimens exposed to the acid and alkaline reagents Commercial Standard CS59-41 (14) show the fabrics as having "Class A colorfastness to normal perspiration". Table 5 p. 33. Such fabrics are considered fast to perspiration. Subjective observation of the uniforms during wear upheld this finding.

Care of the non-controlled uniforms: The girls used nine of the well advertised all-purpose soaps on the mark-

et. These soaps were tested in the laboratory and some were found to have an excess of free alkali and varying amounts of carbonates. No one soap was used consistently throughout the year by the girls at home. Four girls admitted using chlorine on white uniforms. No uniform was dried in direct sunlight. It required approximately 5 hours to dry the uniforms at room temperature 70° F. In the commercial tumbler drier, at school, it required approximately 50 minutes to dry the uniforms. Water ranging in temperature from warm to very hot was used. Five girls washed their uniforms by hand, the other nineteen used electric washers of varying makes. The girls did not remove lipstick, fingernail polish, hair dye or food stains from their uniforms before laundering. Since laboratory tests showed that water temperatures above 112-115° F. for the peach and blue, and above 120° F. for the green would cause discoloration it is safe to conclude that temperature of the water caused some of the discoloration in the non-controlled uniform group. Also excess alkali in the soaps, incomplete removal of soil, and poor rinsing contributed to color changes.

Shrinkage in laundering: The mean percentage of shrinkage of the individual fabrics ranged from a gain of 1.6 percent in the filling direction (Table 7 p. 38) to a shrinkage of 5.62 percent in the warp direction (Table 6 p. 36). The mean percentage of the residual shrinkage for the fabric squares is 5.6 ± .09 percent (Table 6 p. 36) and 1.39 ± .04 percent in the filling (Table 7 p. 38). The shrinkage

Table 6--Summary of Linear Dimensional Changes

Laundry Intervals	Number of Uniforms*	Group[1] Mean Percent	Number of Uniforms	Group[2] Mean Percent	Number of Fabric Squares**	Group[3] Mean Percent
1	31	2.5±.21	24	2.93±.30	12	3.02±.84
2					12	3.46±.09
3					12	3.97±.08
4					12	3.80±.11
5					12	4.5±.08
10	29	3.6±.36	21	4.15±.44	12	5.25±.09
20	26	3.8±.16	17	5.0±.43	9	5.65±.08
25	23	3.9±.26	14	5.1±.52	6	5.62±.09

Group[1] Controlled Uniforms
Group[2] Non-controlled uniforms
Group[3] Fabric Squares controlled

* Uniforms in study
** Fabric Squares in study

Table 6--Summary
Width Dimensional Change

Laundry Intervals**	Number of Uniforms	Bust Percent	Group 1* Shoulder Back Percent	Hips Percent
1	31	-.36≠.59	-.80≠.12	-.05≠1.7
2				
3				
4				
5				
10	29	-.64≠.69	-.44≠.51	-.34≠.48
20	26	-.83≠.17	-1.03≠.44	≠.19≠.49
25	23	-.78≠.69	-47≠.44	-.01≠.53

* Group 1 Controlled Uniforms
** Each laundering interval approximates 20 hours of body wear.

Table 6 (Continued)

Laundry Intervals*	Number of Uniforms	Bust Percent	Group 2 Shoulder Back percent	Hips Percent	Group 3 Filling Percent
1	24	1.6≠.49	.83≠.31	1.5≠.34	-0.6≠.08
2					-2.0≠1.1
3					-1.35≠.07
4					-1.57≠.07
5					-1.4≠.08
10	21	1.29≠.66	1.17≠.09	.96≠.57	-1.30≠.05
20	17	1.43≠1.04	1.01≠.69	.71≠.07	-0.96≠.07
25	14	1.1≠.99	.66≠.84	.83≠.78	-1.39≠.04

Group 2 Non-controlled uniforms
Group 3 Fabric Squares controlled
* Each laundry interval approximates 20 hours body wear.

Chart I
Linear Dimensional Change

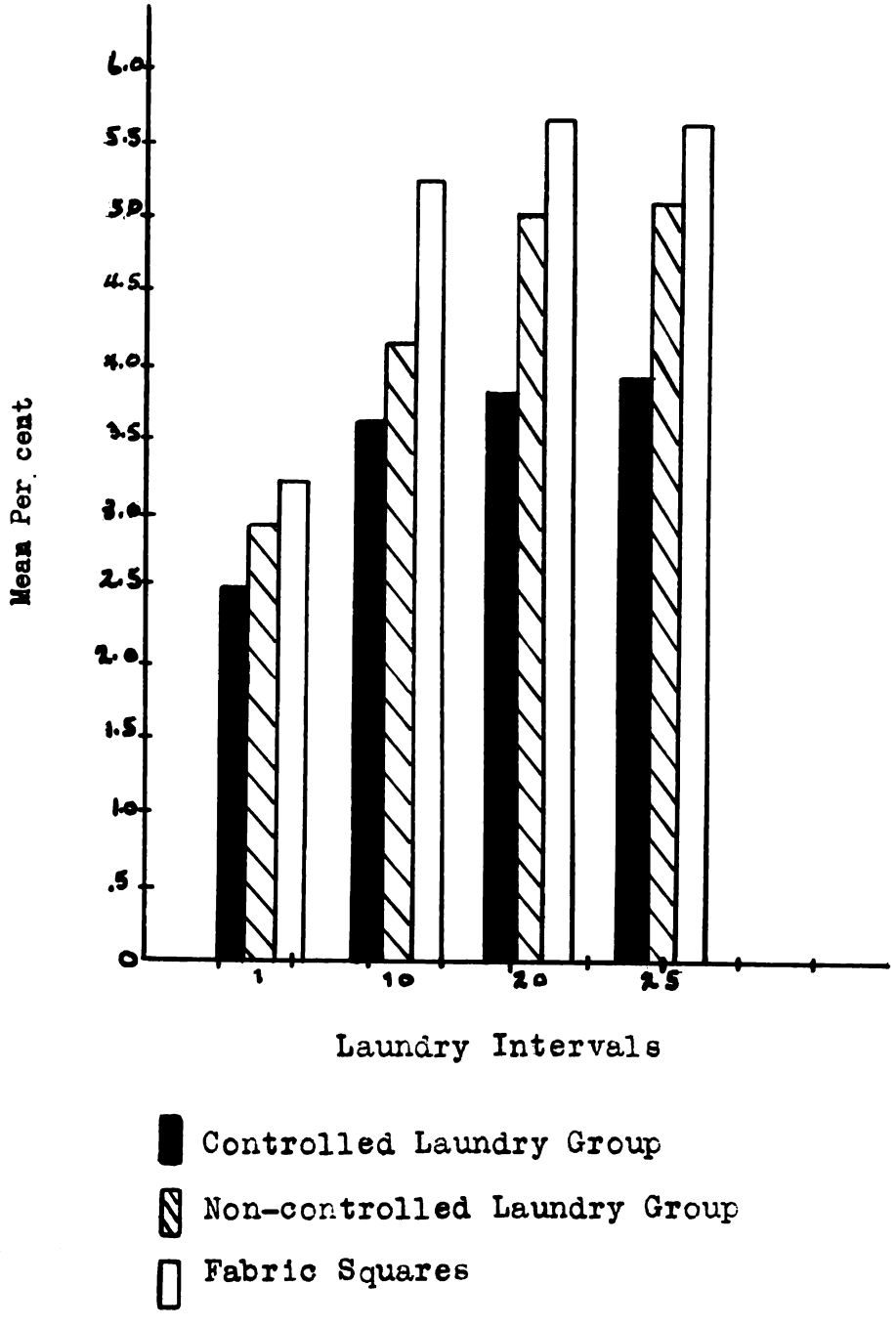
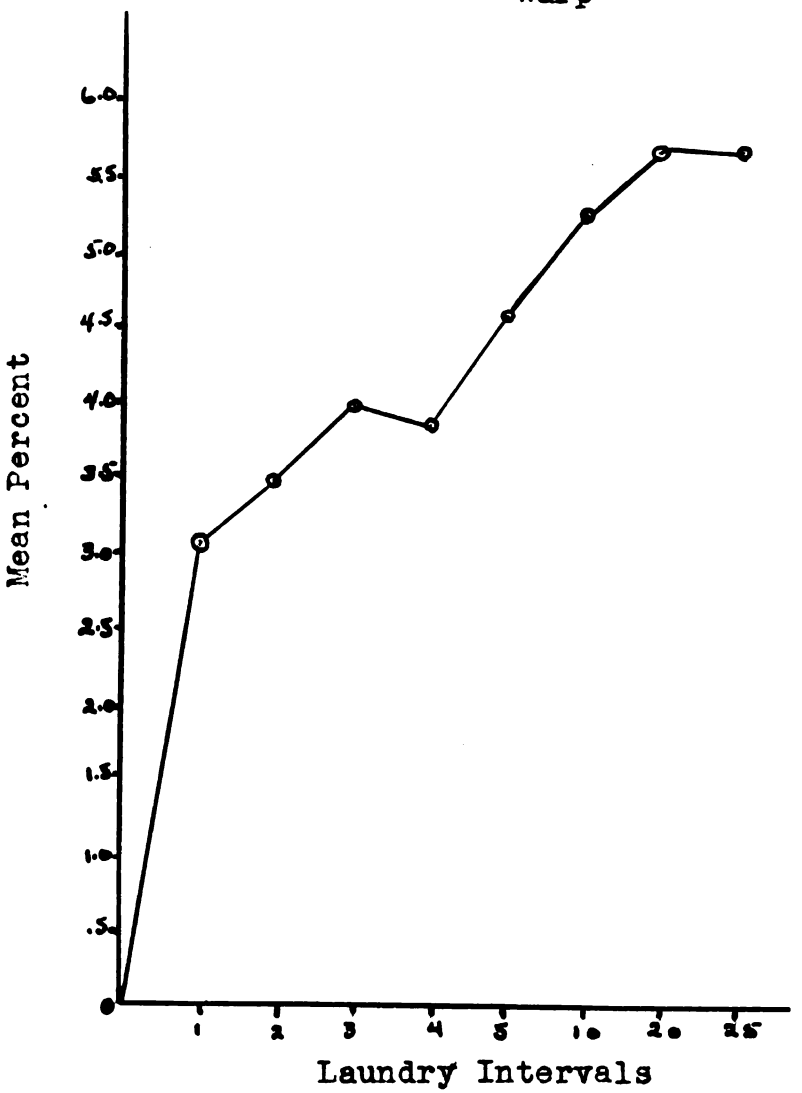


Chart 2--Dimensional Change Fabric Squares



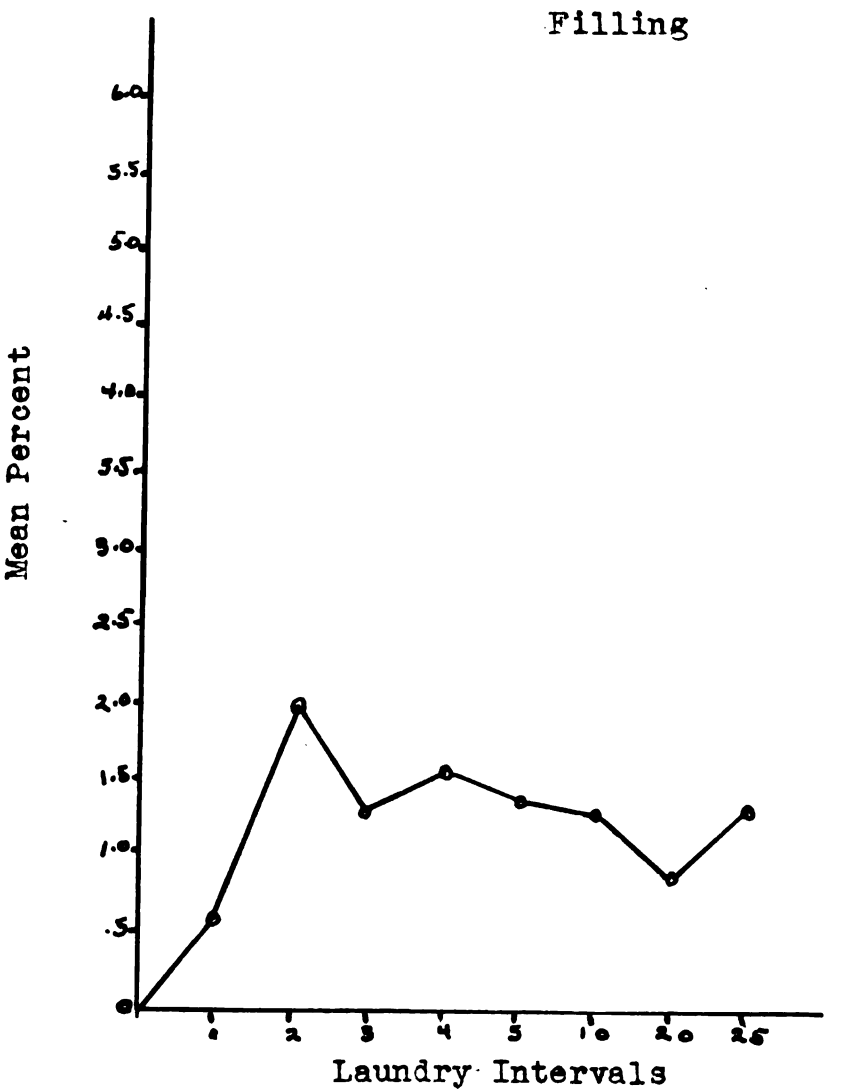
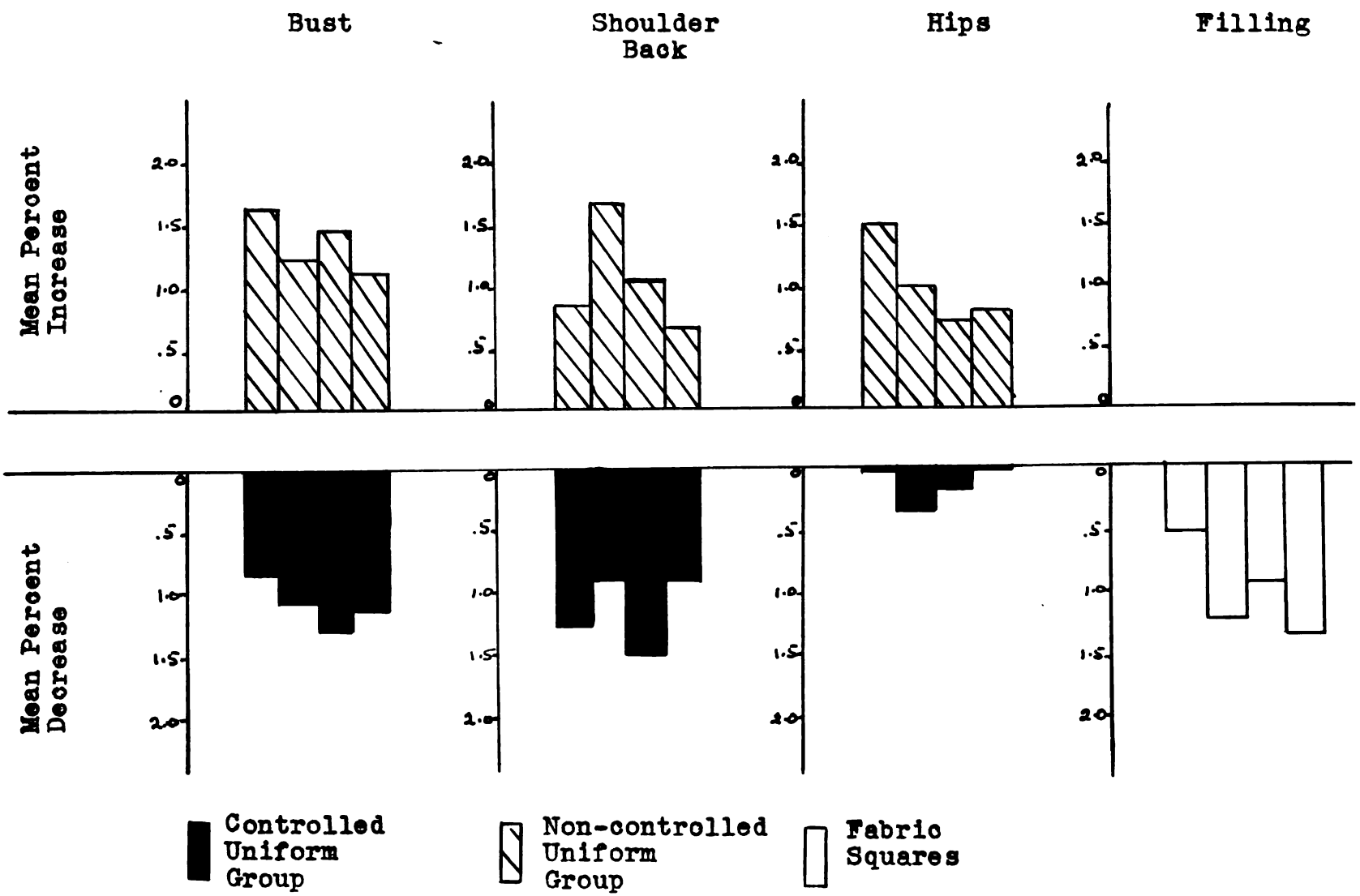


Chart 3--Filling Dimensional Change



for the fabric squares is higher than the shrinkage for the uniforms (Chart I p. 39). However, the former is a truer picture of the actual shrinkage since care was taken to avoid stretchage in drying or in ironing the fabric. Approximately one-half of the warp shrinkage occurred after the first laundering and had reached its maximum by the twentieth (Chart 2 p. 40). The non-controlled uniform group shows an increase in width, while the controlled uniform group and the fabric squares show a decrease (Chart 3 p. 41). This would indicate that the fit of a laundered garment depends to a great extent upon the individual care given to it in the laundering process. Davison (3) reported three-fifths of the total shrinkage occurred after the first laundering. This finding is slightly higher than that for the Kolor Kloth. Hays (8) cited, with but few exceptions ginghams, shantungs, and poplins shrank more than 3 percent in the filling. This is slightly higher than the filling shrinkage of the uniform fabric.

The shrinkage in the filling was not great enough to make an appreciable difference in the fit of the uniforms. No girls gained enough weight to cause a change in width measurements. Only two girls of the fifty-five changed height sufficiently to warrant letting out the hems of their uniforms, even though the warpwise shrinkage was over 5 percent. This, no doubt, was due to the current fashion for short skirts.

Design and workmanship: The writer made a study of

the design and workmanship of the garments in relation to service. The shirtwaist style, without exception, holds up better under actual usage than the princess style. (See Appendix uniform sketches D p.56 and G p. 59.) Table 8 p.44 is a summarization of the findings of the "Wearer's Record of the Care of Uniforms" Chart C (Appendix p. 54.) Without exception the neckline and placket tears are in the princess style uniforms. This, no doubt, is the fault of the girls not opening the placket its full length, and not the fault of the style of the garment. The inexperience of the Power Machine girls in sewing on the bias at the center front neck edge is partly responsible for the breaks at this particular point. However, no such breaks are found in the shirtwaist style garment. The buttonholes that need re-working are in the princess style garment. Students comments in regard to the fit and style indicate preference for the shirtwaist type. This type fits better, because the waistline falls nearer the normal waistline of the average figure than does the princess style, even though both styles are cut for the short, medium or long waisted person. There is greater freedom through the shoulder area because of the fullness at the bottom of the yokeline in the shirtwaist style. The girls in the Clothing, Cosmetology, Foods, and Household Management Shops work with their hands and arms a great deal and have need for freedom through the shoulder region. As a result of this study the shirtwaist style uniform is being adapted as the standard design for the school.

Table 7--Summary*-Wearer's Record of Care of Uniforms

	Controlled Uniforms Laundry Intervals				Total	Non-controlled Uniforms Laundry Intervals				Total
	1	10	20	25		1	10	20	25	
No Mends				12	12				6	6
Neckline		2	2	2	6		2	4	3	9
Placket		1	3	2	6		3	3	4	10
Hem			2		2			3	1	4
Buttonholes	1		4		5		4	4		8
Others**			3		3		6	5		11
Stains***		2	2	3	7		6	9	8	23

* See Appendix Chart C p.
** Acid holes and tears
*** Food stains, lipstick, hair dye, fingernail polish

Conclusions

It would seem from this study that laboratory tests are not adequate in determining the durability of a fabric but they do give a basis for prophesying. Fairly reliable predictions can be made using breaking strength as a measure if these values are considered on the basis of the original breaking strength values. This study indicates that variability within the same fabric, under identical service, limits the predictive value of the breaking strength results. At the end of the 25th laundering the breaking strength of the fabric had decreased approximately 25 percent warpwise and 31 percent fillingwise due to laundry and body wear.

Fabrics treated as in this study can be expected to shrink lengthwise throughout the first year of service. Approximately one-half of the warp residual shrinkage occurred after the first laundering, and reached its maximum after the second laundering. The warp shrinkage was sufficient to warrant preshrinking the fabric before making it into uniforms but the filling shrinkage was insignificant. The warp elongation increased similarly in all groups and the filling elongation decrease varied with the method of care. As a group all colors showed excellent colorfastness to light and perspiration and all colors proved satisfactory in the school controlled laundry group, although the peach and green proved unsatisfactory in the home non-controlled laundry group. The four colors showed negligible differences in yarn count and neither laundering method showed a noticeable shifting

of yarns. The white fabric was the most markedly sized and gave the least satisfactory service.

The princess style uniform did not render as satisfactory service as did the shirtwaist style. The dissatisfaction with the uniforms appeared to be due to improper laundering methods, design of garment, and to imperfections in the workmanship of the inexperienced Power Machine girls.

While a one year study is not long enough to determine the final durability of a fabric similar to the Kolor Kloth it does indicate the trends. Further study is desirable and several changes in procedure could be made. A larger number of uniforms should be withdrawn for testing purposes and the use of only one group of girls directly under the supervision of the person making the study would eliminate many difficulties in securing data. The incorporation of uniforms sent to a commercial laundry could be made to determine whether or not there are variances in home and commercial methods.

Recommendations

1. Labels with the following laundering instructions be placed on the uniforms sold to the girls:

    1. Use mild soap flakes, preferably Ivory or Lux.
    2. Use moderately warm water
       112-15° F. for blue and peach colors
       115-120° F. for green and white colors
    3. Run washer 2-3 minutes to dissolve flakes and make good suds.
    4. Remove stains.
    5. Place soiled garment in washer, run 8-10 minutes.
    6. Rinse 2-3 times very thoroughly in same temperature water.
    7. Hang in shade to dry.
    8. Dampen and iron carefully to avoid stretchage.

    Caution: Too hot water and strong soaps will cause discoloration.

2. Adaption of the shirtwaist style uniform as a standard for the school.

3. The school purchase fabrics that will meet the following specifications:

    1. Yarn count 54 X 50
    2. Breaking strength
       Warp 55-60 pounds
       Filling 45-50 pounds
    3. Weight per square yard 4-5 ounces
    4. Sizing 1-2 percent
    5. Residual shrinkage 3 percent or less
    6. *Colorfastness:
       To light: Class 4 or 5
       To perspiration: Class A
       To laundering: Class 3 or better

4. Pre-testing of fabric by the school's Textile Laboratory for determination of the fabric quality.

5. That another color be substituted for the peach.

* Reference (14)

Summary

Two groups of high school girls were selected at random to wear the uniforms used in this study. One group of uniforms representing three different shops was laundered at school by the writer under carefully controlled conditions while a second group was laundered at home by the girls under varying conditions. The measurable physical characteristics for the fabric from the two groups of uniforms were compared with the original and laundered fabric squares to determine whether or not the causes for dissatisfaction were due to causes inherent within the fabric, to improper laundering methods, variability of wear in the different shops, to structural design and workmanship or to a combination of these factors.

Physical Properties: An analysis of the physical properties of the new Kolor Kloth after the first laundering showed no significant differences in breaking strength, elongation, or shrinkage.

Breaking Strength: The fabrics in this study were by no means worn out at the end of the school year as the breaking strength showed a decrease of approximately 20-25 percent warpwise and 30-35 percent fillingwise. On this basis the uniforms, as far as breaking strength indicated, were approximately half worn out. This finding was further substantiated by actual usage of a two year school period.

Elongation: At the end of this experiment the warp elongation had increased approximately 4 percent and the

filling had decreased approximately 3 percent. After the 25th laundering an analysis of variance of the warp elongation showed no significant differences in the average of the fabric squares, controlled uniforms, or non-controlled uniforms. This was not true for the filling elongation as the average 22.65 percent for the fabric squares was significantly greater than the average 20.36 percent for the controlled uniforms. While the warp elongation increased similarly in all three groups the filling elongation decrease varied with the method of care.

Yarn Count: There were no significant differences in the yarn count warpwise or fillingwise in the four different colors of the fabrics; each having a fairly high and well balanced yarn count.

Colorfastness: All colors rated as having "Class 5 colorfastness to light" and "Class A colorfastness to normal perspiration". At the end of this study the colors in the uniforms in the school controlled laundry group rated as having "Class 2 colorfastness to laundering". The peach color in the non-controlled group showed appreciable color change by the 13th laundering and the blue and green showed appreciable change by the 20th laundering. The method of laundering was a principle factor in the dissatisfaction with the color changes in the fabrics.

Shrinkage in laundering: The mean percentage of the warp residual shrinkage for the fabric squares was 5.62 $\pm$ .09 and the filling 1.39 $\pm$ .04. Approximately

one-third of the warp shrinkage occurred after the first laundering and had reached its maximum by the 20th laundering. Approximately one-third of the filling shrinkage occurred after the first laundering and had reached its maximum by the second laundering. The warpwise shrinkage of Kolor Kloth was sufficient to warrant pre-shrinkage before sewing into garments. The filling shrinkage was negligible.

Sizing: On the basis of sizing the fabrics seemed to fall into two groups, the white and green being markedly sized and the peach and blue had little dressing.

Weight per Square Yard: There was little or no difference in the weight of the blue, green and peach fabric; the white had approximately 16 percent more sizing than the other three.

Care of Uniforms: Laboratory tests on swatches showed that temperatures of water above 112-115°F. for the peach and blue and above 120°F. for the green would cause discoloration. Excess alkali in the soaps, incomplete removal of soil, and poor rinsing likewise contributed to color changes.

Design and Workmanship: A study of design and workmanship of the garments in relation to service revealed that the shirtwaist style uniform held up better in actual usage than the princess style. As a result of this study the shirtwaist style uniform has been adopted as the standard for the school.

It appears from an analysis of the findings in this

study that the dissatisfaction with the uniforms was due to improper laundering methods, design of the garment, imperfections in the workmanship of the inexperienced Power Machine girls and was not due to factors inherent within the fabric nor to variability in wear in the various shops.

APPENDIX


A--SWATCHES

FIT OF UNIFORMS

Measurements To nearest 1/16" | Color-- 1. No change 2. Slight change 3. Considerable change | Bust---2" Under arm seam | Shoulders Back 4½" down | Hips 14"-7" below waist | Change± in inches

UNIFORMS	W (Linear Meas.) ENTIRE LENGTH SHOULDER HEM	X WIDTH BUST	Y WIDTH BACK SHOULDERS	Z WIDTH HIPS	Change± W	X	Y	Z
New								
First Laundry								
Tenth Laundry								
Twentieth Laundry								
Twenty-fifth Laundry								
Comfortable								
Uncomfortable								
Wrinkles Easily								
Wrinkles fall out								
General Appearance (a) Color 1-2-3 (b) Pressing (c) Buttons 1. on 2. off (d) Buttonholes (e) Hemline 1. even 2. uneven								
Height in inches___ Weight in Pounds (a) New								
(b) Twenty-fifth Laundry								

CHART C
WEARER'S RECORD
CARE OF UNIFORMS

1. No change
2. Slight change } color
3. Considerable change

School Laundry
⊗controlled____

Home Laundry
X Not instructed____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Time in Washer (min.) (a) Soap used (b) Bleach																									
Time for Drying (min.) (a) Outdoors (check) (b) Inside																									
Time for Ironing (min.) (a) Hand iron (check) (b) Mangle																									
Finished Appearance (check) (a) Good (b) Fair (c) Poor																									
Time for Pressing (min.) between Laundries																									
Stains (a) Kind (b) Method of Removal																									
Color Change _____1-2-3																									
Breaks (a) When? (b) Where? (c) Mended?																									

Chart C
WEARER'S RECORD

Name_____

Shop_____

Date Purchased_____

Date Withdrawn_____

⊗ School - Controlled

× Days laundered at Home (non-instructed)

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
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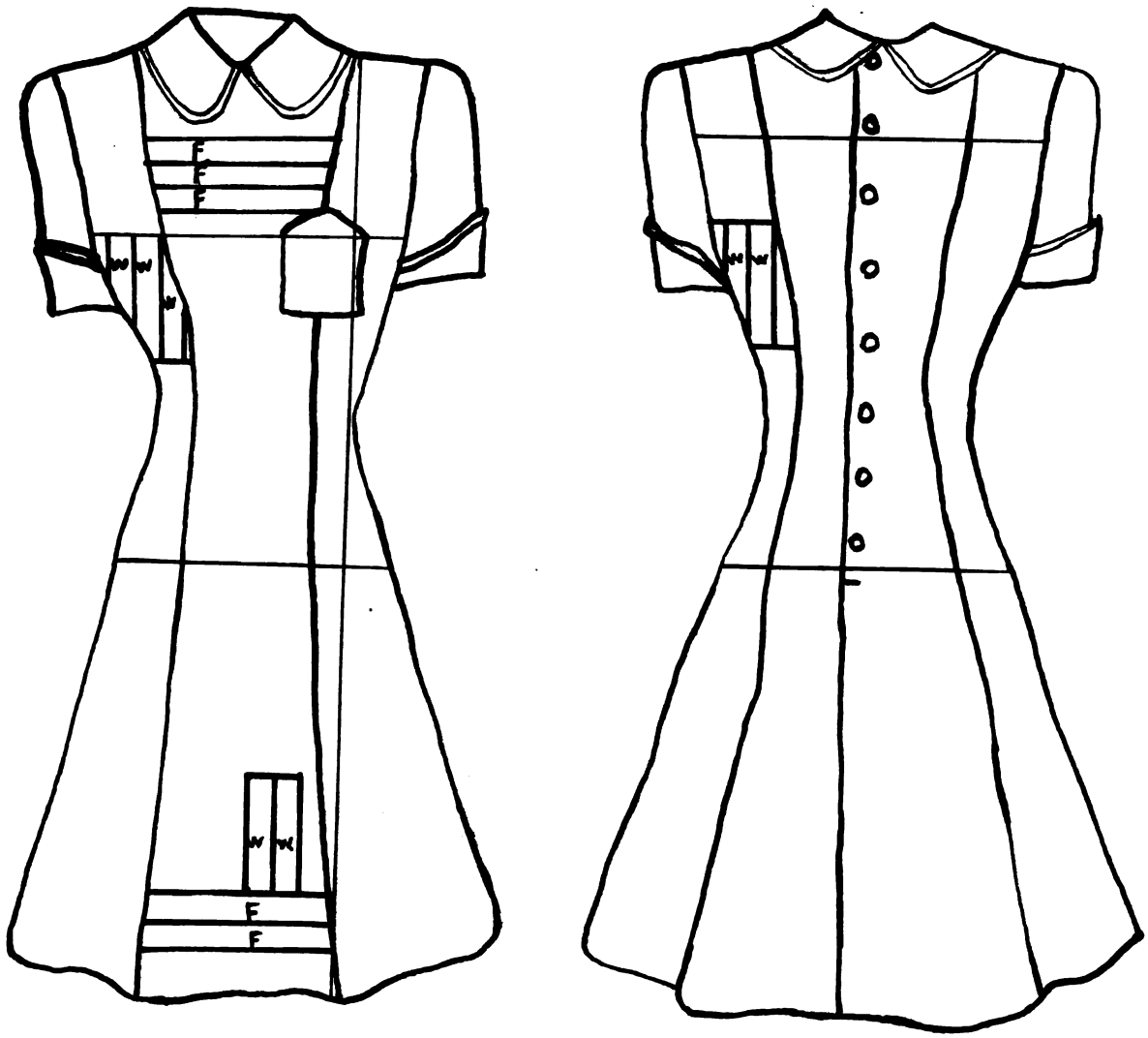
24										
25										
26										
27										
28										
29										
30										
31										

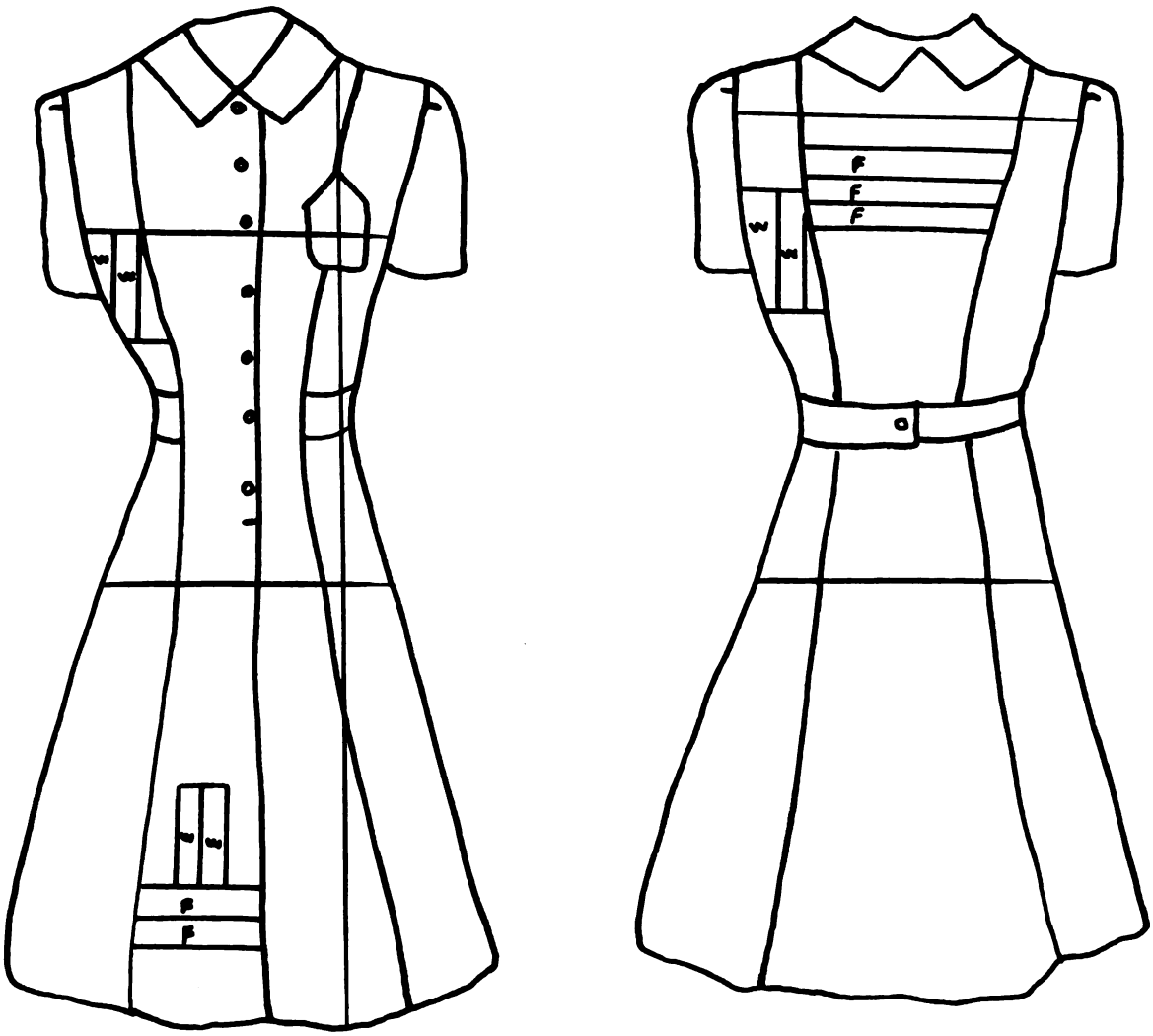
Clothing Uniform-D



———--Indicates Linear and Width Measurements

W and F--Warp and Filling Breaking Strength Strips

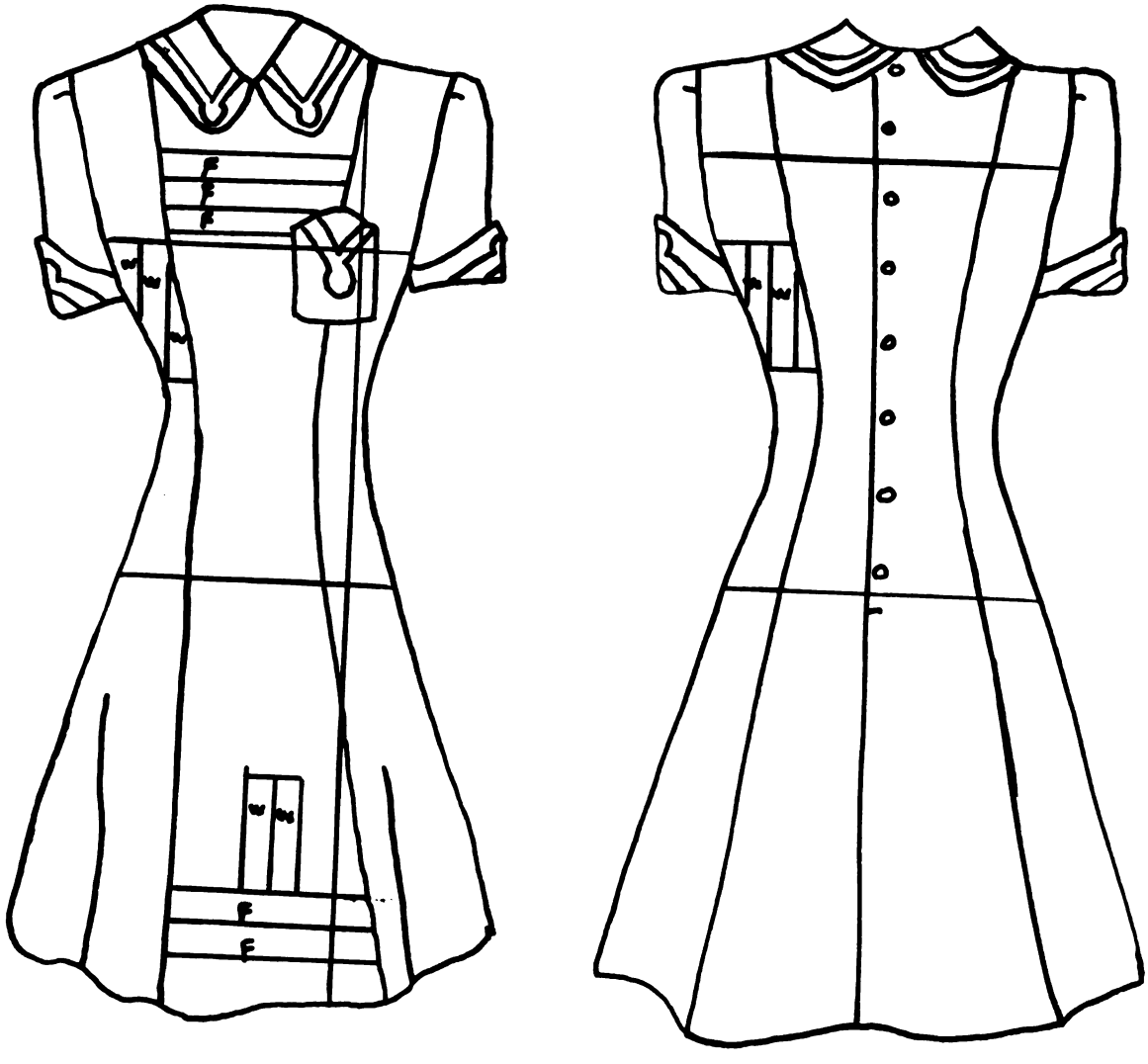
Cosmetology Uniform-E



———Indicates Linear and Width Measurements

W and F--Warp and Filling Breaking Strength Strips

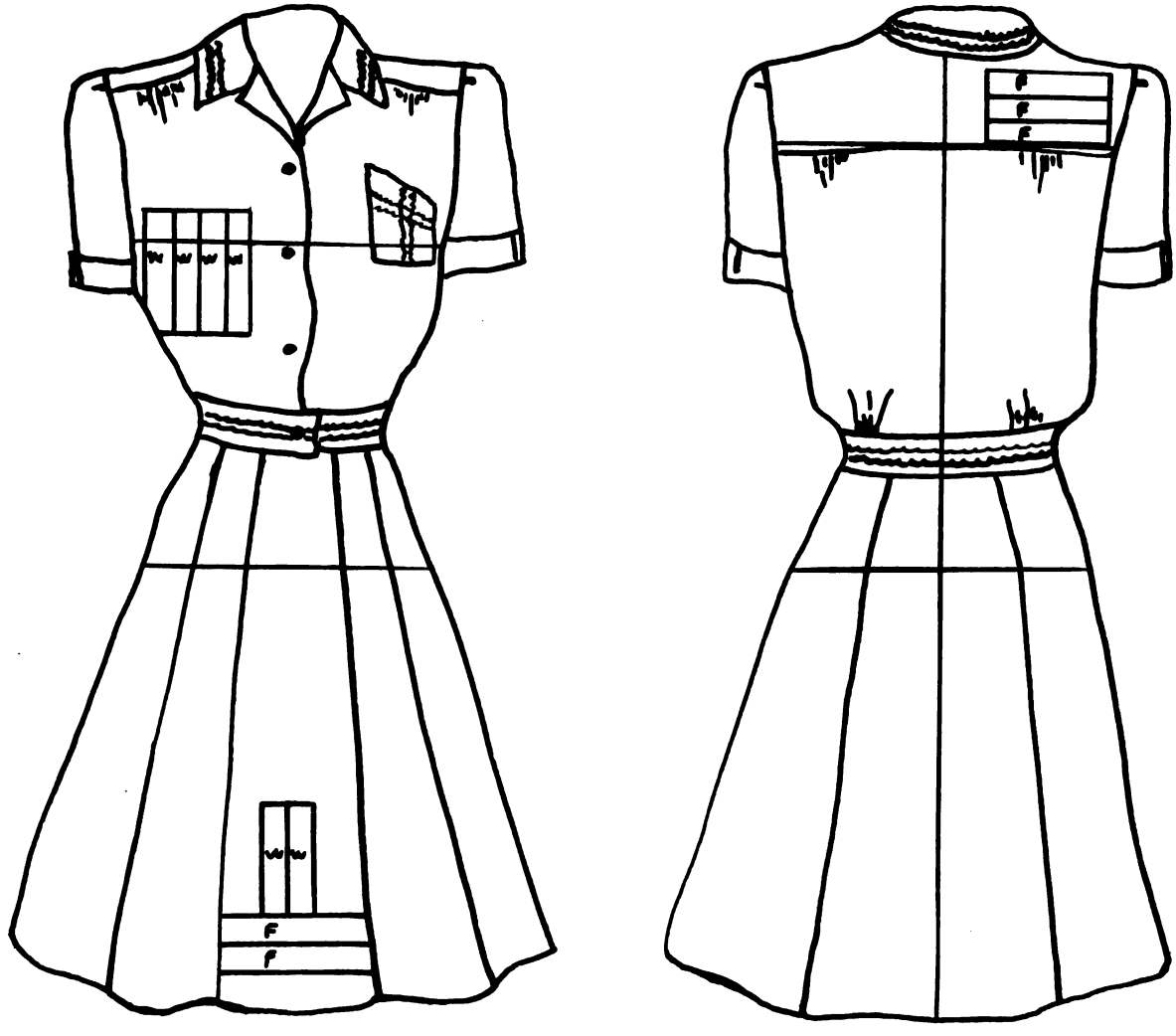
Foods Uniform-F



W and F--Warp and Filling Breaking Strength Strips

———--Indicates Linear and Width Measurements

Household Management Uniform-G



W and F--Warp and Filling Breaking Strength Strips

———--Indicates Linear and Width Measurements

Yarn Count
Fabric Squares Controlled Group
Number per Inch

Laundry Intervals		Blue Squares		White Squares		Peach Squares		Green Squares	
		W.	F.	W.	F.	W.	F.	W.	F.
New		46	49	54	49	54	51	56	47
		54	49	54	49	55	49	55	45
		53	48	54	48	54	50	55	46
		53	49	54	49	55	50	54	46
		53	48	54	48	54	50	54	47
	$\bar{X}$	54	49	54	49	54	50	55	46
First		55	50	56	51	56	53	54	48
		55	51	54	50	56	51	55	47
		56	51	54	52	54	51	54	47
		56	51	55	52	54	51	56	46
		57	50	56	52	53	51	54	47
	$\bar{X}$	56	51	55	51	55	52	55	47
Second		54	50	54	52	57	51	56	47
		55	50	55	52	54	51	55	46
		54	51	53	51	55	52	55	47
		55	51	54	50	55	51	54	48
		55	51	55	51	54	52	53	47
	$\bar{X}$	55	51	54	51	55	51	55	47
Third		54	51	55	50	55	52	56	47
		55	51	53	52	55	51	55	46
		55	51	54	54	54	53	55	48
		55	51	55	52	54	51	54	47
		55	51	55	51	55	52	53	46
	$\bar{X}$	55	51	54	52	55	52	55	47
Fourth		54	51	53	50	56	51	56	49
		55	50	53	52	53	50	54	48
		55	50	53	49	52	53	54	47
		55	51	55	51	54	52	55	48
		56	51	53	52	53	54	54	47
	$\bar{X}$	55	51	54	51	54	52	55	48
Fifth		55	51	50	51	55	51	56	47
		54	51	52	52	55	52	55	46
		55	52	54	52	54	52	54	48
		56	49	54	54	55	52	54	49
		55	51	55	51	55	51	55	47
	$\bar{X}$	55	51	53	52	55	52	55	48

Yarn Count (continued)
Fabric Squares Controlled Group
Number per Inch

Laundry Intervals		Blue Squares		White Squares		Peach Squares		Green Squares	
		W.	F.	W.	F.	W.	F.	W.	F.
Tenth		54	51	53	52	54	51	55	46
		54	51	54	53	55	52	55	49
		55	51	53	51	55	52	55	48
		55	52	53	52	55	52	55	48
		55	52	53	52	55	52	56	47
	$\bar{X}$	55	51	53	52	55	52	55	48
Twenti-eth		55	52	53	53	56	53	54	50
		54	52	53	53	55	52	55	48
		54	51	54	53	55	51	54	47
		55	52	54	53	55	52	54	49
		55	51	53	53	55	52	54	48
	$\bar{X}$	55	52	53	53	55	52	55	48
Twenty-fifth		54	52	54	53	55	52	55	50
		57	52	53	53	55	53	54	49
		55	53	53	53	55	52	56	48
		54	51	54	54	55	52	55	48
		54	51	53	53	55	52	55	49
	$\bar{X}$	55	52	53	53	55	52	55	49

Yarn Count--Uniforms
Number per Inch

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms* Warp	Non-controlled Uniforms* Filling
First		55	52	51	53
		55	52	49	54
		54	51	50	52
		56	52	53	51
		55	53	49	52
	$\bar{X}$	55	52	51	53
		56	51	56	49
		56	50	55	50
		56	50	54	51
		56	50	53	51
		56	50	54	52
	$\bar{X}$	56	50	54	51
				57	50
				55	51
				56	51
				56	51
				57	51
	$\bar{X}$			56	51
Tenth		53	46	53	49
		53	48	54	52
		53	48	55	53
		53	48	56	53
		53	49	56	53
	$\bar{X}$	53	48	55	52
		54	53	54	48
		54	52	55	49
		53	54	54	47
		54	52	53	45
		54	53	53	48
	$\bar{X}$	54	53	54	47
Twenti-eth		54	50	56	52
		53	49	57	51
		54	50	55	53
		55	49	54	53
		56	49	54	53
	$\bar{X}$	54	49	55	52

*Uniforms withdrawn from study.

Yarn Count--Uniforms (continued)

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms* Warp	Non-controlled Uniforms* Filling
Twentieth		55	51	56	52
		53	51	56	50
		53	52	56	51
		54	52	56	51
		53	53	54	51
	$\bar{X}$	54	52	56	51
		55	52	50	53
		54	52	50	53
		54	53	54	54
		55	55	54	50
		55	52	56	51
	$\bar{X}$	55	53	53	52
Twenty-fifth		54	50	55	53
		54	50	55	51
		54	50	54	52
		53	52	54	53
		55	52	54	53
	$\bar{X}$	54	51	54	52
		57	54	54	52
		57	57	54	53
		57	55	54	53
		56	56	55	53
		57	55	55	54
	$\bar{X}$	57	55	54	53
		53	52		
		52	52		
		53	52		
		53	52		
		53	53		
	$\bar{X}$	53	52		
		54	51		
		55	51		
		55	52		
		55	53		
		57	53		
	$\bar{X}$	55	52		
		54	50		
		54	51		
		55	53		
		55	53		
		57	53		
	$\bar{X}$	55	52		

Breaking Strength in Pounds
Strip Method
70°F. 40% R.H.

Laundry Intervals		*Blue Squares		*White Squares		*Peach Squares		*Green Squares	
		W.	F.	W.	F.	W.	F.	W.	F.
New		53	42	54	40	58	50	55	40
		56	45	55	41	59	51	58	41
		59	46	58	41	60	52	59	41
		60	50	59	42	61	53	59	42
		62	54	60	44	62	54	60	43
	$\bar{X}$	58	47	57	42	60	52	58	41
First		58	47	50	41	57	47	51	39
		59	48	52	41	57	49	52	40
		61	49	52	49	58	49	52	42
		61	50	55	50	60	49	53	43
		61	50	59	53	61	50	58	43
	$\bar{X}$	60	49	54	47	59	49	53	41
Tenth		49	42	47	41	49	40	50	36
		50	48	47	42	53	40	50	39
		52	48	48	48	53	42	50	40
		52	48	49	48	53	42	51	40
		53	51	50	49	59	42	52	40
	$\bar{X}$	51	47	48	46	53	41	51	39
Twenti-eth		50	45	43	40	45	37	47	38
		51	45	47	41	48	38	48	38
		51	46	50	43	51	38	50	40
		56	47	50	45	51	40	50	40
		57	48	51	47	52	41	50	42
	$\bar{X}$	53	46	48	43	49	39	49	40
Twenty-fifth		48	28	40	29	42	30	37	29
		49	30	41	30	44	33	40	31
		52	31	41	33	44	34	40	32
		53	31	41	40	45	37	42	32
		54	32	42	41	50	39	47	36
	$\bar{X}$	51	30	41	35	45	35	41	32

*Fabric Squares Controlled Group

Breaking Strength in Pounds
Strip Method
70°F. 40% R. H.

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms** Warp	Non-controlled Uniforms** Filling
First		51	43	50	38
		55	48	50	43
		59	49	51	48
		59	50	52	49
		62	51	54	50
	$\bar{X}$	57	48	51	46
		50	42	45	29
		53	45	45	32
		53	48	50	39
		53	40	51	39
		58	49	52	40
	$\bar{X}$	53	45	49	36
				50	49
				59	49
				62	49
				62	50
				64	50
	$\bar{X}$			59	49
Tenth		47	40	39	33
		47	40	40	34
		48	41	41	35
		48	43	42	35
		48	43	43	38
	$\bar{X}$	48	41	41	35
		41	34	45	35
		44	37	49	40
		46	38	50	40
		46	38	50	41
		51	40	51	43
	$\bar{X}$	46	37	49	40
Twenti-eth		38	25	31	22
		40	27	32	25
		40	27	33	25
		41	31	39	30
		42	36	40	31
	$\bar{X}$	40	29	35	27

* and ** uniforms withdrawn from study

Breaking Strength (continued)
Strip Method
70°F. 40% R. H.

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms** Warp	Non-controlled Uniforms** Filling
Twenti-eth		34	29	43	23
		35	30	43	29
		39	27	45	30
		39	31	46	32
		39	31	51	33
	$\bar{X}$	37	30	46	29
		40	26	42	26
		43	33	49	29
		43	40	50	35
		45	41	50	35
		49	45	52	35
	$\bar{X}$	44	37	49	32
Twenty-fifth		45	26	39	29
		46	32	40	29
		46	33	40	25
		46	34	42	22
		48	41	29	18
	$\bar{X}$	46	33	40	25
		43	30	39	21
		47	31	41	24
		47	32	43	24
		50	34	40	26
		50	40	39	34
	$\bar{X}$	47	33	40	26
		35	28		
		36	30		
		39	31		
		39	38		
		45	38		
	$\bar{X}$	39	33		
		46	25		
		46	25		
		50	31		
		52	34		
		44	29		
	$\bar{X}$	48	29		
		40	25		
		42	29		
		42	32		
		43	35		
		45	40		
	$\bar{X}$	42	32		

Elongation in Percent
Strip Method
3-inch gauge length

Laundry Intervals	*Blue Squares W.	*Blue Squares F.	*White Squares W.	*White Squares F.	*Peach Squares W.	*Peach Squares F.	*Green Squares W.	*Green Squares F.
New	.05	.60	.30	.80	.17	.53	.19	.90
	.12	.70	.15	.75	.17	.53	.12	.62
	.13	.65	.30	.60	.20	.60	.20	.79
	.13	.60	.20	.80	.18	.70	.20	.69
	.14	.61	.30	.80	.21	.60	.20	.62
$\bar{X}$	.11	.63	.25	.75	.186	.59	.59	.706
Percent	3.66	21.00	8.30	25.00	6.20	19.60	6.00	23.50
First	.31	.80	.52	1.00	.34	.90	.20	.80
	.30	.80	.51	.92	.30	.90	.25	.80
	.19	.87	.52	.89	.28	.83	.30	.78
	.30	.83	.40	.90	.28	.80	.30	.80
	.30	.81	.49	.81	.30	.90	.30	.80
$\bar{X}$	.26	.82	.49	.90	.30	.87	.27	.796
Percent	9.30	27.30	16.30	30.00	10.00	29.00	9.00	26.50
Tenth	.20	.99	.31	.59	.20	.74	.30	.70
	.30	.78	.45	.60	.30	.70	.28	.60
	.31	.75	.46	.80	.30	.77	.23	.60
	.30	.79	.47	.70	.29	.72	.31	.61
	.29	.80	.40	.80	.30	.81	.34	.65
$\bar{X}$	.28	.82	.42	.70	.23	.75	.29	.63
Percent	9.30	27.30	14.00	23.30	9.30	25.00	9.60	21.00
Twenti-eth	.20	.50	.50	.62	.20	.67	.30	.71
	.35	.70	.51	.62	.21	.62	.30	.61
	.20	.70	.50	.71	.28	.72	.31	.71
	.26	.70	.45	.70	.20	.68	.35	.70
	.21	.65	.48	.72	.20	.66	.25	.70
$\bar{X}$	.24	.65	.49	.67	.22	.67	.30	.69
Percent	8.00	21.60	16.30	22.30	7.30	22.30	10.00	23.00
Twenty-fifth	.26	.62	.40	.54	.22	.77	.30	.77
	.35	.67	.49	.50	.22	.60	.37	.70
	.24	.68	.50	.71	.25	.69	.30	.68
	.23	.68	.55	.70	.31	.72	.29	.70
	.22	.70	.41	.77	.31	.80	.31	.64
$\bar{X}$	.26	.67	.47	.64	.26	.72	.31	.70
Percent	8.60	22.30	15.60	21.30	8.60	24.00	10.30	23.30

* Fabric Squares Controlled Group

Elongation in Percent
Strip Method
3-inch gauge length

Laundry Intervals		Controlled Uniforms*		Non-controlled Uniforms**	
		Warp	Filling	Warp	Filling
New		.05	.60	.30	.80
		.12	.70	.15	.75
		.13	.60	.30	.60
		.13	.65	.20	.80
		.14	.61	.30	.80
	$\bar{X}$	.11	.63	.25	.75
Percent		3.66	21.00	8.30	25.00
First		.20	.80	.40	.65
		.30	.90	.49	.70
		.25	.70	.39	.75
		.38	.73	.37	.90
		.40	.83	.47	.77
	$\bar{X}$	.31	.79	.42	.75
Percent		10.30	26.30	14.00	25.00
		.20	.83	.20	.50
		.22	.80	.20	.75
		.47	.87	.20	.70
		.30	.88	.21	.59
		.29	.84	.20	.70
	$\bar{X}$	.30	.84	.20	.65
Percent		10.00	28.00	6.60	21.60
				.03	.80
				.15	.80
				.35	.70
				.32	.80
				.27	.80
	$\bar{X}$			.22	.78
Percent				7.30	26.00
Tenth		.20	.52	.30	.60
		.29	.52	.30	.65
		.30	.65	.34	.60
		.25	.60	.52	.64
		.22	.50	.40	.60
	$\bar{X}$	.25	.56	.37	.68
Percent		8.30	18.60	12.30	20.60
		.19	.51	.15	.43
		.18	.60	.20	.40
		.27	.61	.21	.43
		.23	.65	.21	.43
		.21	.62	.21	.60
	$\bar{X}$	.22	.60	.20	.46
Percent		7.30	20.00	6.60	15.30

Elongation (continued)
Strip Method
3-inch gauge length

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms** Warp	Non-controlled Uniforms** Filling
Twenti-eth		.25	.50	.31	.60
		.25	.54	.30	.57
		.23	.50	.25	.60
		.23	.52	.30	.63
		.32	.65	.25	.65
	$\bar{X}$	.26	.54	.28	.61
Percent		8.60	18.00	9.30	20.30
		.40	.50	.24	.59
		.30	.60	.40	.68
		.36	.60	.37	.60
		.25	.61	.23	.61
		.25	.60	.23	.69
	$\bar{X}$	.31	.58	.29	.63
Percent		10.30	19.30	9.60	21.00
		.15	.43	.25	.60
		.25	.50	.30	.67
		.21	.42	.30	.50
		.22	.47	.29	.60
		.20	.45	.30	.55
	$\bar{X}$	.21	.45	.29	.58
Percent		7.00	15.00	9.60	19.30
Twenty-fifth		.20	.59	.27	.51
		.21	.60	.40	.54
		.30	.69	.40	.60
		.20	.57	.45	.55
		.31	.60	.32	.52
	$\bar{X}$	.24	.61	.37	.54
Percent		8.00	20.30	12.30	18.00
		.21	.56	.29	.51
		.31	.60	.21	.60
		.35	.60	.22	.60
		.29	.65	.31	.48
		.30	.62	.32	.55
	$\bar{X}$	.29	.61	.27	.55
Percent		9.60	23.30	9.00	18.30
		.40	.59		
		.25	.55		
		.40	.57		
		.25	.57		
		.26	.55		
	$\bar{X}$	.31	.57		
Percent		10.30	19.00		

Elongation (continued)
Strip Method
3-inch gauge length

Laundry Intervals		Controlled Uniforms* Warp	Controlled Uniforms* Filling	Non-controlled Uniforms** Warp	Non-controlled Uniforms** Filling
Twenty-fifth		.30	.67		
		.35	.66		
		.27	.69		
		.28	.60		
		.24	.62		
	$\bar{X}$	.29	.65		
Percent		9.60	21.60		
		.18	.48		
		.20	.51		
		.21	.62		
		.28	.50		
		.20	.55		
	$\bar{X}$	.21	.53		
Percent		7.00	17.60		

* and ** uniforms withdrawn from study

Summary--Elongation in Percent Averages
Strip Method 3-inch gauge length
Controlled, Non-controlled Uniforms, Fabric Squares

Laundry Intervals	Controlled Uniforms Percent Av. W.	F.	Non-controlled Uniforms Percent Av. W.	F.	Fabric Squares Percent Av. W.	F.
New	6.04	22.27	6.04	22.27	6.04	22.27
First	10.15	27.15	9.30	24.20	10.97	28.22
Tenth	7.80	19.30	9.45	17.95	10.40	24.15
Twenti-eth	8.63	17.43	9.50	20.20	10.40	22.22
Twenty-fifth	8.90	20.36	10.65	18.15	10.87	22.65

Linear Dimensional Change in Percent
Fabric Squares Controlled Group

Laundry Intervals			
First Percent	Second Percent	Third Percent	Fourth Percent
*-2.2	-2.2	-3.3	-2.7
-5.0	-5.8	-6.1	-6.6
-1.6	-2.8	-2.8	-2.2
-3.3	-3.05	-3.7	-3.7
**M-3.02 ±.84	M-3.46 ±.09	M-3.97 ±.08	M-3.80 ±.11

Fifth Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
-3.9	-5.0	-5.0	-5.5
-6.6	-7.2	-7.7	-7.7
-3.3	-3.3	-4.4	-3.8
-4.4	-5.5	-5.5	-5.5
M-4.55 ±.08	M-5.25 ±.09	M-5.65 ±.08	M-5.62 ±.09

Width Dimensional Change in Percent
Fabric Squares Controlled Group

Laundry Intervals			
First Percent	Second Percent	Third Percent	Fourth Percent
*-2.7	-4.4	-3.3	-3.3
-0.5	-0.5	-0.5	-0.5
-3.2	-0.8	-0.5	-1.1
-0.8	-2.4	-1.1	-1.4
**M-0.6 ±.08	M-2.0 ±.11	M-1.35 ±.07	M-157 ±.07

Fifth Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
-2.8	-2.8	-2.8	-2.8
-0.5	-1.1	0.0	-1.1
-2.2	-0.5	-0.5	-1.1
-1.1	-1.1	-0.55	-0.55
M-1.4 ±.08	M-1.38 ±.05	M-0.96 ±.07	M-1.39 ±.04

* Average of 3 measurements based on original measurements
** M of 12 measurements based on original measurements

Linear Dimensional Change in Percent*
Controlled Uniform Group

Laundry Intervals			
First Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
-5.8	-5.1	-6.5	-6.5
-5.1	-5.1	-5.4	-6.2
-4.5	-5.0	-4.9	-5.0
-4.0	-5.0	-4.9	-4.9
-3.5	-4.8	-4.8	-4.9
-3.4	-4.7	-4.5	-4.8
-3.4	-4.7	-4.4	-4.6
-3.3	-4.5	-4.4	-4.3
-2.9	-4.5	-4.3	-4.3
-2.8	-4.4	-4.3	-4.2
-2.8	-4.0	-4.2	-4.1
-2.8	-4.0	-4.0	-4.0
-2.7	-3.9	-3.8	-4.0
-2.5	-3.7	-3.7	-3.9
-2.3	-3.6	-3.7	-3.8
-2.3	-3.5	-3.6	-3.6
-2.2	-3.5	-3.6	-3.5
-2.1	-3.4	-3.4	-3.2
-2.0	-3.3	-3.3	-2.8
-1.9	-3.8	-3.0	-2.6
-1.8	-2.7	-2.9	-2.5
-1.7	-2.7	-2.6	-1.9
-1.6	-2.7	-2.4	-1.7
-1.6	-2.6	-2.4	
-1.6	-2.4	-1.9	
-1.6	-2.4	-1.6	
-1.6	-2.1		
-1.1	-1.9		
-1.0	-1.3		
-1.0			
-0.8			
M-2.54 ±.21	M-3.6 ±.36	M-3.8 ±.16	M-3.9 ±.26
N=31	N=29	N=26	N=23

Withdrawn for testing purposes:
2 2 3 5 Total 12

Withdrawn from study--1 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Linear Dimensional Change in Percent*
Non-controlled Uniform Group

Laundry Intervals First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
-7.3	-9.1	-8.7	-8.7
-5.2	-8.4	-8.1	-8.7
-5.1	-5.9	-6.5	-6.5
-4.4	-5.9	-6.0	-6.1
-3.5	-5.7	-5.9	-6.1
-3.5	-5.7	-5.7	-5.3
-3.2	-5.2	-5.3	-4.8
-3.2	-4.8	-5.1	-4.8
-2.9	-4.6	-4.8	-4.2
-2.8	-4.4	-4.8	-4.2
-2.8	-4.3	-4.3	-4.1
-2.7	-3.8	-4.1	-3.9
-2.7	-3.6	-4.0	-2.6
-2.7	-3.4	-3.9	-1.7
-2.6	-3.3	-3.9	
-2.4	-3.2	-2.6	
-2.3	-2.9	-1.4	
-2.2	-2.5		
-2.1	-1.6		
-1.9	-1.1		
-1.8	-1.1		
-1.7			
-1.1			
-0.9			
M-2.93 ±.30	M-4.15 ±.44	M-5.0 ±.43	M-5.1 ±.52
N=24	N=21	N=17	N=14
Withdrawn for testing purposes: 3	2	3	2 Total 10

Withdrawn from study--2 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Bust-Dimensional Change in Percent*
Controlled Uniform Group

Laundry Intervals			
First	Tenth	Twentieth	Twenty-fifth
**Percent	Percent	Percent	Percent
-7.6	-8.5	-6.5	-6.7
-7.1	-6.5	-5.9	-5.6
-6.2	-6.3	-5.6	-5.5
-6.2	-5.4	-5.5	-5.5
-5.8	∤5.3	∤4.8	∤5.4
-5.2	-5.1	∤4.2	∤4.8
∤4.8	∤4.5	∤3.8	∤4.2
∤4.3	-2.9	-3.5	-3.8
∤4.2	∤2.7	∤2.8	∤3.1
-3.4	-2.5	-2.7	-2.9
∤2.5	∤2.3	-2.5	∤2.3
-2.4	-2.1	∤2.3	-2.1
∤1.6	-2.1	-2.1	-2.1
-1.4	∤1.8	-2.1	∤1.9
∤1.4	∤1.7	-2.0	-1.5
-1.3	-1.5	-2.0	-1.4
∤1.3	-1.4	∤1.6	∤1.4
∤0.9	-1.4	-1.5	-1.3
-0.7	-0.9	-1.4	-0.9
∤0.7	-0.9	-1.4	-0.7
-0.7	∤0.9	∤0.9	-0.7
∤0.7	-0.8	-0.7	-0.3
∤0.7	∤0.8	-0.3	0.0
∤0.6	-0.6	∤0.3	
-0.5	∤0.6	-0.2	
-0.3	-0.3	0.0	
-0.3	0.0		
-0.3	0.0		
-0.3	0.0		
-0.03			
0.0			
M-0.36 ∤.59	M-0.64 ∤.57	M-0.83 ∤.57	M-0.78 ∤.69
N=31	N=29	N=26	N=23

Withdrawn for testing purposes:
2 2 3 5 Total 12

Withdrawn from study--1 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Bust-Dimensional Change in Percent*
Non-controlled Uniform Group

Laundry Intervals First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
∠9.4	∠9.4	∠9.9	∠9.4
∠5.4	∠5.7	∠8.0	∠7.3
∠4.9	∠4.0	∠5.0	∠4.6
∠3.5	-3.7	-4.1	-4.1
∠2.9	-3.5	-3.6	-3.9
∠2.8	∠3.4	∠2.6	-2.6
-2.6	∠3.3	-2.6	∠2.0
∠2.4	∠3.1	∠2.4	-1.8
∠2.4	∠2.6	∠2.1	∠1.7
∠2.4	-2.6	∠1.7	∠1.5
∠1.6	∠2.4	-1.6	∠0.8
∠1.2	∠2.1	∠1.5	∠0.6
∠1.1	∠1.8	∠1.1	∠0.4
∠1.0	∠1.4	∠0.8	∠0.3
∠1.0	-1.3	∠0.7	
-1.0	∠1.2	∠0.5	
∠0.8	-1.2	∠0.0	
∠0.8	∠1.1		
∠0.7	∠0.7		
∠0.7	∠0.6		
∠0.7	∠0.3		
-0.6			
∠0.3			
0.0			
M 1.6 ∠.49	M 1.29 ∠.66	M 1.43 ∠.04	M 1.1 ∠.99
N=24	N=21	N=17	N=14

Withdrawn for testing purposes:
3 2 3 2 Total 10

Withdrawn from study--2 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Shoulder Back-Dimensional Change in Percent*
Controlled Uniform Group

Laundry Intervals

First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
-5.9	-7.9	-5.9	-5.4
-4.7	∤5.6	-4.6	-4.6
∤4.5	∤4.5	∤4.4	∤3.1
-4.0	∤3.9	-4.1	-2.9
-3.9	-3.9	-3.2	-2.6
-2.5	-3.4	-2.9	-2.3
-2.4	-2.9	-2.6	∤2.0
∤2.3	-2.3	-2.5	∤1.8
-2.2	∤2.6	-2.3	∤1.7
-1.9	-2.5	∤2.2	∤1.7
∤1.8	-2.4	-2.1	-1.7
-1.8	∤2.3	-1.9	-1.6
-1.7	-2.1	-1.8	-1.6
-1.3	-2.1	∤1.7	∤1.5
∤1.2	∤1.7	∤1.7	∤0.9
-1.2	-1.6	-1.6	∤0.9
-1.2	-1.5	∤1.5	-0.9
∤1.2	∤1.3	-1.0	∤0.8
-0.9	∤1.1	∤0.9	-0.7
-0.9	-1.0	∤0.8	-0.5
∤0.9	∤0.9	∤0.7	-0.4
-0.9	-0.8	-0.5	0.0
∤0.9	-0.7	-0.4	0.0
-0.6	-0.5	-0.3	
∤0.5	-0.4	0.0	
-0.4	-0.3	0.0	
∤0.3	-0.2		
-0.2	∤0.2		
∤0.1	0.0		
∤0.03			
0.0			
M-0.804 ∤.12	M-0.44 ∤.51	M-1.03 ∤.44	M-0.47 ∤.44
N=31	N=29	N=26	N=23
Withdrawn for testing purposes:			
2	2	3	5 Total 12

Withdrawn from study--1 after tenth laundry

* See appendix uniform sketches D-E-F-G
** All percents are based on original measurements of the uniforms.

Shoulder Back-Dimensional Change in Percent*
Non-controlled Uniform Group

Laundry Intervals First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
±4.5	±7.3	±8.3	±6.5
±3.3	±3.5	±5.1	±6.1
-2.5	-2.8	±4.2	±4.1
±2.5	±2.5	-4.1	-4.1
±2.2	±2.3	±2.5	-2.8
±2.2	±1.8	-2.5	-2.5
±1.8	±1.7	±2.1	±2.5
-1.7	±1.2	±2.1	-2.3
±1.6	±1.2	±1.9	-1.8
±1.5	±0.9	-1.9	±1.3
±1.2	-0.8	-1.9	±1.2
±1.1	±0.8	±1.7	±0.9
±1.0	±0.7	-1.3	±0.02
±0.8	-0.5	±1.0	±0.08
±0.8	±0.4	±0.01	
±0.8	-0.2	0.0	
±0.5	±0.1	0.0	
-0.4	±0.09		
-0.4	±0.01		
±0.1	0.0		
±0.1	0.0		
-0.01			
0.0			
0.0			
M±0.83 ±.31	M ±1.17 ±.09	M ±1.01 ±.69	M ±0.66 ±.84
N=24	N=21	N=17	N=14

Withdrawn for testing purposes:
3 2 3 2 Total 10

Withdrawn from study--2 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Hips-Dimensional Change in Percent*
Controlled Uniform Group

Laundry Intervals First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
±8.9	±8.2	±8.9	±8.9
-6.5	-5.4	±6.6	±5.0
-5.4	±5.0	-3.7	-4.4
±5.0	±4.2	±3.1	-3.8
-4.5	-3.1	-3.0	±2.3
±3.4	-2.9	-2.7	±2.0
±2.8	-2.7	±2.3	-1.7
±2.8	-2.5	±2.2	-1.6
-2.5	-2.3	±2.1	±1.5
-2.4	±2.0	-1.7	-1.5
-2.4	-1.7	-1.6	-1.5
±2.2	-1.7	-1.5	-1.4
±2.1	-1.6	-1.3	±1.4
-2.0	±1.4	±1.2	-1.3
-1.9	-1.3	-1.2	-1.2
-1.8	±1.3	-1.2	-1.1
±1.7	-1.2	-0.9	-1.0
-1.5	-1.2	-0.9	-0.7
±1.3	-1.2	-0.8	-0.4
±1.3	-1.1	-0.7	±0.3
-1.1	±0.9	-0.4	0.0
-0.9	-0.9	-0.4	0.0
±0.7	-0.7	±0.3	0.0
±0.6	-0.6	±0.3	
-0.6	-0.6	0.0	
-0.6	-0.5	0.0	
-0.3	±0.3		
0.0	0.0		
0.0	0.0		
0.0			
0.0			
M-0.05 ±1.7	M-0.34 ±.48	M±0.19 ±.49	M-0.01 ±.53
N=31	N=29	N=26	N=23

Withdrawn from study for testing purposes:
2 | 2 | 3 | 5 Total 12

Withdrawn from study--1 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

Hips-Dimensional Change in Percent*
Non-controlled Uniform Group

Laundry Intervals First **Percent	Tenth Percent	Twentieth Percent	Twenty-fifth Percent
∕5.4	∕6.9	∕8.3	∕7.9
∕5.0	∕5.4	-4.1	-4.1
∕4.8	-4.4	∕4.1	∕3.8
∕4.2	∕4.2	-3.5	∕3.5
∕2.9	∕3.2	-3.2	-3.4
∕2.6	∕3.0	∕2.9	∕2.6
∕2.5	∕3.0	∕2.6	∕1.1
∕1.3	-2.6	∕2.6	-1.1
∕1.3	∕2.6	∕1.1	-0.0
∕1.3	-1.4	-1.1	∕0.7
∕1.1	-1.2	∕1.1	∕0.6
∕1.1	-1.1	∕0.9	∕0.6
∕1.1	∕1.0	-0.9	∕0.3
∕0.9	∕0.9	∕0.7	0.0
∕0.7	∕0.7	∕0.6	
∕0.6	∕0.66	0.0	
∕0.6	-0.6	0.0	
∕0.44	∕0.6		
-0.1	-0.55		
0.0	-0.3		
0.0	∕0.3		
0.0			
0.0			
0.0			
M ∕1.57 ∕.34	M ∕0.96 ∕.57	M ∕0.71 ∕.71	M ∕0.83 ∕.78
N=24	N=21	N=17	N=14

Withdrawn for testing purposes:
3 2 3 2 Total 10

Withdrawn from study--2 after tenth laundry

* See Appendix uniform sketches D-E-F-G.
** All percents are based on original measurements of the uniforms.

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