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A COMPARISON OF FOUR SELECTED MEN'S DRESS SHIRTS

by

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Textiles, Clothing and Related Arts, 513A, presented to fulfill the problem requirement for the Master of Arts Degree in Textiles and Clothing at Michigan State University, August, 1960.

Professor Miss Hazel B. Strahan

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CHAPTER I

INTRODUCTION

Every man who has worn a white dress shirt as well as every woman who has ever cared for one is vitally concerned with wanting to get a shirt that will give maximum wear with minimum care. To determine some of the differences in performances, this study will involve the testing of men's, easy-care, white, cotton, broadcloth, dress shirts, taking into consideration both price and brand names as factors in conparison.

I. THE PROBLEM

Statement of the problem. The purpose of this study is to compare by laboratory study the fabrics from four ready-made, men's easy-care, white, cotton, broadcloth, dress shirts. In the selected shirts, there is both a difference in price range and in brand names. The shirts to be tested are a $4 Japanese made summer shirt, a $4 chain store shirt, a $5 name brand shirt, and a $7 shirt of the same name brand.

Statement of specific objectives. The specific objectives for this problem are: (1) to compare the fabrics of the shirts selected for this study; (2) to determine the relationship of price to fabric performance in the selected white dress shirts for this study; (3) to compare any quality differences in the nationally advertised shirts with the others in the study; (4) to make assumptions as to the probable ease of care required for the selected shirts; and (5) to interpret laboratory test

results on various performances of these shirts; namely, wrinkle recovery, dimensional stability, chlorine retention, breaking strength, and resistance to abrasion.

II. LIMITATIONS

Statement of limitations. Laboratory testing will be according to standards set by the American Society for Testing Material (ASTM), Federal Specifications, and American Standard Performance Requirements for Textile Fabrics. This study will not include the practical testing of actual wear and care.

The shirts used are typical of purchases that my husband and other young men in the teaching profession would be apt to make.

This study is limited by the length of time available for working with the problem. There has been, of necessity, a concentration of testing and analysis in order that the problem could be completed in the time available.

CHAPTER II

METHODS AND PROCEDURES

I. SELECTION OF SHIRTS

The four shirts used for this study were typical of shirt purchases that my family would make. Price and brand name were to be two factors to compare in this study.

Due to the textile competition from Japanese manufacturers, it was decided to have one Japanese made shirt to compare its fabric for price and performance qualities with American manufactured shirts.

A chain store shirt was chosen to represent a less expensive shirt. A name brand shirt was also chosen to be used as a more expensive type shirt.

The fourth shirt was a more expensive shirt with a brand name for comparison of price to the other shirts as well as quality factors. This shirt, a blend of Dacron and cotton, was chosen to be compared with the other cotton shirts.

The Japanese shirt was purchased in Detriot, Michigan at the time of the riots in Japan. It was interesting to note the hostility felt when inquiring about Japanese made shirts as well as while making the final purchase. Most of the inquiries were by telephone. The usual answer to the question of whether Japanese made shirts were sold at that store was to the effect that, no, we never carry Japanese shirts. Only three of the

20 stores contacted in the Detroit area carried Japanese made shirts. Only one store carried a shirt acceptable for my study. This was a short sleeved, Jacquard weave, 100% Pima cotton, white shirt selling for $3.98. No claim was made as to ease of care. This Japanese shirt is referred to as Shirt A in this problem.

The chain store shirt was purchased at Montgomery Ward's. This shirt was their $3.98, 100% Pima and combed cotton blended. It was claimed to be wash and wear, as well as having a non-yellowing finish. This shirt is referred to as Shirt B throughout this study.

The third shirt chosen was an Arrow brand name in their "Chase" style. This was a $5, 100% cotton shirt. It was also claimed to be wash and wear. This shirt is referred to as Shirt C throughout this study.

The fourth shirt purchased was an Arrow brand name also, but this time their "Decton" style. This shirt was $6.95, and contained 65% Dacron and 35% cotton. This shirt was also a wash and wear and will be referred to as Shirt D throughout this study.

II. LABORATORY TESTS

Laboratory tests were carried out according to standards set by the American Society for Testing Material (ASTM), Federal Specifications, American Standard Performance Requirements for Textile Fabrics (L22), and American Association of Textile Chemists and Colorists (AATCC).

Standard conditions. ASTM: D 39-49. Tests were completed in standard condition, unless otherwise specified. Standard condition of woven fabrics shall be that reached by the fabric when in moisture equilibrium with a standard atmosphere having a relative humidity

of 65% at 70 F. A tolerance of plus or minus 2% is permitted in relative humidity and plus or minus 2 F in temperature.

A. YARN CONSTRUCTION

Yarn number. ASTM D 12244-57T. Test instrument: Universal Yarn Numbering Balance. Procedure: By accurately measuring a designated length of yarn, it can be placed on the Universal Yarn Numbering Balance and its yarn number read directly with no further calculations needed.

The test specimen is measured by a specially made ruler which has marks for proper lengths of various fibers needed. One yard of my fabrics was needed to give the correct yarn number.

After the specimen is measured, it is brought against the cutting edge of the ruler and cut off. The yarn is then twisted into a knot so as to hang centrally on the hook.

After the yarn is on the hook, the weighing chamber is closed. The beam is unlocked and the index lever rotated until the beam is in balance. The index pointer then indicates the correct yarn number.

Direction of twist. ASTM: D 123. A single yarn has S twist if, when held in a vertical position, the spirals around its central axis conform in direction of slope to the central position of the letter "S", and Z twist if the spirals conform in direction of slope with the central portion of the letter "Z".

Amount of twist. ASTM: D 1423-56T. Principle: The twist in a known length of yarn is counted as it is removed, by rotating one end of the specimen until the elements being tested are parallel. The number of turns required to remove the twist is reported in terms of turns per inch.

Apparatus: Suter Twist Tester. Test Specimens: One inch was used as the guage length. Ten tests were made on the yarns in each direction.

Procedure: From an 18" strip (the longest possible in my fabrics), the yarn was ravelled back to 4" and inserted in the right hand jaw and carefully removed by a pick needle to retain the original twist. The yarn was then carried under a deflection load of 3 grams. After inserting into the left hand jaw, the yarn was drawn tautly with allowance for a deflection of 1/8". The three gram deflection load is then lifted. The yarn is completely untwisted and given a reverse twist by continuing to turn the handle of the twist tester in the same direction, until about the same amount of twist has been put back into the yarn as it had originally. The depressor was lowered, and twisted or untwisted until the yarn was again opposite the lower mark on the guide which represents the 1/8" deflection from the straight line. The dial shows double the amount of twist, therefore it is devided by two to obtain the average twist per inch.

II. FABRIC CONSTRUCTION

Weight. ASTM: D 39-49. A number of specimens not less than 2 inches square and having a total area of 20 square inches were cut from the fabrics, weighed on a Becker Chainomatic Balance, and the weight per square yard calculated.

The following formula from Textile Testing by John S. Skinkle was used in calculating the weight per square yard. $S = 45.71 \frac{G'}{A}$
A equals area of sample in square inches and G' equals weight of sample at standard regain in grams.

Count. ASTM: D39-49. Number of Warp Yarns per inch by use of a yarn counter. The actual number of warp yarns in one inch were counted at five places in the fabric, and the average number of yarns per inch was calculated. No two spaces counted included the same yarns.

Number of Filling Yarns per Inch. The average number of filling yarns per inch were determined in accordance with the previous paragraph.

<u>Breaking Strength</u>. ASTM: D 39-49. Ravel-Strip Method. Specimen: The specimens were $1\frac{1}{2}$ inch in width. Each specimen was raveled to 1 inch by taking from each side approximately the same number of yarns. Two sets of six specimens each were used, one set, for warp breaking strength, had the longer dimension parallel to the warp yarns; and the other set, for filling breaking strength, had the longer dimension parallel to the filling yarns. No two specimens for warp breaking strength contain the same warp yarns, or for filling breaking strength the same filling yarns.

Testing machine: The Scott Tensile Strength Machine.

Procedure: The specimens were placed symmetrically in the clamps of the machine, with the longer dimension parallel to, and the shorter dimension at right angles to the direction of application of the load. Care was taken to grip the same yarns in both clamps. The average of the results was reported on six individual tests on the warp as warp breaking strength, and the average of the six individual tests on the filling as the filling breaking strength.

Wet Breaking Strength: Preparation of Test Specimens: Specimens were prepared as above with the test specimens cut 12" in length. Each specimen was numbered, and divided into two parts, one 6 inches long for determining the dry breaking strength, and the other for determining

the wet breaking strength. Each portion bore the specimen number. In this manner, each break was performed on test specimens containing the same yarns.

Procedure: The test specimens for wet breaking strength were immersed in tap water at room temperature until thoroughly wetted. Then, the specimens were removed and tested immediately for wet breaking strength in accordance with the methods specified above for determining breaking strength.

Elongation. ASTM: D 39-49. The elongation of the fabrics was obtained when the breaking strength was determined for the same specimens by means of an autographic recording device on the testing machine. The elongation is the average of the results obtained for six specimens, and it is expressed as percentage increase in length. An initial load of 6 ounces, was placed on the specimen before gripping the specimen in the lower clamp of the machine. The elongation was calculated from the start of the line as shown on the graphic record.

Wrinkle recovery. AATCC: 66-1959 and ASTM: D 1295-53T

Principle: A test specimen, creased and compressed under controlled conditions of time and load, is suspended in the test instrument for a controlled recovery period, after which the recovery angle is measured.

Apparatus: Monsanto Wrinkle Recovery Tester, Specimen Holder, and Plastic Press.

Test Specimens: Six 1.5 x 4 centimeter test specimens in both warp and filling directions at widely separated places, were cut from each fabric sample. The long dimension corresponded to the direction of test.

Procedure: The samples were conditioned for a 24 hour period. The test specimen was placed between the leaves of the holder with one end flush with the longer metal strip. The exposed end of the specimen was lifted over and back to the guide line on the shorter, thin-metal leaf. The plastic press was spread, and the holder and specimen was inserted into the press with the jaw with the raised platform on the outside of the longer metal strip. The press-holder combination was an inverted table and a load of 1 pound was applied gently for 5 minutes.

After 5 minutes, the load was removed, and the exposed end of the specimen holder was placed in the mount of the face of the tester.

To eliminate gravitational effects, the specimen was kept dangling in alignment with the vertical guide line during the 5 minute recovery period. After this 5 minute recovery, the dangling leg is finally adjusted to the vertical guide line and the wrinkle recovery value read from the protractors scale by means of the vernier. All data was taken with the protractors in the "A" position.

Evaluation: The individual warp and filling readings were averaged separately to the nearest degree. The data was reported as percentage crease recovery to the nearest 1%, and calculated as follows:

$$\text{Crease recovery, per cent} = \frac{\text{crease recovery angle}}{180 \text{ deg.}} \times 100$$

Dimensional change. AATCC: 65-1960. Principle: A specimen is washed in an automatic washer, dried, and restored to shape when needed. Distances marked on the specimen in warp and filling direction are measured before and after laundering.

Apparatus: A domestic automatic washer and a hand iron were used for testing on my specimens. The detergent used was Duz.

Test specimens: One specimen, 20 inches square was used from each fabric. Distances were marked in both lengthwise and widthwise directions by a basting thread. The marked distances were parallel to the respective yarns. Four distances were measured and marked off parallel to each of the warp and filling directions. The distances were at least two inches from any edge of the specimen.

Procedure: Specimens were laundered according to the procedures followed for testing of wrinkle resistance which is given below.

Ironing: The dry specimens were pressed by hand, using a cotton setting, on a padded ironing board.

Measurements were taken in both directions after the 1st, 2nd, 3rd, 4th, 5th, and 10 th launderings.

Evaluation: The shrinkage in each direction was calculated to the nearest .5% as follows:

$$\% \text{ Shrinkage} = \frac{\text{original measurement} - \text{final measurement}}{\text{original measurement}} \times 100$$

Wrinkle resistance. AATCC 88-1958. Principle: Fabric specimens were subjected to procedures simulating home laundering practices. Low washing temperatures and drip drying procedures were used. Specimens were evaluated under close to standardized lighting conditions and assigned numerical ratings based on their similarity to standard photographs.

Apparatus: Automatic washing machine, Duz, and drip drying facilities.

Test specimens: Test specimens were prepared in the specifications for dimensional change mentioned above, since the same specimens were used in both cases.

Procedures: Test 2 - 105 plus or minus 5 F.

A full water level was used with enough dummy pieces to make a four-pound load. The washer was set for a 10 minute washing time. The washing proceeded automatically up to the final deep rinse cycle. The test specimens were removed and hung each by two corners with the warp in the vertical position in still air at room temperature until dry. This procedure was repeated ten times.

Evaluation: The test specimens were placed flat on a table. The Photograph number was assigned to each specimen which most nearly matched the appearance of the test specimen. Class 5 is equivalent to Photograph 5 and represents the best wrinkle resistance, while Class 1 is equivalent to Photograph 1 and represents the least wrinkle resistance.

Calculation and reporting results: The average of the ten launderings was made, and the average reported to the nearest decimal and indicated the procedure used.

Abrasion resistance. ASTM: D 1175-55T. Apparatus: Taber Abraser. A pressure of 500 grams and the CS-10 Calibrase wheels were used.

Test specimens: The test specimens were taken from areas of the fabric not represented by the same warp or filling yarns. Specimens are cut 5 inches square, and made circular when applied to the specimen holder. A $\frac{1}{4}$ inch hole was cut in the center of each specimen. Six specimens were used from each fabric.

Procedure: After mounting the specimen, it was made sure that the ring clamp, washer and knurled nut were securely in place.

The number of revolutions to be made was determined by a sample from each fabric run through a warp break, a filling break, and then to complete destruction.

The specimen and wheels were brushed clean and the wheels resurfaced at regular intervals.

Report: Test results were reported in revolutions required to give first a warp break, then a filling break (hole). Each sample was carried through 600 revolutions and the appearance recorded.

Chlorine retention: AATCC 92-1958. There were many exceptions made in the original test and the results were not conclusive for this study.

Principle: The fabrics are treated in sodium hyphochlorite solution, rinsed, dried, and pressed between hot metal plates. The damaging action of the retained chlorine is calculated from the difference in tensile strength before and after pressing.

Apparatus needed: Breakers, ph meter, constant temperature bath, wringer, Scorch Tester, Scott Tensile-Strength Tester, sodium hypochlorite stock solution, and distilled water.

Apparatus needed: Not available; pH meter, wringer, and Scorch Tester.

Specimens: Specimens were cut with the same yarns in both warp and filling as were used for the breaking strength. There were only six available in both warp and filling directions.

Preparation of solutions: The pH could only be assumed to be within the range of 6 to 7.

Chlorine solution: The chlorine solution was prepared to 0.25% available chlorine by using the figures given on the bottle of bleach as the basis for calculations. The distilled water was used.

Procedure: Prewetting bath - The samples were immersed, six at a time for 3 minutes in to 160 plus or minus 5 F, stirring frequently. Samples were removed and allowed to drain and cool to room temperature.

Chlorination bath—The samples were then transferred into the chlorination solution which was maintained at a temperature of 77 plus or minus 2 F. The samples were agitated frequently and gently with a glass stirring rod during the 15 minutes chlorination period. The samples were then removed, drained and pressed dry by using a rolling pin over the samples placed between the paper towels.

Rinsing—The samples were then immersed into distilled water at a temperature of 70-90 F for two minutes, agitating gently and continually. After this, the samples were removed, allowed to drain, and passed through the rolling pin, as before. This process was repeated six times.

Drying—The samples were air-dried by placing them flat on a non-corrosive rack, until just dry.

Scorching—After the samples were at standard condition, half of each of the warp and filling samples were scorched by using a hand iron set at a cotton temperature. Each sample was folded in half, lengthwise, and heat applied to 1" from the fold on one side for 30 seconds, and then the reverse side for 30 seconds.

Tensile strength--Following the reaching of standard condition again, the samples, both scorched and unscorched were tested for breaking strength as mentioned before.

Calculations: The average tensile strength for each set of samples was calculated.

The formula of each calculation of damage caused by retained chlorine was:

$$\frac{Tc - Tcs}{Tc} \times 100 = \% \text{ loss in tensile strength due to damage caused by retained chlorine.}$$

Tc equals average tensile strength of chlorinated specimens, unscorched.

Tcs equals average tensile strength of chlorinated specimens, scorched.

Tests after ten launderings. Tests performed after ten launderings were:-

Weight

Count

Breaking Strength - dry

Wrinkle Recovery

Abrasion resistance

These tests were performed by the methods given in this chapter for each of these tests.

CHAPTER III

DISCUSSION OF RESULTS

In this analysis, Shirt A refers to the $3.98, short sleeve, 100% pima cotton, Japanese made shirt. Shirt B refers to the $3.98, 100% pima and combed cotton blended, chain store shirt. Shirt C refers to the $5.00, 100% cotton brand name shirt. Shirt D refers to the $6.95, 65% Dacron and 35% cotton, name brand shirt.

I. ANALYSIS OF YARN CONSTRUCTION

Yarn structure. The yarns in all four shirts, both in the warp and in the filling, are single structure. Therefore, since this factor is the same for all the shirts, it did not account for any differences among the shirts.

Yarn number. The yarn number of the filling and warp yarns in the four shirts tested did not vary to any great extent except in the case of the filling in Shirt D which was 60. The other yarns were not so fine, ranging around 40.

Direction of twist. The four shirts all had "Z" twist in both warp and filling yarns.

Amount of twist. The warp yarns of Shirt A have the highest twist of the warp yarns and the filling yarns of Shirt D have the highest twist of all filling yarns. All of the shirts except D have a higher

warp twist than filling twist. This exception in D might be due to the fact that the filling yarns of this shirt are finer than the others.

Shirt A has the greatest over all twist with Shirt D having the next greatest. Shirts B and C are close in amount of twist. In Shirt C, the warp and filling twist are close with 19 tpi in the warp and 18 tpi in the filling.

It is expected that Shirts A and B will be stronger than Shirts B and C. All of the yarns had a high twist to add strength to all of the shirts.

II. ANALYSIS OF FABRIC CHARACTERISTICS

Weave. Since Shirts B, C and D are plain weave, they can be expected to perform in similar ways. On the other hand, the Jacquard weave of the Shirt A will account for many differences throughout the remainder of the testing.

Weight per square yard. The weight of Shirt A is the greatest. Shirt D is the lightest in weight. However, it should be noted that the difference from heaviest to lightest in the four shirts is only one ounce. Also, all four shirts could be classed as light in weight and therefore would be comfortable in this respect for the wearer.

After ten launderings, there was a loss in weight of 3.7% in Shirt A, and a gain in weight of 2.8% in Shirt C, with Shirts B and D showing no gain or loss of weight.

Shirt A probably lost its finish in the laundering process while B and C, especially C, may have part of the detergent used in laundering clinging to either the fibers or the finish. With no gain or loss in

Shirt D, it can be assumed that it either had no finish to wash out or to catch detergent particles, or that it lost as much finish as it accumulated in detergent.

Count. The count in Shirts A, B, and C is very similar, especially in the case of Shirts A and C. Shirt B has about the same count in the warp as the others, but the filling count is much less. Shirt D has not only fewer yarns in the warp, but also more yarns in the filling. Since the filling yarns in Shirt D are finer, this no doubt accounts for the greater number of yarns in that direction.

After ten launderings, there was not much change in count of the fabric. The difference was especially small in the warp direction with the greatest change in Shirt A, at -2.9%, with no change in Shirts B and C and only +.7% change in Shirt D's warp. There was a gain in the filling count of three shirts ranging from +3.3% in Shirt A to +2% in Shirt D. The filling in Shirt B was the only loss in count at -1.3%.

There was a minimum in shrinkage as shown by the small change in count before and after laundering.

Breaking strength. Shirts A and D have the greatest strength, both dry and wet. Shirt A is a little stronger in both warp and filling direction when dry, but Shirt D has more strength in the warp direction when wet. The warp strength of Shirts B and C is almost the same, but the filling in Shirt B is a little more than twice as strong as the filling in Shirt C.

Shirt A is the strongest, followed closely by Shirt D. Shirt B would be next in strength and Shirt C would have the least strength.

All of the shirts show a gain in strength when wet in both warp and filling. Shirt D shows the greatest increase in the warp at 15.3%. Shirt A is next with 11.8%. Shirt B shows a 2.6% increase and Shirt C remainded the same when wet as dry. Shirt B increased in strength the most in the filling direction with 35.4%. Shirt C was next with an increase of 22.8%. Shirt D was close to Shirt C with a 21.5% gain while Shirt A showed only a 1.3% gain in filling strength when wet.

There was a definite loss of strength in all shirts except C after ten launderings. With only dry breaking strength tested, the warp strength of Shirt B decreased by 15.6%. Shirt C warp decreased by 11.0%. Shirt A decreased by 5.8% while Shirt D decreased by only 3.2%. The filling of Shirt C was the only increase by 21.2% while all others decreased. Shirt A decreased the most at 15.0%. Shirt D decreased by only 1.5% and Shirt C by only .2%. Therefore, Shirt A lost the most strength after ten launderings with Shirt C the only shirt showing an increase, which was in the filling direction.

Elongation. Shirt D far exceeded the other three shirts in elongation when both wet and dry, having three times as much strength as the next closest, Shirt A. Shirt B has the least elongation in the warp direction and Shirt C the least elongation in the warp direction. It is interesting to note that Shirt D has four and a half times as much elongation as Shirt B in the warp direction and almost six times as much in the filling direction as Shirt C.

All of the shirts except Shirt C, and D fillings, lost elongation when wet. All of the other dimensions gained in elongation when wet.

Shirt A gained in elongation after ten launderings, in both warp and filling. Shirts C and D lost elongation in the warp, but gained in the filling. Shirt B lost elongation both in the warp and in the filling.

III. ANALYSIS OF FABRIC PERFORMANCE

Wrinkle recovery. Shirt D has the greatest crease recovery with Shirt C very close, and Shirt B not much lower than Shirt C. Actually, all three shirts show a highly desirable crease recovery for a shirt fabric. It is apparent that some finish has been applied to these shirts to give them this property. Shirt A is far behind the other three with only half the recovery power as Shirt D.

Shirt C lost the least amount of its crease recovery properties after ten launderings. Shirt D did not lose much more than C. Shirt B lost 19% in its filling crease recovery but no more than Shirt C in the warp direction. Shirt A, even with less than the other three shirts before laundering, lost more than the others in laundering. This would indicate that Shirt A, as the others, must have had some finish applied. The finish came out of Shirt A more readily than the others upon laundering, but all show a loss in crease recovery after ten launderings.

Dimensional changes. After one laundering, only Shirt B showed no change in dimension. Shirt C did not shrink in the filling, but shrank ½% in the warp. Both Shirts A and D shrank ½% in both warp and filling after the first laundering.

All of the shirts in both directions had shrunk to ½% after the second laundering.

Shirts B and C had not shrunk any more than ½% after the third laundering, but Shirt D had shrunk 1% in the filling and ½% in the warp. Shirt A had shrunk 1% in both warp and filling after the third laundering.

Results after the fourth laundering were the same as after the third laundering except that the warp in Shirt A had gone back to only ½% shrinkage.

After the fifth laundering, Shirts B and C had still not shrunk more than ½%, Shirt A had shrunk 1% in both directions, and Shirt D had shrunk ½% in the warp, but 1½% in the filling.

After the tenth, and final laundering, Shirt B showed the least amount of shrinkage, at ½% in the warp, and 1% in the filling. Shirts A and C had both shrunk to 1% in both warp and filling. Shirt D had shrunk the most at 1% in the warp and 2% in the filling. This last shrinkage is beyond their Sanforized standard.

Overall, Shirt B gave the best laundering performance in dimensional stability, with Shirt C and A not far behind, and Shirt D the least satisfactory in dimensional stability.

Wrinkle resistance. Wrinkle resistance in this case is based on Test 1 of the L22 Standards where the use of photographs of wrinkle resistance are shown by Class. They go from Class 1 (least wrinkle resistance) to Class 5 (most wrinkle resistance). Both Shirt B and Shirt C were classed at an average of 4.8 which is very good. It should be noted, that my observations, after some of the launderings indicated that both had a better wrinkle resistance than even Class 5. Shirt D was given a class of 4.4 which is still quite good, but not

so much as the other two. It should be noted, that Shirt D was increasing again in wrinkle resistance after more launderings. Shirt A was the least satisfactory in all classes. It averaged out as a Class 3 which is medium in standard. It must be remembered that Shirt A made no claims of wrinkle resistance or ease of care so that this factor can not be held against the shirt, but none the less, it was far behind the other three shirts in these observations.

Dimensional restorability. All of the shirts have a low percentage of restorability meaning that they can all be easily restored to their original shape by hand ironing.

Shirt A has the least percentage of restorability with Shirt D the largest percentage. Shirts B and C are very similar in percentage of restorability. It must be remembered that all four have a very good restorability factor.

Abrasion resistance. Shirt A, with the Jacquard weave with many floats in the warp direction broke at 70 revolutions. Shirt B warps lasted almost twice as long, to 131 revolutions, and Shirt C to 160 revolutions. In the tested 6 samples, Shirt D had no warp breaks even when carried to 2000 revolutions, indicating that it far exceeded all the others in abrasion resistance. This is due to the fact that Shirt D is of 65% Dacron which is known to resist abrasion.

Filling yarns broke at 411 revolutions for Shirt B, 456 for Shirt C and 479 for Shirt A, so that all three had filling breaks at about the same point. Shirt D, again far exceeded the others in that it had only one filling break at 1925 revolutions.

Upon ten launderings, there was a decided increase in abrasion resistance, in both warp and filling directions, except in the warp of Shirt A which was only a decrease of 5%. Shirt C increased by 43.7% in the warp and 29.6% in the filling. Shirt B increased 37.9% in the warp and 53.6% in the filling. Shirt D went well beyond the abrasion resistance of the others after launderings as well as before.

Shirt B showed complete destruction both before and after ten launderings. Shirt C was next, and Shirt A followed. Still Shirt D showed its outstanding properties of abrasions resistance in that it showed no breakdown when carried past 2000 revolutions.

All shirts except D showed enough wear to be termed unusable after 600 revolutions before laundering, but not after laundering. Shirt D showed absolutely no wear at 600 revolutions except some pilling and soiling. Soiling seemed to increase somewhat after the ten launderings.

Shirt D was by far outstanding in the performance of abrasion resistance. Shirt C would be second best with Shirt A third since the warp wore so quickly, and Shirt B the least abrasive resistant.

All samples showed such an increase in abrasion resistance after the ten launderings to show that there had been a finish that had washed out in laundering, to give greater wearing properties with small decrease in crease recovery properties. These results substantiate proof found in other studies that special finishes applied to fabrics for the purpose of special properties in ease of care show loss of strength and wear. When these finishes are washed out in laundering, the fabric will show a gain in strength and wear.

Chlorine retention. Due to the great number of variations from the standard procedure set by the L22 Standards, as well as to the small sampling, this test did not show conclusive evidence for reporting of data. The results showed as much gain in the breaking strength as loss. Even though no comparison of the four can be drawn based on these results, it can be said from comparisons of breaking strength of both unscorched and scorched samples with the dry breaking strength of non-treated specimen that the damage caused by retained chlorine is very low in all four cases thus proving that all would withstand a reasonable amount of bleaching.

IV. SUBJECTIVE ANALYSIS

Ironing. Shirt D ironed the easiest after laundering even though it was less wrinkle resistant than B or C. B and C both ironed with ease, but not so easily as D, with both B and C ironing with the same amount of effort. Shirt A needed much more effort to appear well ironed, but it must be remembered again that they made no claim to be wash and wear.

Construction. Shirt A, except for buttons, has the best construction. All the seams, even the armseye, are flat fell. The stitches are smaller, the buttonholes are well finished, and the grain line is not off as bad as the other shirts.

Shirt B would be next best since it is the least off grain and still has the desired qualities of a well constructed shirt. Shirt D would be next best since the back is on grain, but the fronts have the warp going across the body making this not as desirable.

Shirt C would be the least desirable due to the fact that its grainline was more distorted than that of the other shirts.

Actually, all of the shirts would be highly successful as far as construction but I list them in the order above for comparative analysis.

<u>Fit</u>. First, to determine fit as well as can be done with unlaundered shirts, all shirts were purchased in my husband's size so that he might try them on for his opinions, as well as comparison to actual measurements of the shirts.

My husband's comments were:

Shirt A: "Feels very comfortable"
"Does not bind"

Shirt B: "Feels thinner than others"
"Not too comfortable to skin, rough"
"More arm room"

Shirt C: "Binds a little in shoulders and arms"
"Everything else, fine"

Shirt D: "Real soft against skin, more so than others"
"Little close under arms"
"Material really soft"

Choices: Shirt A; "Most comfortable of all, not fair test since it has short sleeves."
Shirt D; "Most comfortable of long sleeves."

Since Shirt A is a short sleeve, it is not a comparable shirt to the other long sleeved shirts so for a comparison of measurements, I shall say that Shirt A would appear to be a very good fit, and base my comparisons only on the long sleeved shirts, B, C, and D.

Shirt B appears to have the largest measurements throughout the chart for measurements. Shirt D would be next, and Shirt C would be the least.

This would parallel my husband's comments on the roominess of Shirt B especially through the armseye and the length of cap. The armseye of Shirt B is 7/8" larger than Shirt C and 1/4" larger than Shirt D. The cap length is 1/2" larger than Shirt C and 1/8" larger than Shirt D. The yoke back width is 1 1/8" more than Shirt C and 7/8" more than Shirt D. Shirt B is also just a little longer at center back than the other two.

From these measurements mentioned above, it can be understood why my husband said (Shirt C) "Binds a little in shoulders and arms".

CHAPTER IV

CONCLUSIONS

All of the shirts used in this study would make satisfactory purchases. My conclusions are based on the interpretation of data results in relation to my own family situation.

My husband and I are both teaching. Therefore, it is important to my husband to have neat, clean white shirts to wear to school every day. Also, as a working homemaker, time needed in caring for these shirts must be a minimum for me. The shirt must also be able to stand up under commercial laundering when my time does not allow me to launder my husband's white shirts. The price of the original shirt, as well as its performance, are important to us.

Although Shirt A proved very high in breaking strength, construction, and fit, it is far below the standards of easy care which my family situation demands. Since the manufacturer made no claim as to ease in care, this does not disprove him. None the less, it does not meet the performances of wrinkle resistance, crease recovery, and ease in ironing that are musts for my family.

Shirt D was extremely high in resistance to abrasion, far exceeding all of the others. This proves that the potential wear in this shirt is at least twice that of the other three. Its crease recovery is very high, but not much more than the other shirts. The breaking strength was greater than Shirts B and C, but not more than Shirt A. Elongation

was two to three times greater than the other three shirts. Shirt D proved very high in all of the tests made, except in dimensional stability, in wrinkle resistance, and in construction. In dimensional stability, Shirt D shrank up to 2% in the filling. In wrinkle resistance, it did not look nearly as good as Shirts B and C after laundering. In construction, the fronts were cut off grain. Since the price is $2 to $3 more than Shirts B and C which proved very high in most of these same factors, I do not feel that the difference in price is worth the small difference in performance characteristics. Therefore, I do not feel that Shirt D would be a wise choice for my family, mainly due to the more money involved.

This leaves my choice to either Shirts B or C. These two shirts proved to very similar in characteristics of performance. Where Shirt B was lower in warp breaking strength, Shirt C was lower in filling breaking strength. The same was true for elongation, and crease recovery. Both of these shirts ironed with the same amount of effort and looked identical after each laundering. These similarities are noted throughout the study.

For this reason, my choice for a white dress shirt for my family situation would be Shirt B. Shirt B is $1 less than Shirt C. It has a little better crease recovery, dimensional stability, and fit of the garment than does Shirt C. The only performance characteristics in which it falls below Shirt C is in abrasion resistance. This would mean it would wear out faster, but when six Shirt B's could be purchased for $1 less than five Shirt C's, this wear factor could be distributed over more shirts for less money. It can also be noted that for the price of three Shirt D's, seven Shirt B's could be purchased which is more

than twice as many to distribute any wear. Also, three shirts in my husband's profession would not be enough to get him through one week.

In relation to the specific purposes of this study, the above information compares the fabrics used in the selected shirts giving the characteristics outstandingly good as well as bad.

The relationship of price was the final factor in deciding as to which shirt I would choose. Price, then, in this study does not mean that the more one pays for a garment, the more one can expect in performance. On the contrary, the difference in price from Shirt B to C is $1, but the performances vary only slightly.

The two nationally advertised brand name shirts, Shirts C and D, did not prove extensively better or worse than the other two shirts tested. In fact, with no more difference in Shirts B and C than shown, it might be indicated, that the extra price for Shirt C is at least in part for the advertising of that shirt rather than for its performance.

My choice for a man's white dress shirt for my particular circumstances is Shirt B. It showed the desirable performance factors and is the best buy for the money. It must be remembered that other persons will have their own set of values on which they would base an opinion which might well differ from mine.

Further study in this area of men's white dress shirts should involve more test shirts, as well as include a practical use factor which this study did not go into.

More testing could be done to bring out more factors in the characteristics of the tested shirts, such as, reaction to starch, commercial laundering, and comfort (air permeability, as well as absorption). Tests could be made on the actual strength of construction points such as seams, or interfacing. Abrasion tests could be made on points of wear such as the collar and cuffs as well as buttonholes.

This is but a small problem covering a small area of men's white dress shirts. It has satisfied both my husband's and my curiosity as to wise choices for us in the selection of white dress shirts, since the selected shirts used in this study were typical of purchases we would make.

CHAPTER V

SUMMARY

I. YARN CONSTRUCTION

All yarns in the four shirts were single structure. They all have a yarn number close to 40 except the filling yarn in Shirt D which has a 60. All yarns have been given a "Z" twist. Shirt A has the greatest amount of twist, with Shirt D not much less. All shirts have a higher warp twist than filling, except in Shirt D.

II. FABRIC CHARACTERISTICS

All shirts are of plain weave, except Shirt A which is a Jacquard. Shirt A is the heaviest in weight per square yard and Shirt D is the lightest in weight.

The count in Shirts A, B, and C, are very similar. Shirt D has fewer yarns in the warp and more yarns in the filling.

Shirt A had the greatest strength in both warp and filling. Shirt D was second in warp strength, but third in filling strength. Shirt C was third in warp strength, but a low fourth in filling strength. Shirt B was fourth in warp strength, but second in filling strength.

All of the shirts gained strength when wet.

Shirt D had the greatest elongation, both dry and wet. Shirt B had the least elongation in the warp and Shirt C had the least in the

filling. All except the fillings in Shirts C and D lost elongation when wet.

III. FABRIC PERFORMANCE

Shirt D had the greatest crease recovery in the warp and Shirt B had the greatest in the filling. Shirt C was second in warp crease recovery and Shirt D was second in filling. Shirt A had the least crease recovery of any of the shirts.

Shirt B had the greatest dimensional stability to laundering, while Shirt D had the least. Shirt C had the second greatest dimensional stability.

Both Shirt B and C had good wrinkle resistance, with Shirt D not far behind. Shirt A was far below the other three in this performance characteristic.

All of the shirts had a low percentage of restorability by hand ironing.

Shirt D far exceeded all of the other three shirts in resistance to abrasion. Shirt C was next, but far below Shirt D. Shirt B showed the least resistance to abrasion, except for the warp floating yarns of Shirt A.

The damage caused by retained chlorine is low in all four shirts and was not used as a factor of comparison.

Shirt D touched up the best upon hand ironing, with Shirts B and C requiring only a little more effort than D. Shirt A required the greatest amount of effort in ironing.

Shirt A had the best construction, with Shirt B next, and Shirt C having the poorest construction.

Shirt A had the best fit of all the shirts in both my husband's opinion and by actual measurements, but since it was short sleeved, it is not fair to compare it to long sleeved shirts. Of the long sleeved shirts, Shirt B had the best fit by measurements, with Shirt C having the poorest fit.

Upon ten launderings, all of the shirts appeared to have lost some of their finish applied for ease in care. This was most evident in the great increase in abrasion resistance of all four shirts. At the same time, they did not lose much of their crease resistance, except in Shirt A.

All of the shirts used in this study would make satisfactory purchases for the consumer. Based on my own family standards, I would select Shirt B as the most performance characteristics for the least money.

APPENDIX

SAMPLES OF SHIRT FABRICS

USED IN STUDY

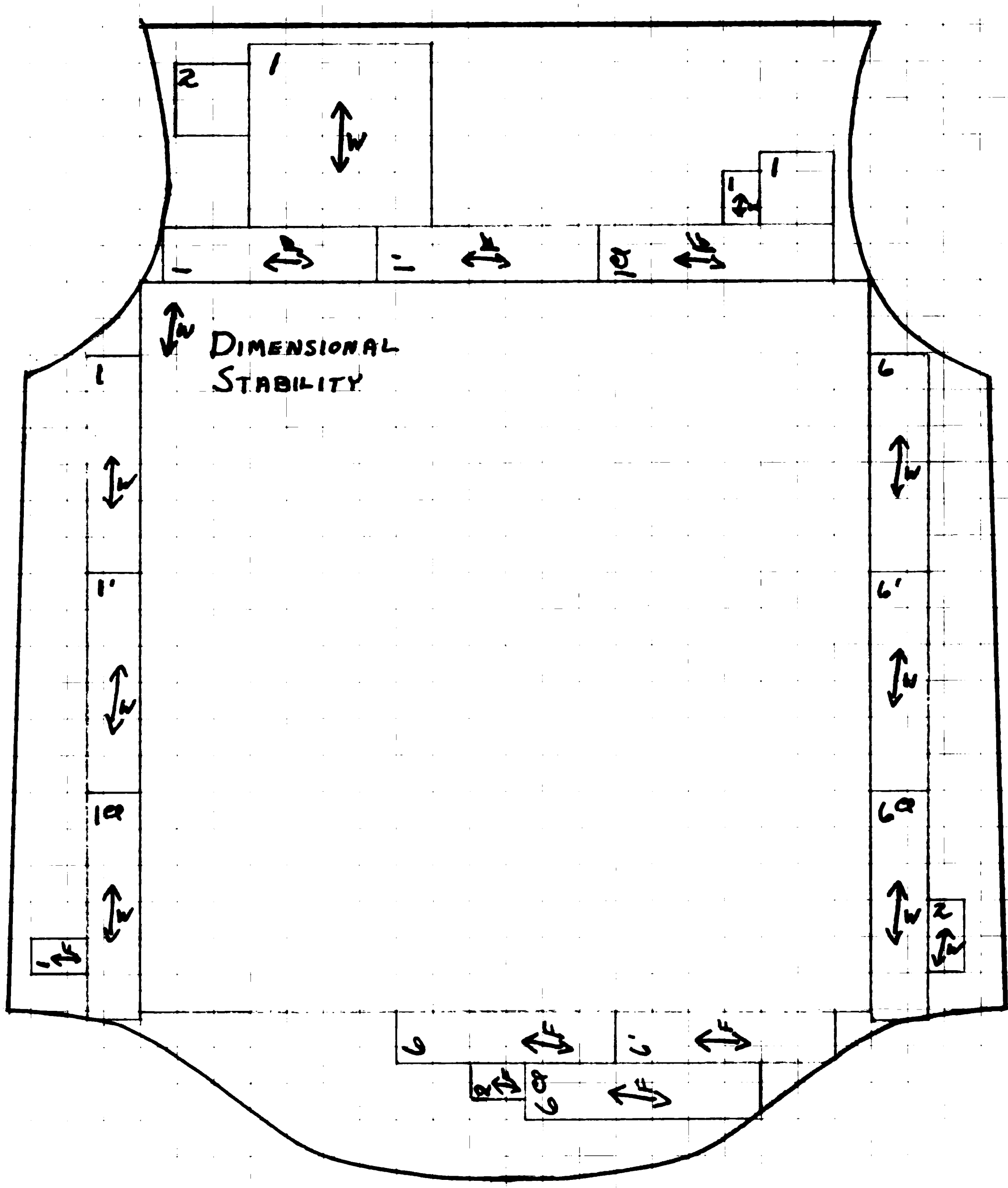
A
100% Pima Cotton
Japanese
Short Sleeve
$3.98

B
100% Pima and Combed Cotton
Montgomery Ward
$3.98

C
100% Cotton
Arrow "Chase"
$5.00

D
65% Dacron 35% Cotton
Arrow "Decton"
$6.95

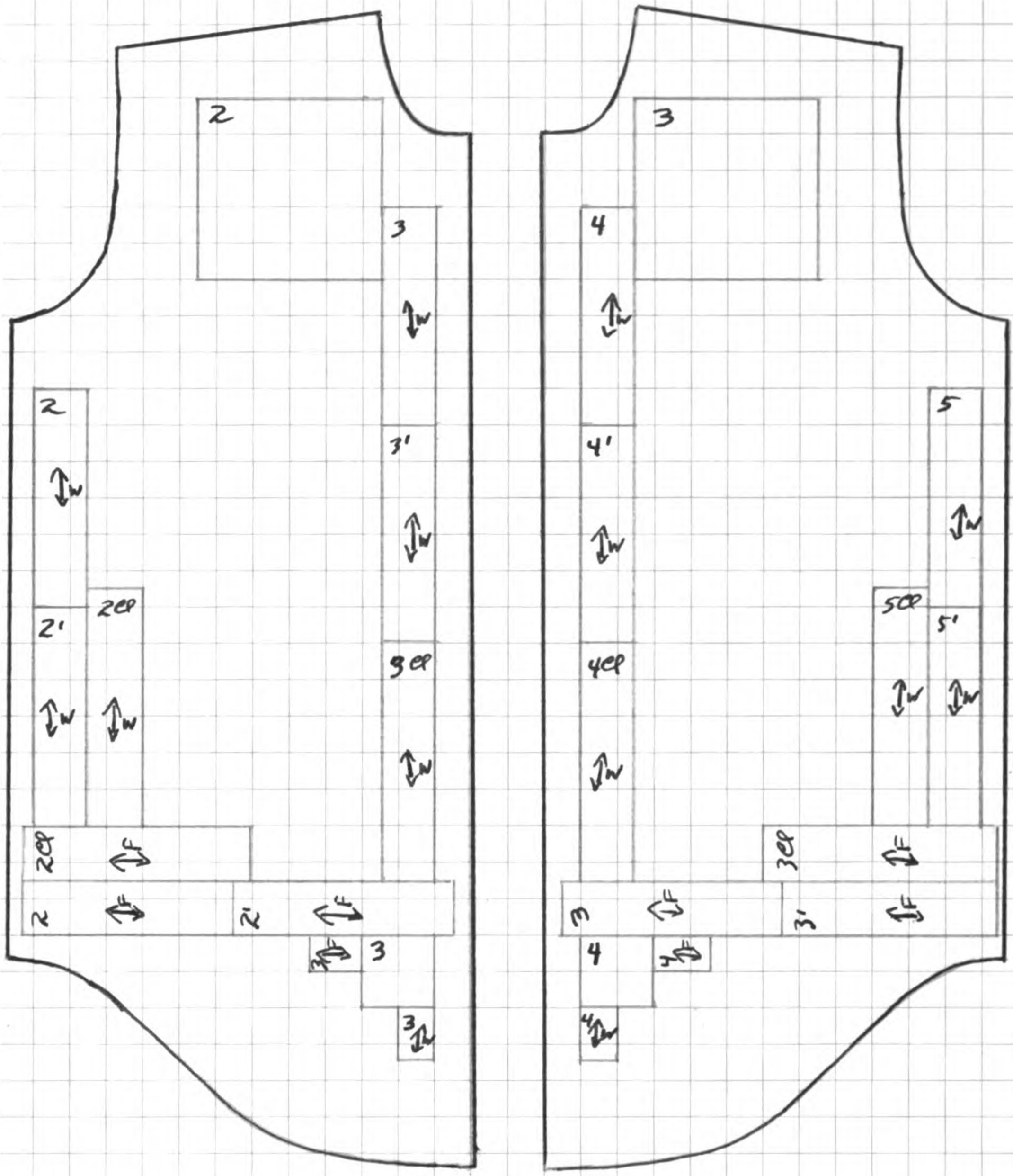
Cutting Charts*



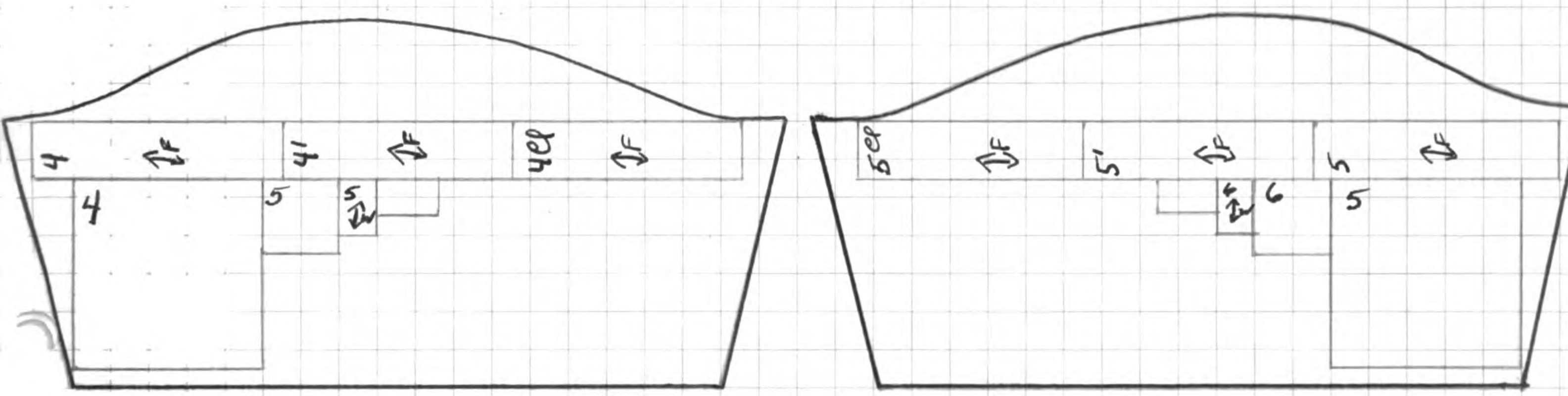
Shirt Back

1 square = 1 inch

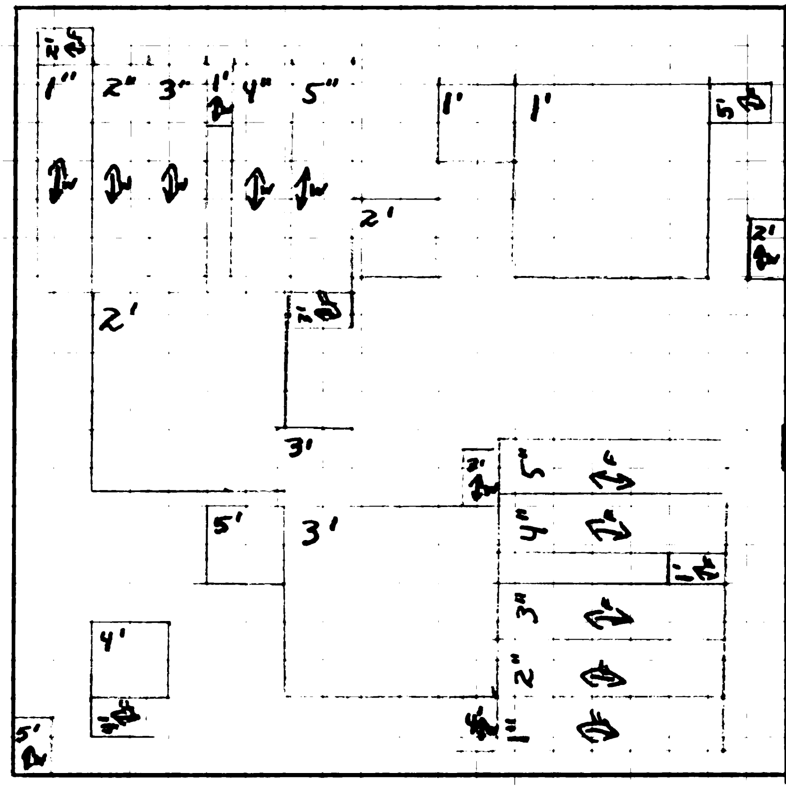
* Based on Measurements of Shirt A



SHIRT FRONTS



SLEEVES



DIMENSIONAL STABILITY
CUTTING CHART
AFTER TEN LAUNDERINGS

PURCHASE DATA OF SHIRTS USED IN THIS STUDY

	A	B	C	D
Brand Name	Torino (Japanese)	Golden Brent (Montgomery Ward)	Arrow "Chase"	Arrow "Decton"
Price	$3.98	$3.98	$5.00	$6.95
Fiber Content	100% Pima Cotton	100% Pima and Combed Cotton Blended	100% Cotton	65% Dacron and 35% Cotton Madras
Style	Short Sleeve Two Pocket Permanent Stays	Long Sleeve Permanent Stays Two-Way Cuff (button or wear with cuff links)	Long Sleeve Permanent Stays French Cuffs	Long Sleeve Permanent Stays Convertible Cuff (wear buttons or with cuff links)
Place of Purchase	Detroit, Michigan	Traverse City Michigan	Traverse City, Michigan	Lansing, Michigan
Date of Purchase	June, 1960	July, 1960	July, 1960	August, 1960
Label Information	Single Needle Sanforized	Wash and Wear Sanforized Non-Yellowing Finish	Wash and Wear Sanforized	Wash and Wear Sanforized
Suggestions For Laundering	Do Not Starch	Machine Wash Can Use Bleach Tumble or Drip Dry, Touch-Up Iron	Wash By Machine By Hand Or By Commercial Laundry Tumble Dry Or Drip Dry Do Not Starch Press With Cool Iron	Wash By Machine By Hand Or By Commercial Laundry Tumble Dry At Low Temperature Or Drip Dry Press With A Cool Iron

SUMMARY OF DATA

		A	B	C	D
Yarn Construction:					
Yarn Structure	Warp	single	single	single	single
	Fill	single	single	single	single
Yarn Number*	Warp	40	42	40	35
	Fill	40	35	42	60
Direction of Twist	Warp	Z	Z	Z	Z
	Fill	Z	Z	Z	Z
Amount of Twist*	Warp	26 tpi	21 tpi	19 tpi	19 tpi
	Fill	19 tpi	15 tpi	18 tpi	21 tpi
Fabric Analysis:					
Weave		Jacquard	Plain	Plain	Plain
Weight/ sq. yd.*		7.8 ozs	7.4 ozs	7.2 ozs	6.8 ozs
Count	Warp	138	141	138	119
	Fill	71	62	66	77
Breaking Strength*	Warp-dry	56.3 lbs	36.0 lbs	36.8 lbs	55.4 lbs
	wet	63.8 lbs	36.6 lbs	36.8 lbs	65.4 lbs
	Fill-dry	22.3 lbs	20.3 lbs	9.8 lbs	16.8 lbs
	wet	22.6 lbs	21.4 lbs	12.7 lbs	21.4 lbs
Elongation*	Warp-dry	24.8%	14.6%	14.9%	64.5%
	wet	29.4%	15.9%	16.1%	59.5%
	Fill-dry	10.6%	8.4%	4.6%	28.5%
	wet	11.6%	8.3%	5.2%	28.0%
Fabric Performance:					
Crease Recovery*	Warp	36%	68%	77%	80%
	Fill	53%	83%	79%	80%
Dimensional Change	Warp-1st	½%	0%	½%	½%
	10th	1%	½%	1%	1%
	Fill-1st	½%	0%	0%	½%
	10th	1%	1%	1%	2%
Wrinkle Resistance*		Class 3.0	Class 4.8	Class 4.8	Class 4.4
Dimensional Restorability*					
	Warp	.7%	.7%	.7%	.8%
	Fill	.6%	.9%	.9%	.9%
Abrasion Resistance* (in cycles)	Warp	70	131	160	600+
	Fill	479+	411	456+	1925
Complete Destruction		1000	825	950	2000
Damage Caused by Retained Chlorine*	Warp	+22.9%	-11.8%	-11.4%	- 9.5%
	Fill	- 3.0%	+ 8.9%	+ 3.3%	+ 2.7%

*Based on Average Results

SUMMARY OF CHANGES

Before and After 10 Launderings

		A			B		
Fabric Analysis:		before	after	% change	before	after	% change
Weight/sq. yd.*		7.8 ozs.	7.5 ozs.	- 3.7%	7.4 ozs.	7.4 ozs.	+ 0.
Count*	Warp	138	134	- 2.9%	141	141	0 %
	Fill	71	74	+ 3.3%	62	61	- 1.3%
Breaking Strength*							
Dry	Warp	56.3 lbs.	53.0 lbs	- 5.8%	36.0 lbs	30.4 lbs	-15.6%
	Fill	22.3 lbs	19.0 lbs	-15.0%	20.3 lbs	20.2 lbs	- .2%
Elongation* Dry	Warp	24.8%	29.0%	+14.5%	14.6%	13.3%	- 8.6%
	Fill	10.6%	11.1%	+ 4.6%	8.4%	8.3%	- .1%
Fabric Performance:							
Wrinkle Recovery*							
	Warp	36%	30%	-16.7%	68%	63%	- 7.4%
	Fill	53%	48%	- 9.4%	83%	67%	-19.3%
Abrasion Resistance*							
(in cycles)	Warp	70	66	- 5.7%	131	211	+37.9%
	Fill	479	1209	+60.4%	411	886	+53.6%
Complete Breakdown		1000	1975	+49.4%	825	1476	+44.1%

		C			D		
Fabric Analysis:		before	after	% change	before	after	% change
Weight/sq. yd.*		7.2 ozs	7.4 ozs	+ 2.8%	6.8 ozs	6.8 ozs	0 %
Count*	Warp	138	138	0 %	119	120	+ .7%
	Fill	66	67	+ 2.4%	77	78	+ 2.0%
Breaking Strength*							
Dry	Warp	34.8 lbs	31.0 lbs	-11.0%	55.4 lbs	53.6 lbs	- 3.2%
	Fill	9.8 lbs	12.4 lbs	+21.2%	16.8 lbs	16.5 lbs	- 1.5%
Elongation* Dry	Warp	14.9%	12.9%	-13.3%	64.5%	53.9%	-16.5%
	Fill	4.6%	4.9%	+ 6.1%	28.5%	29.4%	+ 3.3%
Fabric Performance:							
Wrinkle Recovery*							
	Warp	77%	71%	- 7.8%	80%	73%	- 8.8%
	Fill	79%	74%	- 6.3%	77%	73%	- 5.6%
Abrasion Resistance							
(in cycles)	Warp	160	284	+43.7%	600+	600+	0 %
	Fill	456	635	+29.6%	1925	600+	
Complete Breakdown		950	1572	+39.6%	2000+	2068	

SUMMARY CHART

Rank In Comparison Of Performances

Ranked I Through 4 With 1 Being Best

			A	B	C	D
Breaking Strength						
	dry	Warp	1	4	3	2
		Fill	1	2	4	3
	wet	Warp	2	4	3	1
		Fill	1	3	4	2
Elongation						
	dry	Warp	2	4	3	1
		Fill	2	3	4	1
	wet	Warp	2	4	3	1
		Fill	2	3	4	1
Crease Recovery		Warp	4	3	2	1
		Fill	4	1	3	2
Dimensional Change						
	Warp	1st.	2	1	2	2
		10th.	2	1	2	2
	Fill	1st.	3	1	1	3
		10th.	1	1	1	4
Wrinkle Resistance			4	1	1	3
Dimensional Restorability						
		Warp	1	1	1	4
		Fill	1	2	2	2
Abrasion Resistance		Warp	4	3	2	1
		Fill	2	4	3	1
Complete Destruction			2	4	3	1
Ironing			4	2	2	1
Price			1	1	3	4
Construction			1	2	4	3
Fit	measurement		1	1	4	3
	husband's opinion		1	3	4	1