

THE RELATIONSHIP OF SPECIFICATIONS
TO SERVICEABILITY AND COST
IN SELECTED TYPES OF
DAMASK TABLE LINENS

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THE RELATIONSHIP OF SPECIFICATIONS
TO SERVICEABILITY AND COST IN SELECTED TYPES
OF DAMASK TABLE LINENS

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INTRODUCTION

The twenty-three tablecloths and one hundred napkins constituting the six groups under immediate consideration in this thesis were a part of a more comprehensive Michigan State College Experiment Station research study of table linens. The larger study was divided into two major categories for analysis and eventual publication. The table linens to be discussed in this thesis had as a constant factor, a damask weave. These tablecloths and their accompanying napkins were woven of cellulose acetate rayon, linen, cotton, and a combination of cotton and viscose rayon yarns. The tablecloths in the second division, not herein discussed, contained fabrics of various weaves and fibers including spun rayons and blends.

The study was begun in 1945. All purchases of materials were made during that year with the exception of three sets of cellulose acetate tablecloths and napkins purchased in 1948 which to all outward appearances were identical to the table linens numbered one through three. At the time the study was initiated, the purchase of tablecloths was limited by the fact that numerous fabrics and qualities previously available had disappeared from the market as a result of the critical wartime shortage of consumer textiles. A second difficulty encountered was the procurement of sufficient quantities of similar tablecloths within groups to lend validity to the study.

Until very recently the Irish damask was the traditional dining table covering of elegance and had remained practically unchallenged for

several generations. Cotton damasks were more commonly used. Table linens were not only conventionalized as to style but also woven almost exclusively of cotton or linen fibers. Both kinds of damasks were semi-standardized as to yarn and weave construction. The color was more often white than not. The predictive performance of table linens was based more or less upon quality represented to some extent by their comparative cost. Constant use of and association with the conventional linens furnished the housewife with some additional information predictive of service, but it was based upon rather unscientific deductions. There was, in fact, a dearth of scientific investigation as to the performance to be expected from the conventional linens.

Over the period of the past several years, a variety of fabrics of the newer fibers has been placed on the market. Frequently novelty yarn and weave constructions appeared. The tendency has been to promote fiber and fabric innovations before their performance characteristics are established through adequate research. Expressions of consumer dissatisfaction have been heightened by the use of fabrics for purposes for which they were not designed. Unfortunately there was an increased use of any fabric available irrespective of its intended purpose during the wartime shortage of textiles. Not a few of the new fibers and novelty constructions have been used as table linens.

The traditional damask weave has been used throughout the table fabrics considered in this thesis, but it is to be noted that filament rayon alone and in combination with cotton has been introduced. While these fibers have received consumer acceptance, it is no more

possible to predict their performance from past experience than when they are used in any of the other recently introduced fabrics.

A host of explanations may be cited as to the factors which have brought about the change in the styling of table linens. The introduction of new fibers and novelty weaves has already been mentioned. Style and fashion trends in twentieth century architecture and interior furnishings effected changes in china, glassware, and table silver. Also a decided change in the American mode of living has occurred during the previous two decades. The advent of the smaller family group led to the elimination of the dining room in many instances; and entertaining, of necessity, became less elaborate, and tableware became less formal. Keeping pace with changing needs and style trends, table linens also became less formal and more colorful. Thus was the element of fashion introduced into table appointments.

The performance of the new table linens could not be predicted on the basis of past consumer experiences; nor was there much pertinent information available from labels, where they existed, or from salespeople. The urgency, consequently, for some scientific basis for evaluation of table linen purchases was intensified. Furthermore, little or no scientific study of specifications of the traditional linens had been made. Only a few consumer textile commodities, in fact, have to date been studied in relation to specifications and performance in use. It was for these reasons, primarily, that the Michigan State College tablecloth study was initiated; and an investigation of the performance of various types of table linens found on the current market begun.

A subjective analysis was to be made throughout the study for observable signs of wear, change in appearance, ease of care, and durability of hems; items which represent consumer satisfaction. Observations relative to the progressive effects of laundry upon the fabrics of various fibers were to be made at specified intervals. An analysis of data based on specifications and performance would provide a scientific basis for comparing the different fibers. The subjective and scientific analyses together would result in valid criteria for more intelligent selection of table linens by the consumer. It was also hoped that suggestions of value to the trade might be made as to construction features desirable in textile fabrics for table use insofar as the element of fashion will permit standardization.

The specific objectives of this laboratory study from which conclusions and recommendations will be drawn are included in the following points:

1. To compare and predict the probable serviceability of the six groups of tablecloths and napkins of cellulose acetate rayon, linen, cotton, and a combination of cotton and viscose rayon through an analysis of laboratory test data
2. To analyze and compare the physical properties of the new cloths with those same properties after fifty launderings
3. To relate specifications to performance characteristics after fifty launderings for the different types comprising the groups
4. To evaluate these table linens on a performance-price relationship
5. To compare the specifications and performance of one type of fabric purchased in 1945 with the same type purchased in 1948

REVIEW OF LITERATURE

As has been stated previously, this study of tablecloths and napkins was begun because their construction was not standardized and because of the lack of scientific studies of any magnitude dealing with table linens. The one previous investigation conducted at Purdue University was a wear and laundry study of napkins. Studies related through common features to the research project under discussion, however, will be cited in this section.

In the Purdue study³² napkins of linen, cotton, and a combination of cotton and rayon were used in a college dormitory for a period of thirty-two weeks. Sumner found in general that weight per square yard was significant in the cost of the napkins but not in their serviceability. There was no relationship between weight and the elements of shrinkage, soluble sizing, yarn count, or yarn number. After thirty-two weeks service, the cotton and linen fabrics showed losses in breaking strength; but the rayon filling yarns in four cases out of five showed a gain and not a loss in strength. This indicated that wear and laundry over the period of the study caused less loss of strength in rayon than in cotton or linen. The loss in breaking strength of the linen fabrics positively correlated with loss in weight per square yard. Because linen is a somewhat brittle fiber, a loss of fibers occurs in laundering and wear. Cotton and cotton and rayon napkins with only one exception showed a gain in weight which was probably due to shrinkage. The linen napkins shrank

the least. The greatest shrinkage occurred in the warp direction of the cotton and cotton and rayon mixtures. Excessive shrinkage of the cotton warp yarns was due apparently to tension during weaving and finishing. Greater shrinkage occurred in the napkins sent to the college laundry than in those laundered in the laboratory even though the temperature in the latter procedure was 50 degrees hotter. The increased breaking strength of the rayon filling yarns after the final laundry seemed to occur partly as a result of the shrinkage of the cotton warp yarns. This increase in breaking strength was accompanied by an increased filling yarn count.

Deterioration was greatest in linen fabrics as indicated by the loss of both breaking strength and weight per square yard. Cotton fabrics with a permanent finish tended to deteriorate the least. The rayon and cotton mixtures were cheaper than linen, but would give poor service because the hems frayed. After thirty-two weeks service, the linens were still attractive and the cottons retained their permanent finish. Some of the rayon and cotton mixtures had faded from ecru to cream, and two of the five looked worn and thin.

The next two studies were conducted at the University of Missouri and were reported by Pauline E. Keeney. In comparing the quality of cotton dress fabrics¹⁸ purchased in 1942 and in 1943, she found that there were fewer types of fabrics and less yardage available and that prices had increased somewhat by 1943. No perceptible difference was noted in the weight of fabrics when compared according to type or the year they were purchased. Greater amounts of water soluble sizing were used in 1943. Little difference in shrinkage was noted in the two years.

The majority of fabrics tested during both years had over 2 per cent shrinkage in both length and width. The increased strength of fabrics purchased in 1943 probably resulted from the use of coarser and stronger yarns. Color losses were slightly more frequent after laundering in 1942, but color losses from light were more frequent in 1943. As late as February, 1943, the quality of dress fabrics had been affected very little by wartime measures.

The second study conducted at Missouri¹⁷ compared the differences of drapery fabrics available in 1942 and 1943. There was a decided decrease in the number of materials which were available in the later year. As few fabrics containing linen and rayon were available, they were considerably more expensive than fabrics of cotton alone. Price was found to give no indication of durability. Factors such as type and quality of yarn, weave, color, and design as well as manufacturing cost all influenced price. There was little relationship between weight and construction and durability because of the wide variation in the strength and structure of the yarns. A marked difference in the range of yarn counts of fabrics purchased in the two different years was noted. The range for 1943 was considerably lower. The decrease in strength which was expected to accompany the lower yarn count was not apparent to any great extent, but there was a greater shrinkage from both laundry and dry cleaning which might be attributable to the lower yarn counts in the later year. There was slightly less fastness of color in the fabrics purchased in 1943. Any labels which implied fastness and quality of dyes used were found to mean little when actual tests were performed on these fabrics.

A comparative study of price and performance of wearing apparel textiles was conducted at Pennsylvania State College by Davis⁷. The compilations of data were made for certain cotton and viscose rayon fabrics for the years extending from 1935 to 1941. Changes in price, construction, and performance were recorded. Comparisons of prices were made with the cost of living index insofar as it related to clothing, commodities, and services. It was found that in some instances an average rise in the price of fabrics was accompanied by some improvement of durability factors but this was not always the case. If prices remained level in spite of a cost of living increase, there was a tendency for some performance factors to become lower. The maintenance of the price level with a rising living cost seemed to indicate the price level was kept at the expense of some of the qualities of the fabrics. In spite of price considerations, there were some improvements in performance factors through the years which probably occurred as a result of technological advances.

In 1937 a study of the standardization of textile fabrics was made by Hale¹⁵. The constant development of new textile products for individual and household use marketed without any definite information as to quality and performance had made wise selection increasingly difficult. Hale advocated standardization and labeling to aid consumers in making purchases. While twelve years have elapsed since the writing of the dissertation and many of the recommendations have been put into effect, there is still much room for further standardization of textile merchandise. The need for dissemination of merchandise information is even greater today.

Ashcraft² warns against using textile laboratory tests as final measures of quality in promotional copy and on labels. His article, "The Interpretation of Laboratory Tests as Quality Indices in Textiles," points out further that identification of fiber has no relation in many instances to durability or other consumer values.

Two studies have been carried out at Pennsylvania State with regard to the relationship between construction and durability. Roseberry in reporting an investigation of ninety-five filament viscose rayon fabrics²⁹ indicated that dry and wet filling breaking strengths increased with the use of coarser filling yarns and yarns of a high filament count. Increased twist in filling yarns was associated with a decrease in strength. Unmeasured factors which may have accounted to some extent for the variability in strength were the variability of filament strength in the respective yarns, the amount of tension used in finishing the fabrics, the type of dye, and the type of finish. Shrinkage in the filling direction increased when coarser and more tightly twisted yarns were used.

As a result of the second Pennsylvania study, Howorth¹⁵ found a relationship between variable construction features and performance based upon the test data of one hundred cotton fabrics. The construction factors likely to lead to a high dry breaking strength in the warp were a low yarn number in both the warp and filling and a low twist in each direction. A high dry breaking strength in the filling correlated with a high weight per square yard, a low yarn count in the warp and a high count in the filling, and a low yarn twist in both directions. A low shrinkage in the warp direction of cotton fabrics was found to be

related to a low filling count and a low warp yarn number. Low shrinkage fillingwise was associated with a low weight per square yard, a low warp count, a high yarn number in the warp and filling, and a high twist in the warp and filling.

Much of the early dissatisfaction with rayons resulted from the fact that they would not withstand ordinary laundry procedures; however, two recent studies indicate that improvements have made former washing precautions unnecessary. Lyle and Black²⁰ studied the effects of wringing during laundry upon the tensile strength of rayon fabrics. The findings showed that it may not be necessary to include "squeeze gently" in present washing instructions, but original wet breaking strengths should be taken into consideration. Graydon, Lindsley, and Brodie¹² used dry breaking strengths to measure the degradation of five types of rayon fabrics when given wash treatments of varying severity. A statistical analysis of the breaking strengths indicated that all four laundry methods used compared favorably since no one method produced significantly greater tensile strength losses. Repeated washing, however, did cause a slight decrease in tensile strength. Results of this investigation indicate that present day rayon fabrics may withstand more vigorous laundry methods than are now recommended. The severest method proved to be more efficient in soil removal.

Shrinkage has long been one of the causes for dissatisfaction with the performance of textiles. Rayons until recently have been especially aggravating as their stability performance was entirely unpredictable. Several investigations of the dimensional stability of fabrics have been conducted. The report of the New Jersey Laundry Owners' Association⁸

study stressed the need for simplification of present wash tests which are too varied and too numerous and the need for duplicating industrial and consumer practices. Of significance was the relative slowness of cotton warp yarns in reaching complete relaxation when washed repeatedly. Cotton filling yarns relaxed after the first or second laundry. All but one of the rayons obtained complete relaxation after one to four launderings.

Gaston and Fletcher¹¹ found no significant differences in the shrinkage of laundered fabrics when they were pressed under different tensions or when the number of launderings varied. Tests were conducted on linens, cottons, and rayons. Significant differences were obtained in the shrinkage of fabrics of different fiber content and in the shrinkage of the warp versus the filling. The continuous filament viscose and acetate rayons shrank less than did the cotton and linen fabrics.

A Sub-committee on Home Laundering of the American Association of Textile Chemists and Colorists⁹ conducted shrinkage tests on both stabilized and unstabilized rayon fabrics. The tests involved laundering and shrinkage measurements carried out in commercial laundries, in homes, and in textile laboratories. The tests indicated that the correlation between the results predicted in tests on stabilized rayons and the results attained in practice was very great. It was also found that equilibrium in shrinkage is established very quickly with stabilized rayons. With unstabilized rayons, however, various test methods indicated considerable variation in results and lack of correlation between test methods and results obtained in either commercial or home laundering practices.

In the article, "Elimination of Chaos from Shrinkage Testing," Clayton⁵ summarized the difficulties that have been experienced in

laundering rayons. On the whole viscose rayon fabrics have been more unpredictable with respect to dimensional stability than acetates. Some early stabilizing agents had a tendency to retard shrinkage but were often progressively removed in successive washing; and some early resin stabilizers absorbed chlorine during laundry which very shortly attacked the cellulose of fibers. Mechanical relaxation of rayon fabrics by wetting is not satisfactory as they may stretch later in use. Yarn and weave constructions influence the degree of stability in fabrics. Rayons now may be stabilized permanently through the use of two recently developed finishes which do not absorb chlorine or alter the hand of fabrics. "Sanforset"²⁶ when applied to rayon fabrics controls stability within 2 per cent, and "Definized"²⁴ fabrics exhibit a dimensional tolerance within 1 per cent.

At the mill level, Chaky⁴ indicated shrinkage increased directly with the number of turns per inch in yarns and also with the number of filaments or thickness of the yarns. Morton²³ presented the additional fact that weaves permitting minimum crimp in yarns reduced shrinkage.

Laboratory tests of colorfastness of women's and children's wearing apparel fabrics³ when compared with the results of simultaneously conducted wear studies failed to predict color performance under conditions of use. The laboratory tests were too mild in the majority of the cases. Average scores regardless of fiber content or dye type were relatively high insofar as all laboratory colorfastness tests were concerned. The poorest ratings irrespective of fiber or dye resulted from light tests.

MATERIALS

A summary of the purchase information for the damask table linens in this study is given in Chart 2 on pages 87 and 88 of the appendix. Designation of the tablecloths and their napkins is made by code number. An explanation of the coding system will be found at the beginning of the section titled "Procedures". The chart contains the following information for each tablecloth: fiber content, size in inches, color, date and place of purchase, price, and trade name where one existed. The number and size of napkins accompanying the cloths are also given. Only in the instance of Group V were the napkins not included in the price of the tablecloth.

The variation in purchase dates occurred because sufficient numbers of multiple units to constitute a group were not always obtainable at one time. Fabrics within each group were as similar in quality and construction as it was possible to obtain. The purchases were made from four retail firms.

Group I: The three tablecloths and eighteen napkins of this group were woven of filament acetate rayon with lustrous yarns in the warp direction and delustered yarns in the filling. The tablecloths had firmly woven selvages; the two ends were machine hemmed with eight stitches per inch. The hems were well-turned and even and had the ends backstitched. All four sides of the napkins were hemmed. The damask patterns of the three cloths were not identical.

Group II: Cotton warp and filament viscose rayon filling yarns were used in weaving the five tablecloths and twenty-eight napkins of Group II. The cotton had a rather fuzzy appearance; and the rayon, little luster. The fabrics were quite loosely woven and had a limp hand. The selvages were fairly firm. The hems were not perfectly even and did not have the ends backstitched. Stitches varied from nine to eleven per inch. Napkins were hemmed on four sides. The only information given on the merchandise tickets was size and price. The damask patterns were dissimilar. The warp of specimen fourteen was yarn-dyed.

Group III: A fiber content similar to that of the preceding group was used in tablecloths numbered fifteen through eighteen with the exception that the warp yarns of this group were mercerized. Both sets of yarns had more luster than those in Group II. The fabric was closely woven and had a firm hand. Selvages were of excellent construction. Raw edges were finished with one-eighth inch hand-sewn hems; the stitches were fine and closely spaced. The twenty-four napkins were woven with selvages on either side and required hems only at the top and bottom. Where color occurred, it was confined to the warp yarns. Tablecloths fifteen and sixteen were of identical damask pattern; the other two were not. Labels on fifteen and sixteen indicated that the fabric contained 48 per cent rayon and 52 per cent cotton. The trade name, hand hemmed, and made in Ireland were additional facts given on the label. The fiber content but not the percentage was given for tablecloth seventeen. Other information on the label stated the fabric was of superior quality, had been made in Ireland, and was hand hemmed. Fiber content and made in Ireland were the only facts given about tablecloth eighteen.

Group IV: These four all-cotton fabrics had a crisp, starched hand. During finishing the position of the yarns had been distorted which might indicate excess sizing. The yarns were irregular with heavy places appearing on the surface. Imperfections in the weaving operation produced a surface shot with long floating yarns. All cloths were identical in pattern. Selvages were fairly firm but had quite a few floating yarns. The ends of the hems were backstitched, and nine stitches per inch were used. Sales tickets gave only price and size of the merchandise.

Group V: The labels indicated that the fabrics in the four tablecloths and twelve napkins had been made in Ireland. Neither the tablecloths nor the napkins were hemmed. Cloths numbered thirty to thirty-two were identical; thirty-three was of a slightly poorer grade, and the pattern varied from that of the others. The materials had a good luster and appeared to be of a medium quality. The stiffness of the fabrics seemed to indicate the presence of some sizing.

Group XI: Purchased in 1948 these three sets of acetate rayon table linens were of the same brand as those in Group I bought in 1945. The materials had a firm hand, and the damask pattern was identical throughout the group. Manufacturers' labels gave the size, fiber content, trade name, resource, and washing instructions. Specimens one hundred two and one hundred three were colored. The selvages and hems were constructed in the same manner as in the first group.

PROCEDURES

Inasmuch as this investigation was comprehensive in scope and would take several years to complete, it was necessary to devise a labeling and code system which was sufficiently clear to make possible the identification of the many specimens. Through the coding and the recorded purchase and test data, it was feasible for a changing personnel to carry on the study.

Nontechnical Procedures

Group Numbers: The tablecloths and napkins were divided into groups upon the basis of their fiber content. Groups I and XI were kept separate because of the difference in their purchase dates. The tablecloths in each group were assigned consecutive numbers. All napkins accompanying a tablecloth were given the same number as the cloth. The plan for the division of the damasks into groups and the code numbers assigned to each group for the identification of individual materials within the groups follows:

Group I: acetate rayon, code numbers 1 through 3

Group II: (viscose) rayon and cotton, code numbers 10 through 14

Group III: (viscose) rayon and mercerized cotton, code numbers
15 through 18

Group IV: cotton, code numbers 20 through 23

Group V: linen, code numbers 30 through 33

Group XI: acetate rayon, code numbers 101 through 103

Labeling Codes: The capital letter "T" preceded all labeling codes applied to sections of the tablecloths, and a capital letter "N" preceded codes placed upon napkins. As each tablecloth was to be cut into quarters, it was necessary to identify the sections. Plate 11 in the appendix indicates the manner in which the quarters were designated as sections "A" through "D."

The capital "T" or "N," as the case might be, was followed by an arabic numeral written as a subscript which identified each individual tablecloth or its napkins. For tablecloths this numeral was followed by a subscript capital letter corresponding to the quadrant from which the section was cut. The lower case letters "a" through "f" were assigned to the napkins accompanying a tablecloth. In labeling the napkins, the lower case letters were written as a subscript following the arabic numeral.

The fiber content of the tablecloths and napkins in each group was indicated by one or two lower case letters. The initials used were the first letter of the fiber or fibers contained in the fabric. Lastly the weave was indicated by a capital, the initial letter of the name of the weave. By way of illustrating the coding system, section "A" of tablecloth 1, Group I would be labeled: $T_{1A}arD$. Napkin "c" accompanying tablecloth 3, Group II would be labeled: $N_{3c}r/cD$.

Cutting Charts: Large sheets of tracing paper were marked with one-inch squares and placed over the fabric so that the design might be reproduced. Cutting charts for test specimens were first worked out on the tracing paper. In designing the sampling pattern, an effort was made to distribute the specimens for every test to include both plain and patterned areas.

The outside dimensions of each tablecloth of different design and napkins "a" and "b" were drawn to scale on large sheets of squared paper. The tablecloth was divided into four equal parts. The damask pattern of the two napkins and of one-quarter of the tablecloth and the cutting charts for test specimens were blocked in to scale. Plates 12 and 13 in the appendix reproduce the sampling pattern followed in the original testing.

After the tablecloths were divided into quarters, each section was permanently labeled as were the napkins. Section "A" of the tablecloths and napkins "a" and "b" were used for original test purposes; sections "B" and "D" and napkins "c" and "d" were laundered; and section "C" and napkins "e" and "f," where they existed, were preserved as controls. Each test specimen cut was marked for identification as to warp or filling direction and as to the number of the tablecloth or napkin from which it was taken. The weight and yarn number samples were placed in envelopes to prevent distortion.

Weave Analysis: The weave was determined by plotting the pattern of the interlacing of the warp and filling yarns on cross-sectional paper.

Procedures for Determining Specifications

Original Dimensions: After every tablecloth and napkin were temporarily-labeled and before they were cut, the average length and width of each was determined in accordance with the A. S. T. M. general method¹. The averages of five warpwise and five fillingwise measurements were

recorded as the length and width respectively. These measurements were taken correct to the nearest one-eighth inch with a steel tape..

Cost per Square Yard: The formula given below was used in computing the cost per square yard of a tablecloth and its napkins. When tablecloths and napkins were priced independently, the cost per square yard was computed separately for each.

$$\frac{36 \times 36 \times \text{purchase price}}{\text{total square inches}} = \text{cost per square yard}$$

Fiber Contents: The identification of fiber content in warp and filling yarns for each tablecloth and napkin was made upon agreement of the results of microscopic analysis¹, Tex-Chrome indicator, and the burning and acetone tests. Directions on the bottle for the use of the chemical indicator were followed.

Yarn Count: A micrometer was used for determining the number of yarns per inch for both the warp and filling. Beginning in the lower lefthand corner of the test piece and proceeding at random diagonally to the upper righthand corner, three counts were taken on section "B" and two on "D." Five counts were taken likewise from napkins "c" and "d." An average of five yarn counts in each direction was recorded as the original count for the tablecloth and its napkins.

Yarn Number: The test was not conducted under standard conditions. Yarn number was determined for tablecloths only with the exception of the napkins in Group XI. A Universal Yarn Numbering Balance was used for the determination of yarn number. The procedure used was that outlined in the directions furnished with the instrument. A length of yarn was removed from the tablecloth in the direction being tested, measured without tension on a metal ruler accompanying the instrument,

and cut at the designated length. The lengths used for the various types of fibers were 90 centimeters for filament rayon, 36 inches for cotton, and 12 27/32 inches for linen. The yarn was formed into a loop and hung centrally on the hook of the balance. By rotating the index lever until the beam was in balance, the index pointer automatically indicated the correct yarn size. The average of five such results was recorded as the yarn number for the warp or filling.

Yarn Twist: A Suter Twist Tester was used for the determination of yarn twist. Directions provided by the manufacturer and in accordance with A. S. T. M. procedures were followed¹. Yarns ten inches in length were used in all determinations, and the depressor was adjusted to a constant weight of three grams for all types of yarns. The untwist and twist method was followed. Determination of twist replacement was based upon a one-eighth inch deflection of the yarn from horizontal. The dial reading was divided by ten multiplied by two to obtain the twist per inch. The average twist per inch was computed from ten individual determinations. The direction of twist was recorded as the opposite of that used to remove twist from yarns.

In the instance of ply yarns, the twist was removed from the ply; and one of the singles cut away. The same procedure as outlined above was followed to determine the twist of each single component of a ply yarn.

Filament Count: For rayon yarns the filament count was determined by placing a single yarn on a piece of black plush. Five filaments were counted and pinned to the plush. The counting was completed in this manner. The number of pins multiplied by five plus any remaining

filaments constituted the filament count for that yarn. The average of five yarns was computed and recorded as the filament count per yarn.

Weight per Square Yard: Five specimens two-inches square were cut from the test section of the tablecloth and a total of five from the two napkins, three from napkin "a" and two from "b." The five specimens were placed in a weighing bottle previously dried to constant weight and were conditioned in an oven regulated to a temperature ranging from 105° to 110° Centigrade for one and one-half hours. The bottle and specimens were transferred to a desiccator for a half hour or until the samples had reached room temperature before being weighed. The drying, cooling, and weighing continued until a constant weight within a plus or minus 0.0003 grams was obtained. The weight of the bottle was subtracted to obtain the weight of the fabric. Standard regain was not computed in figuring weight per square yard because of the fact that other tablecloths in the study were blends of indeterminate percentage composition. The following formula¹⁹ was used in computing weight in ounces per square yard:

$$\frac{36 \times 36 \times \text{wt. in gm.}}{\text{wt. of sample} \times 23.35} = \frac{45.71 \times \text{gm.}}{20 \text{ sq. in.}} = \text{ounces per square yard}$$

Breaking Strength: The breaking strength specimens were cut from parallel areas of the tablecloths and napkins in accordance with Commercial Standard procedures for the raveled strip method⁶. Both warp and filling specimens were cut twelve inches in length and one and one-half inches in width. These were raveled to one inch. The breaking strength strips were then cut through the center. The upper sections of strips, numbered consecutively from one through five, were tested dry and under standard conditions; six through ten were tested wet. The

jaws used on all Scott Tensile Strength Testers had faces measuring one inch by one and one-half inches. Measurements were read correct to the nearest one-half pound.

The dry breaking strength strips were conditioned four hours before tests were made. The temperature and relative humidity were controlled to 70° Fahrenheit and 65 per cent relative humidity respectively. The conditioning room and the Scott Tester were the equipment of Ohio State University.

Wet breaking strength strips were allowed to condition in water at room temperature for two hours⁶ before being tested. The strips were tested within one minute after their removal from water. The Scott Tensile Tester used was one installed in the research laboratory of Michigan State College. The original warp wet breaking strengths for Group III and the original warp and filling wet breaking strength strips for Group V were tested on a third machine without elongation attachment when it became apparent that the equipment in the research laboratory had a final calibration below the breaking point of the strips. An average of five tests was recorded as the warp and filling dry and wet strengths.

Elongation: Elongation determinations were made simultaneously with the breaking strength tests. The elongation percentage was calculated from the vertical rise of the line made by a pen attached to the pendulum of the tensile tester. The measurement was taken in fifty-hundredths of an inch, correct to the nearest two-hundredths. The figure obtained was multiplied by two. This product was divided by six, a correction factor representing the initial load in ounces, and the

conversion to percentage made by multiplication by one hundred. An average of five determinations each for warp and filling dry and wet was recorded as the percentage elongation.

Colorfastness to Light: The Atlas Fade-Ometer was used for this test, and the machine was operated in accordance with A. S. T. M. procedure¹. Two specimens seven by two and one-half inches for each colored cloth were placed in Atlas Test Masks. These samples were exposed in the Fade-Ometer for periods of 20, 40, 60, and 80 hours. The fading was judged by comparison of the exposed area with the adjacent unexposed area of the specimen. Ratings were made subjectively in accordance with Commercial Standard rating classes⁶.

Laundry Procedures

Sections "B" and "D" of the tablecloths, which were designated for laundry and dimensional change determinations, were hemmed prior to laundering. Plate 11 in the appendix shows the exact manner in which the two sections were hemmed. Original hems and selvages were preserved.

Washing: A Westinghouse Laundromat was used to wash the specimens by procedures duplicating acceptable home practices. The temperature of the water was regulated to approximately 110° Fahrenheit for rayon and rayon and cotton fabrics and to approximately 140° for the all-cotton and the linen materials. The length of time was kept constant for all fabrics. The sudsing, rinsing, and drying operations were completed in about 25 minutes. The sudsing time varied from about 5 to 7 minutes. Calgon was added to soften the water. Lux Flakes were used for fabrics containing rayon; and Super Suds, for laundering the cotton and linen

damasks. Test pieces were spread on towels placed on screens to permit more uniform drying for about one-half hour before being ironed.

Ironing: Iron temperatures were regulated in accordance with the fiber content. The accuracy of their thermostatic controls was checked with Tempilstiks. For fabrics containing acetate rayon, the temperature of the irons was kept below 300° Fahrenheit; viscose rayon, below 350°; and cotton and linen, below 450°. To keep ironing techniques as uniform as possible, the "B" section of each tablecloth and the "c" napkin were ironed by the same person throughout the fifty launderings. The "D" section of the same tablecloth and the "d" napkin were ironed by another individual. To further standardize ironing techniques, the tablecloths and napkins were first ironed on the wrong side of the cloth in the warp direction and then in the filling and were finished by ironing warpwise on the right side. The acetate cloths were ironed only on the wrong side.

Dimensional Stability: Prior to laundry the centers of section "B" and "D" were thread marked with squares. Third threads were placed halfway between the two sets of parallel markings. Those fabrics composed of rayon or rayon and cotton were marked with ten-inch squares; and those of cotton or linen, with eighteen-inch squares. The napkins "c" and "d" were marked similarly and according to fiber content.

Three vertical and three horizontal measurements correct to the nearest one-sixteenth of an inch were made on each laundered specimen after the first, second, third, fourth, fifth, tenth, fifteenth, twentieth, twenty-fifth, thirtieth, fortieth, and fiftieth laundry. The average of the three warpwise and the three fillingwise measurements were

recorded and the percentage dimensional change calculated for warp and filling each time measurements were taken. The percentage area change was also calculated for the same intervals. The tablecloths and napkins were permitted to condition on metal screens for two hours after ironing before dimensional measurements were made and subsequent yarn counts taken.

Yarn Count: The same procedure for determining yarns per inch was used as outlined for establishing the original counts. Yarn counts were taken following the first, fifth, tenth, twentieth, and fiftieth launderings.

Subjective Analysis: Throughout laundry the tablecloths and napkins were inspected for visible signs of wear, change in appearance, and durability of hems. The ease of caring for the fabrics was also noted.

Post-laundry Procedures

Colorfastness to Laundry: After the final laundry, the colored fabrics were compared with the control section. Determination of the degree of color loss was made by Commercial Standard rating classes⁶. The final decision was made by consensus of opinion of two persons as were other final subjective analyses.

Performance Testing: After completion of the final yarn counts and dimensional stability measurements, the "D" section was marked according to the original cutting chart in such a manner that the test specimens had the same position in relation to the hems and selvages as the specimens cut from section "A" for the original testing. Napkins

"c" and "d" were marked for testing exactly as the napkins used for establishing original specifications. Tests after laundry included dry and wet breaking strength determinations for the warp and filling, elongation percentages corresponding to the tensile strength determinations, and weight per square yard. Procedures for the original tests were duplicated.

Abrasion: The original cutting charts provided for five six-inch-square abrasion test specimens, but to date these tests have not been completed. Abrasion resistance also will be determined after the fifty launderings.

DISCUSSION OF RESULTS

The qualities of cloth as delivered from the mill are known as its specifications. The results, therefore, of the analyses of the original fabrics will be considered first in the discussion of the findings. The specifications that have been verified for the materials of this study are original dimensions, yarn and weave constructions, fiber content, yarn count, tensile strength and elongation, and weight and cost per square yard.

Specifications of Original Fabrics

Fiber Content: The acetate rayon damasks in Groups I and XI were woven with lustrous filament yarns in the warp direction and delustered filament in the filling. The fiber composition of Groups II and III, cotton and rayon damasks, varied through the use of mercerized cotton warp yarns in Group III and unmercerized yarns in Group II. The filling yarns in both cases were of filament viscose rayon. The warp and filling yarns in Group IV were cotton; and in Group V, linen.

Weave Analysis: The tablecloths and napkins in this study were woven in a double damask construction with the exception of the all-cotton fabrics which were single damasks. A summary by groups as to type of damask and direction of background floats is given in Chart 1 on the following page. For the purposes of this study the distinction between the two types of damasks will be made upon the basis of the

Chart 1
WEAVE ANALYSIS BY GROUPS
ORIGINAL TABLE LINENS

Group	Fiber Content		Type	Background
	Warp	Filling		
I	acetate	acetate	double	filling-face
XI	acetate	acetate	double	filling-face
II	cotton	viscose	double	warp-face
III	cotton	viscose	double	warp-face
IV	cotton	cotton	single	filling-face
V	linen T ₃₀₋₃₂ , N ₃₀₋₃₁ T ₃₃	linen	double	warp-face filling-face

length of the floats. The double damasks had eight-shaft satin background constructions; and the single damasks, a five-shaft background. The usual practice of weaving damasks except those of cotton with a warp-face background did not hold true for the groups of table linens under study.

Original Dimensions: All tablecloths and napkins varied somewhat from the measurements given on the merchandise tickets. Usually the variation was a fractional part of an inch less than that stated. One of the individual cloths, however, was 4.6 inches shorter in length than the given figure. All tablecloths in the cotton damask group had a greater length than that stated while the width conformed exactly to the

given size. The napkins of Group XI purchased in 1948 tended to be greater than the given size in one direction, but the excess did not appear consistently in either the warp or filling direction. With the exception of the one tablecloth, the variation from the stated sizes was not excessive and did not exceed the slight inaccuracy to be expected in mass production.

Yarn Count: The exact yarn counts for all groups are given in Table 1 on the following page. The warp and filling yarn counts per inch for the acetate rayons of Group I were nearly identical with those of Group XI. The fabrics in both groups were well balanced as evidenced by the number of warp to filling yarns. The total of warp and filling counts exceeded slightly the 180 minimum¹⁴ construction considered satisfactory for double damasks.

While the size of the cotton warp yarns in Group II and III did not vary greatly, there was a difference of 10 yarns in their warp counts. The lower count occurred in Group II. This same group, had only somewhat larger viscose rayon filling yarns but a filling count that was approximately 30 yarns lower. Table 1 shows that Group II also had a much poorer ratio of warp to filling yarns and a total number of yarns per square inch that falls considerably below the 180 minimum. Roseberry from her study of viscose rayon fabrics found that as the filling count²⁹ increased the twist and number of filaments increased and the size of the filling yarns decreased. Her findings are not substantiated in whole. Group III with the higher filling count and smaller yarns had the lower filament count and less twist. Group III is very definitely superior on the basis of yarn count. It would seem that an effort had been made

Table 1
AVERAGE YARN COUNTS
ORIGINAL TABLE LINENS

Group	Fiber Content	Damask Type	Warp	Filling	Total *
I	acetate	double	95 ^a	91 ^a	186
XI	acetate	double	94 ^a	90 ^a	184
II	cotton-viscose	double	86 ^b	58 ^b	144
III	cotton-viscose	double	96 ^c	89 ^c	185
IV	cotton	single	74 ^d	63 ^d	137
V	linen	double	72 ^a	84 ^a	156

* yarns per square inch, total of warp and filling counts

a. average of 30 determinations

c. average of 40 determinations

b. average of 50 determinations

d. average of 20 determinations

to maintain the price and conserve fiber by reducing the yarn count in the fabrics of Group II.

The cotton damasks had the lowest yarn count per square inch, but the 74 x 63 construction fell about midway in the range of 62 x 48 to¹⁶ 80 x 76 which are the usual limits for cotton single damasks. The maximum total count used in the construction of single damasks is 175 yarns per square inch¹⁴. A comparison of the counts of Group IV with the customary construction practices indicated that the cotton damasks in this study were only average in quality. Keeney¹⁸ and Morrison²² both noted

that yarn counts in cotton fabrics tended to drop during the early war years. There was a decrease as a rule in the yarn counts of the cottons studied by Davis⁷ during a cost of living increase, and she attributed it to excessive stretching in finishing.

The linen damasks were the only group having an excess of filling yarns, 84 to 72 warp yarns, which is the usual manner of constructing double damasks. It has been indicated, however, that double damasks should be 50 per cent over-welshed¹⁰, and the fabrics of Group V did not meet this requirement. The total count of warp and filling yarns, 156, is considerably below the generally accepted arbitrary minimum of 180 set for double linen damasks¹⁰. Thus it may be assumed that the linen damasks fell below the minimum construction standards.

Yarn Number or Denier and Filament Count: A complete summary of the yarn analysis of the various groups is to be found in Table 11 of the appendix. The two groups of fabrics having acetate rayon yarns had almost identical denier and filaments counts irrespective of their year of purchase. Reference to the Rayon Textile Monthly "Revised Table of Deniers and Filament Numbers of American Rayon Yarns" for March, 1945²⁷, and 1948²⁸, showed that the Celanese Corporation of America manufactured dull acetate yarns of 200 denier, 52 filament in both years. The two filling constructions, 200/51 in 1945 and 197/52 in 1948, corresponded very closely to the standard. Such close verification of denier was not possible for the warp yarns. The American Viscose Corporation manufactured in both years 300 denier, 80 filament bright acetate yarns. Warp test results were 276/79 in 1945 and 278/80 in 1948. While the filament construction was very similar to the standard, there was a deviation of

over 20 denier in the warp yarn sizes.

Of Groups II and III, the imported fabrics in the latter group had somewhat finer viscose rayon filling yarns; and the domestically manufactured damasks of a lesser price had coarser yarns. The filament counts were almost identical. Contrary to expectation the imported fabrics had yarns, 250/54, which corresponded more closely to the manufacturing specifications published in the Denier-Filament Table of March, 1945²⁷, as the Du Pont Corporation produced 250 denier, 50 filament bright viscose in that year. Several companies were spinning 300 denier yarns with a filament count ranging from 44 to 60 which, however, varied considerably from the test results of 284/55 for Group II.

According to Hoye¹⁶ the denier of filament rayon warp yarns in damasks is usually 300 and the filling ranges from 150 to 300. Thus it may be seen from Table II that the deniers of rayon yarns used in Groups I, XI, II, and III fell within the ranges customarily used.

Cotton warp yarn numbers in damasks vary from 16 to 30 according to Hoye¹⁶ and the filling from 18 to 26. The warp yarns of Groups II, III, and IV of size 20, 21, and 22 respectively fell about midway in the usual range. The one fabric having cotton in the filling direction had coarser yarns than are customarily used. This would indicate that fabrics of finer yarns were not generally available during the war years.

The linen damasks had warp yarns of 50 lea and fillings of 57. These are yarns of about average size as linen is spun as coarse as 12 and as fine as 125 lea³³.

Twist per Inch: The acetate rayons purchased in 1948 had approximately one-third the amount of twist in the warp yarns as those purchased

earlier. While the filling twist had also decreased, the difference was not so great. None of the yarns in either of these two groups had much twist. The twist of the warp and filling had been reversed from a "Z" to an "S" direction in 1948.

The only yarns in the study of a ply structure were the warp yarns of the two groups of cotton and viscose fabrics. Those in Group II had more tightly twisted singles with ten more turns per inch than those in Group III with a twist of 16. The twist in the ply yarns was quite similar in both groups. The viscose yarns in the filling had little twist in either of the groups.

Group IV had a twist of 18 turns in the warp and 13 in the filling. All cotton warp yarns had only a moderate amount of twist and as pointed out previously were of a medium size. Thus is Howorth's¹⁵ study substantiated as she found cotton yarns of a higher number had a greater amount of twist.

In the warp direction the linen damasks had been given a twist of 8 turns per inch, about half as much as that of the cotton warp yarns. The filling twist of 12 turns was quite similar to that of the cotton damasks.

Weight per Square Yard: The average weight in ounces per square yard for each group may be ascertained by consulting Table 2 on the following page. There was little variation in the weights of the damasks in the six groups; a difference of only .9358 ounces existed between the highest and lowest average weights. The acetate rayon tablecloths and napkins in Group XI had the highest weight per square yard, but those of Group I were only slightly lighter. There was a greater difference

Table 2
AVERAGE WEIGHTS IN OUNCES PER SQUARE YARD
ORIGINAL TABLE LINENS

Group	Fiber Content		Ounces
	Warp	Filling	
I	acetate	acetate	5.4067 ^a
XI	acetate	acetate	5.5874 ^a
II	cotton	viscose	4.6516 ^b
III	cotton	viscose	5.4134 ^c
IV	cotton	cotton	5.1339 ^d
V	linen	linen	5.3896 ^a

a. average of 6 determinations
b. average of 10 determinations

c. average of 8 determinations
d. average of 4 determinations

in the weights of the cotton and viscose damasks of Groups II and III as they had the highest and lowest weights of the fabrics in the original purchases made in 1945. Damasks are considered light when they weigh less than 6 ounces per square yard according to Hess¹⁴. By reference to Table 2 it may be seen that all damasks in the study fell below the medium weight category usually preferred for general use.

The relationship between cost and weight per square yard found by³² Sumner is substantiated in part in this study as the damasks of Group III had the highest cost and highest weight of the fabrics purchased in 1945. The relationship between price and weight did not exist throughout the study. The slightly higher weight of the acetates purchased in

1948 and the greatly increased cost placed them first in each respect when all groups of the study are considered; however, no close relationship between price and weight for the acetates purchased in 1945 existed. The greatly increased price of the fabrics purchased at the later time is attributed to inflation rather than to any appreciable increase in weight.

Keeney in her study of drapery fabrics¹⁷ in 1942 and 1943 found very little relationship existed between weight and construction and durability due to the wide variation in the strength and structure of the yarns. In her study of cotton fabrics¹⁸, she found little difference in the weight of fabrics by years. Evidently the increased size of yarns used in 1943 offset the decreased count per inch. Chart 3 in the appendix shows the relationship of weight to other construction features and to price.

Breaking Strength: The average breaking strengths of each individual tablecloth and napkin within a group were averaged to arrive at the mean original dry and wet, warp and filling breaking strengths for a group. In a few cases there was considerable difference between the filling strength averages for the tablecloth and napkin, but the difference was not as great as the range of strengths occurring in the individual tablecloth or napkin. The slight variation in the results of construction analyses of the fabrics--yarn count, yarn number or denier-filament count, and weight per square yard--justified the computation and the assumption that tablecloths and napkins were of the same universe.

Table 3 at the top of the next page gives the actual warp and filling dry and wet breaking strengths in pounds for all groups. Plates 1

Table 3
AVERAGE BREAKING STRENGTHS IN POUNDS
ORIGINAL TABLE LINENS

Group	Fiber Content	WARP			FILLING		
		Dry	Wet	Per Cent*	Dry	Wet	Per Cent*
I	acetate	68.4 ^a	36.6 ^a	53.51	36.6 ^a	19.6 ^a	53.55
XI	acetate	72.8 ^a	43.5 ^a	57.75	39.6 ^a	24.4 ^a	61.62
II	cotton-viscose	71.2 ^b	80.0 ^b	112.36	48.6 ^b	20.2 ^b	41.56
III	cotton-viscose	132.1 ^c	124.0 ^c	93.87	77.6 ^c	33.1 ^c	42.65
IV	cotton	60.8 ^d	68.1 ^d	112.01	64.4 ^d	67.7 ^d	105.12
V	linen	92.2 ^a	126.6 ^a	137.31	90.4 ^a	96.2 ^a	106.42

* wet strength as a percentage of the dry strength

a. average of 30 determinations

b. average of 50 determinations

c. average of 40 determinations

d. average of 20 determinations

and 2 on pages 37 and 38 give a pictorial representation of the comparison of the dry and wet strengths of the warp and filling yarns for the various groups.

By consulting Table 3 it will be seen that the acetate rayons of Groups I and XI had widely divergent strengths in the warp and filling indicating that they had poorly balanced strengths in terms of the warp-filling ratio. The fact that delustered yarns were used in the filling

Plate 1
A COMPARISON OF WARP BREAKING STRENGTHS
ORIGINAL TABLE LINENS

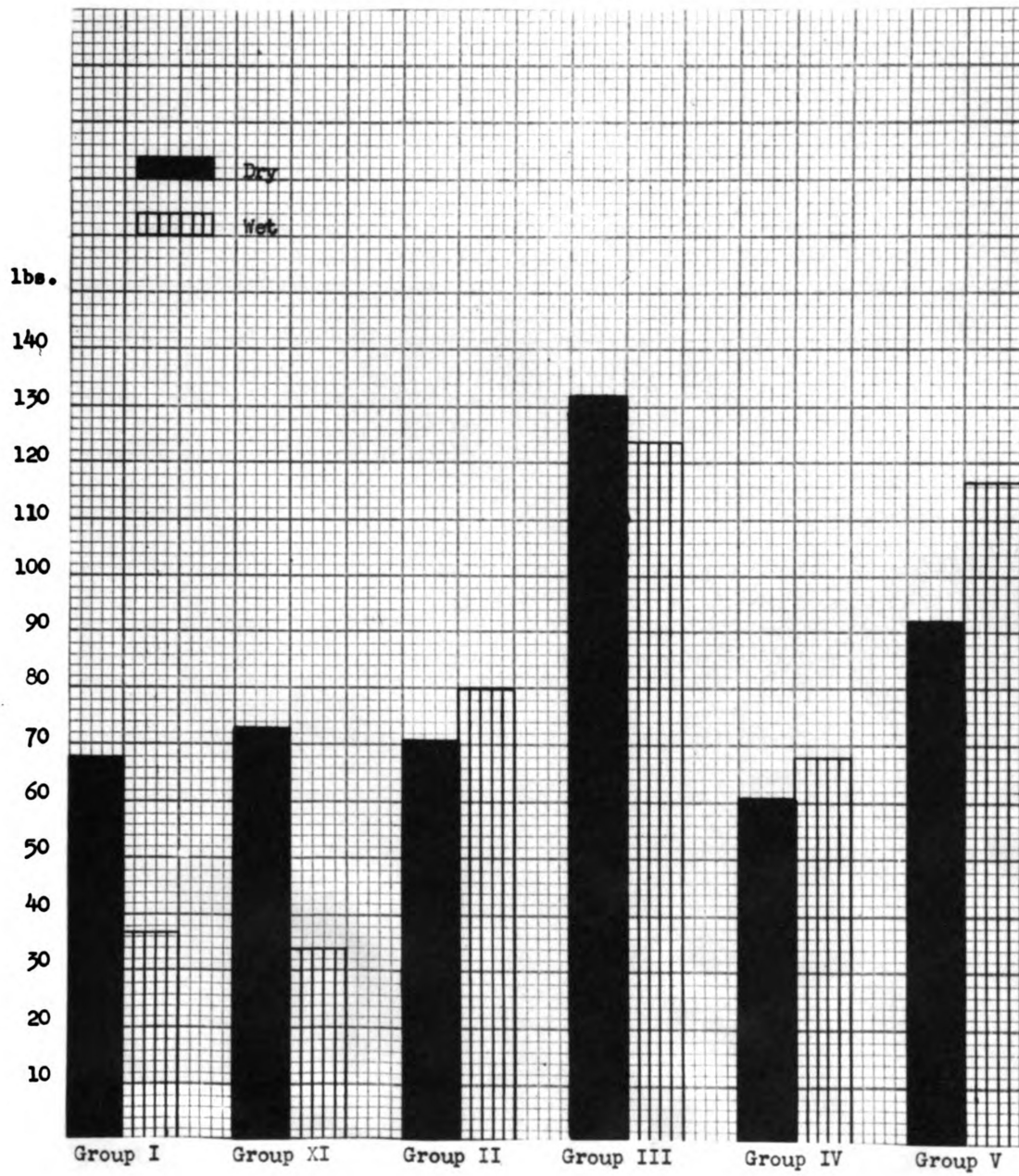
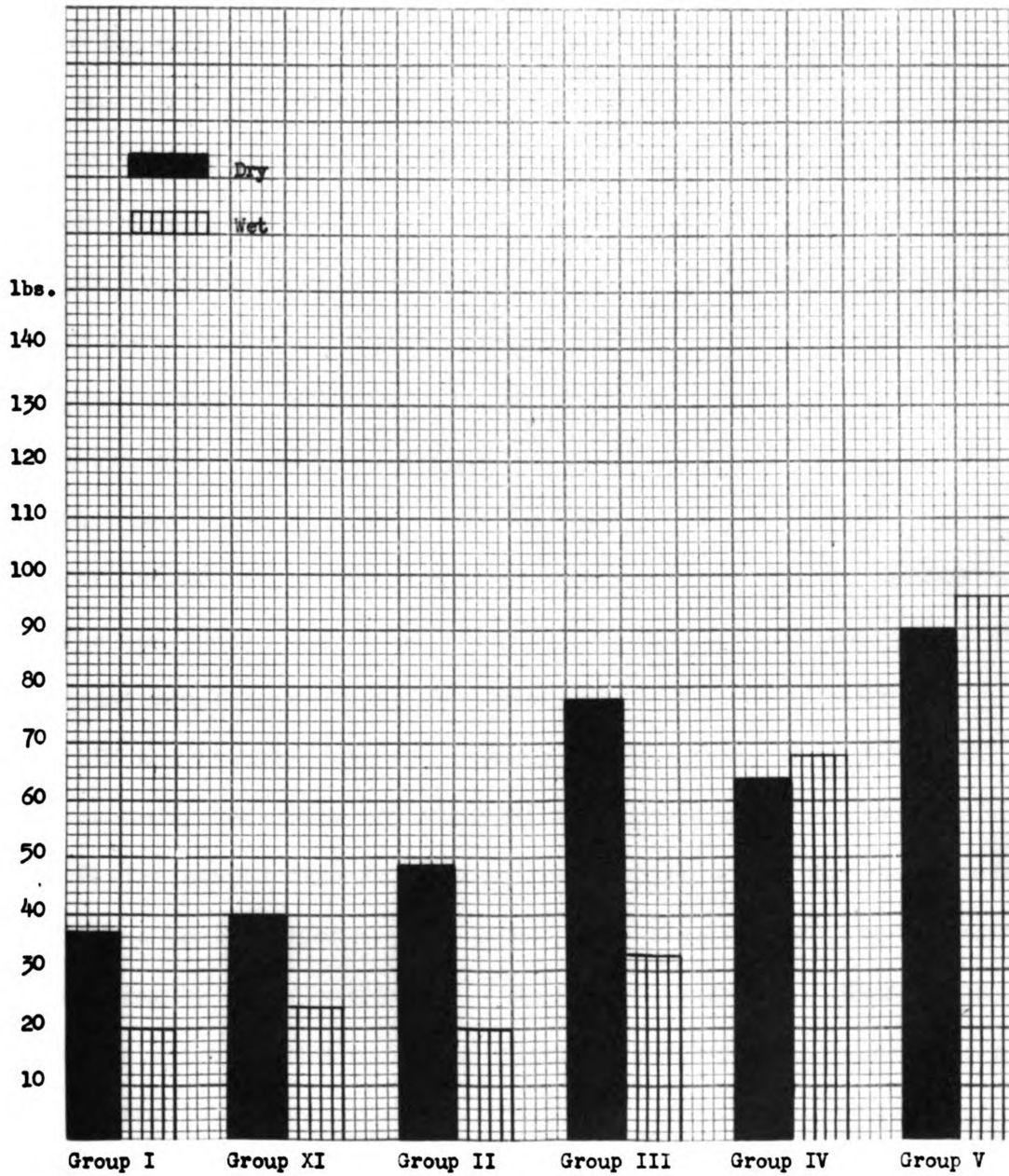


Plate 2

A COMPARISON OF FILLING BREAKING STRENGTHS

ORIGINAL TABLE LINENS



may account for the lower strength in that direction as dull yarns are usually weaker than bright. Also of importance is the fact that Group XI had a dry warp breaking strength that was over 5 pounds greater than that of Group I, and the dry filling strength had increased 3 pounds. There was likewise an actual pound increase in both warp and filling wet strengths of the fabrics purchased in 1948 as well as a higher wet-dry percentage relationship. Phelps²⁵ indicates that the wet breaking strength for acetate yarns runs between 56 and 70 per cent of the dry. Table 3 shows that the acetate damasks purchased in 1945 had a wet strength percentage below this range, but those purchased in 1948 fell within the range. As the yarn counts, size of yarns, filament counts, and twist are almost identical in both groups, the increased breaking strengths of Group XI are attributed to improvements in the yarns.

For the three groups of tablecloths having cotton warp yarns, there is a great range in breaking strengths. The mercerized cotton yarns in Group III had the highest dry strength of any group irrespective of fiber content, but their wet strength was only 93.87 per cent of the dry. Davis⁷ stated that wet linen and cotton strengths are as high or higher than their dry strengths unless the cellulose has been damaged in finishing by overbleaching or other chemical action. Then it is considerably lower than the dry. Phelps²⁵ indicated that there is a range of 110 to 130 per cent for wet cotton strengths as a per cent of the dry. The wet per cents for the cotton yarns in this study fell below or just within the lower limits of the usual range. The cotton filling yarns of Group IV had a slightly greater breaking strength than the warp. The coarser yarns used in this direction may account for their

strength. Keeney¹⁸, Howorth¹⁵, and Morrison²² attributed the greater strengths of wartime manufactured cottons to the use of coarser yarns. Howorth also found that a high breaking strength was related to a low twist. The variation in the warp strengths cannot be explained on this basis as their yarn numbers and twist did not vary greatly. It may be assumed that inherent quality, differences in yarn counts, and the use of ply yarns caused the variability of warp strengths in Groups II, III, and IV. Table 19 in the appendix has reduced the strengths for the various groups to an index number on the basis of strength per yarn.

The viscose filling yarns in Groups II and III had widely divergent dry strengths with decreased wet strengths that were only slightly higher than 40 per cent of the dry and lower than the usual 45 to 55 per cent range given by Matthews²¹. The difference in the breaking strengths seems to have a more feasible explanation upon the basis of the much higher yarn count in Group III than upon the basis of increased filament count, larger yarn size, and lower twists which Roseberry²⁹ found correlated with a high breaking strength. The Breaking Strength Index Table in the appendix does not account for the entire difference in filling breaking strengths for the two groups, and it is to be assumed that inherent differences of the yarns are responsible. Roseberry cites variability in strength of filaments in yarns, the amount of tension used in finishing, the type of dye and finish as possible causes of variation in strength. Davis⁷ found that the dry breaking strength of viscose rayons decreased in 1940 and 1941 when prices were rising but not so rapidly as the cost of living.

The balance of the warp-filling strengths of Group II was very poor and the greatly lowered wet filling strength widened the difference. The difference between the warp and filling strengths in Group III was not so serious as the filling strength was sufficiently higher to give satisfactory performance.

The linen damasks were well balanced with regard to breaking strengths. The increase of the wet warp strength over that of the dry was about 21 per cent greater than the percentage increase observed in the filling.

The fact that the percentage relationship of dry and wet strengths for all fibers tends to follow the lower limits of the usual percentage ranges indicates that the yarns or fibers used in the fabrics of this study were not of the best quality. Only the all-cotton and the linen table fabrics gave satisfactory predictive performance when the wet tensile strengths were taken into consideration. All other fabrics showed a loss of about 40 to 60 per cent in one or both directions when tested wet. An increase in the actual number of pounds required to rupture the acetate fabrics purchased in 1948 indicated some technological improvement in acetate yarns during the three years separating the purchase dates of the two groups. The viscose yarns were observed to have in general dry and wet strengths greater than the acetate fabrics in actual pounds, but the dry-wet percentage indicated a poorer relationship for the viscose yarns. Matthews²¹ substantiated this observation in his statement that viscose has the lowest wet strength of all rayon yarns.

Elongation: A study of the elongation percentages given in Table 4 at the top of the following page shows that the elongation for both groups of acetate rayon fabrics increased when they were tested wet. Matthews²¹

Table 4
AVERAGE ELONGATIONS IN PER CENT
ORIGINAL TABLE LINENS

Group	Fiber Content	WARP		FILLING	
		Dry	Wet	Dry	Wet
I	acetate	32.1 ^a	40.7 ^a	30.9 ^a	46.2 ^a
XI	acetate	33.0 ^a	35.7 ^a	31.4 ^a	45.2 ^a
II	cotton- viscose	14.4 ^b	15.0 ^b	31.9 ^b	29.5 ^b
III	cotton- viscose	24.2 ^c	-----	29.9 ^c	23.2 ^c
IV	cotton	13.0 ^d	14.1 ^d	20.6 ^d	18.4 ^d
V	linen	13.2 ^a	-----	17.4 ^a	8.1 ^a

a. average of 30 determinations

b. average of 50 determinations

c. average of 40 determinations

d. average of 20 determinations

states that elongation tends to increase as strength decreases. Phelps²⁵ gives the usual ranges for acetate rayons as 23 to 30 per cent dry and 30 to 38 per cent wet.

The dry and wet elongations for the viscose rayon yarns used fill-wise in Groups II and III were nearly the same, but the wet elongations were actually less than the dry. The dry elongations for both groups exceeded the 16 to 20 per cent range for viscose yarns dry and conform more closely to the wet elongation range of 18 to 35 per cent²⁵.

Matthews²¹ gives an expected range of 4 to 10 per cent elongation for cotton when dry, but no figures are available for the expected wet performance. All elongations for the cotton yarns in this study exceeded the usual percentage performance. Furthermore, the cotton warp yarns of Groups II and IV had slightly greater elongations when tested wet.

A considerable decrease in the wet elongation was obtained for the filling yarns of the linen damasks which conforms to the normal performance to be expected with an increase in strength. Warp elongation percentages were not available for the warp yarns of Groups III and V because their breaking strengths necessitated the use of a machine without elongation attachment.

Not all fabrics performed in accordance with the usual inverse strength-elongation relationship. All of the fabrics in the study for which elongation determinations were available tended to surpass the upper limits that occur normally indicating less than average strengths.

Cost per Square Yard: Through reference to Table 5, it will be seen that the price per square yard of the acetate rayon fabrics purchased in 1948 increased considerably over that of those purchased in 1945. A comparison of the yarn structures, yarn count, and the weight per square yard did not show any appreciable variation, but some improvement in the breaking strengths for those purchased at the later time has been noted. The greatly increased price, however, of Group XI must be attributed to the spiral of prices that followed the removal of price controls.

The cotton and viscose rayon fabrics of Group III had the highest cost per square yard of all purchases made in 1945. Group II of the

Table 5
COST PER SQUARE YARD
ORIGINAL TABLE LINENS

Group	Fiber Content	Cost per Square Yard
I	acetate	\$2.51
XI	acetate	4.56
II	cotton-viscose	3.11
III	cotton-viscose	5.18
IV	cotton	.71
V	linen	3.58

same fiber content had a lesser price, but a comparison of the specifications of the two groups will show those of the higher priced damasks were definitely superior.

The linen damasks were the second highest in price of those fabrics purchased originally while the cottons were by far the lowest. The price of the linen may be attributed to its scarcity, the initial cost of the fiber, and the care and skill required in spinning the yarns and weaving the fabric rather than to outstanding construction. The original breaking strengths of the linen fabrics were satisfactory. The all-cotton fabrics might be expected to give satisfactory service and to be the best purchase from a price consideration. The damask weave in itself is the most expensive of weave constructions, and therefore, accounts for a considerable part of the purchase price of the materials in this study.

Cost per square yard when ranked from highest to lowest as has been done in Chart 3 of the appendix and compared with the warp breaking strengths, ranked in a like manner, has a direct relationship except for the reversal in position of the breaking strengths of Groups V and XI. There is a tendency for other construction features to show a relationship, but they by no means follow the pattern of price as closely as does warp breaking strength.

Performance of Damasks

Performance for the purposes of this study has been defined as the manner in which textiles react after fifty launderings. Measurement of performance is made by comparing after laundry test results with specifications established earlier. Post-laundry tests were performed to determine changes in dimensions, area, yarn count, weight per square yard, breaking strengths, and color that occurred as a result of laundry. Change in color after exposure to light was noted and subjective evaluations made to complete the measurements of performance.

Dimensional Change: The percentage dimensional change which took place in each direction of the various groups of table linens will be considered before the discussion of other changes occurring as a result of fifty launderings. Increase or decrease in length and width frequently accounts for changes in yarn count, weight per square yard, and breaking strength. Decrease of dimension in one direction causes an increase in yarn count in the opposite direction; conversely an increase in dimension one way of the material results in a decreased yarn count in the other. Loss of area will cause fabrics to increase in weight through a

greater concentration of yarns per square inch. Greater breaking strength may occur in the same direction as an increased yarn count because of the presence of more yarns per inch. Degredation of the fibers would minimize the effects of shrinkage upon weight and strength. A complete tabulation of warp and filling dimensional change at each laundry interval measurements were made is given in Tables 12 and 13 of the appendix. The performance, however, of the various groups of table linens analyzed as to fiber content is presented as line graphs in Plates 3 and 4 on pages 47 and 48. Similar tabulations and graphs for change in area follow those for dimensional change. The trends of the fabrics as to stability are to be more readily observed from the graphs.

From the graphing of the warp yarns, it will be noticed that in all cases regardless of fiber content the greatest change occurred during the first laundry. In all cases except the acetate rayons purchased in 1948, the shrinkage as a rule was progressive throughout laundry, but at a much less accelerated rate. The greatest change in the filling direction also took place as a result of the first laundry. The highest percentage dimensional change did not by any means occur on the fiftieth laundry. Frequently the greatest changes were partially corrected before the final laundry.

Both groups of acetate rayon damasks reached a relative degree of stability after the first laundry. The warp and filling yarns of Group I fluctuated considerably after the tenth and through the fiftieth laundry. The shrinkage in warp and filling direction for Group I was nominal as it did not exceed 2 per cent. The fabrics purchased in 1948

Plate 3

DIMENSIONAL CHANGE IN LENGTH

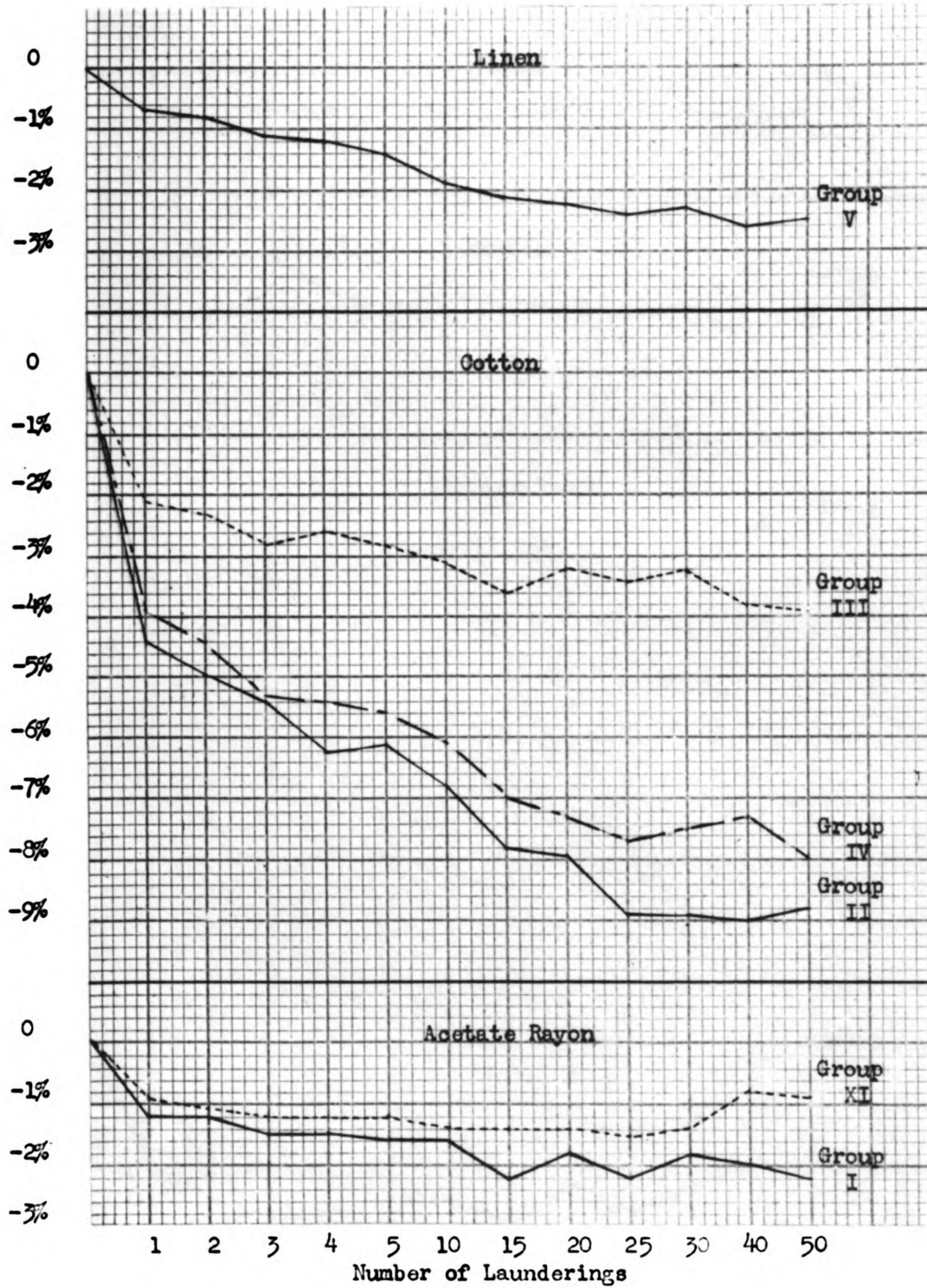


Plate 4

DIMENSIONAL CHANGE IN WIDTH

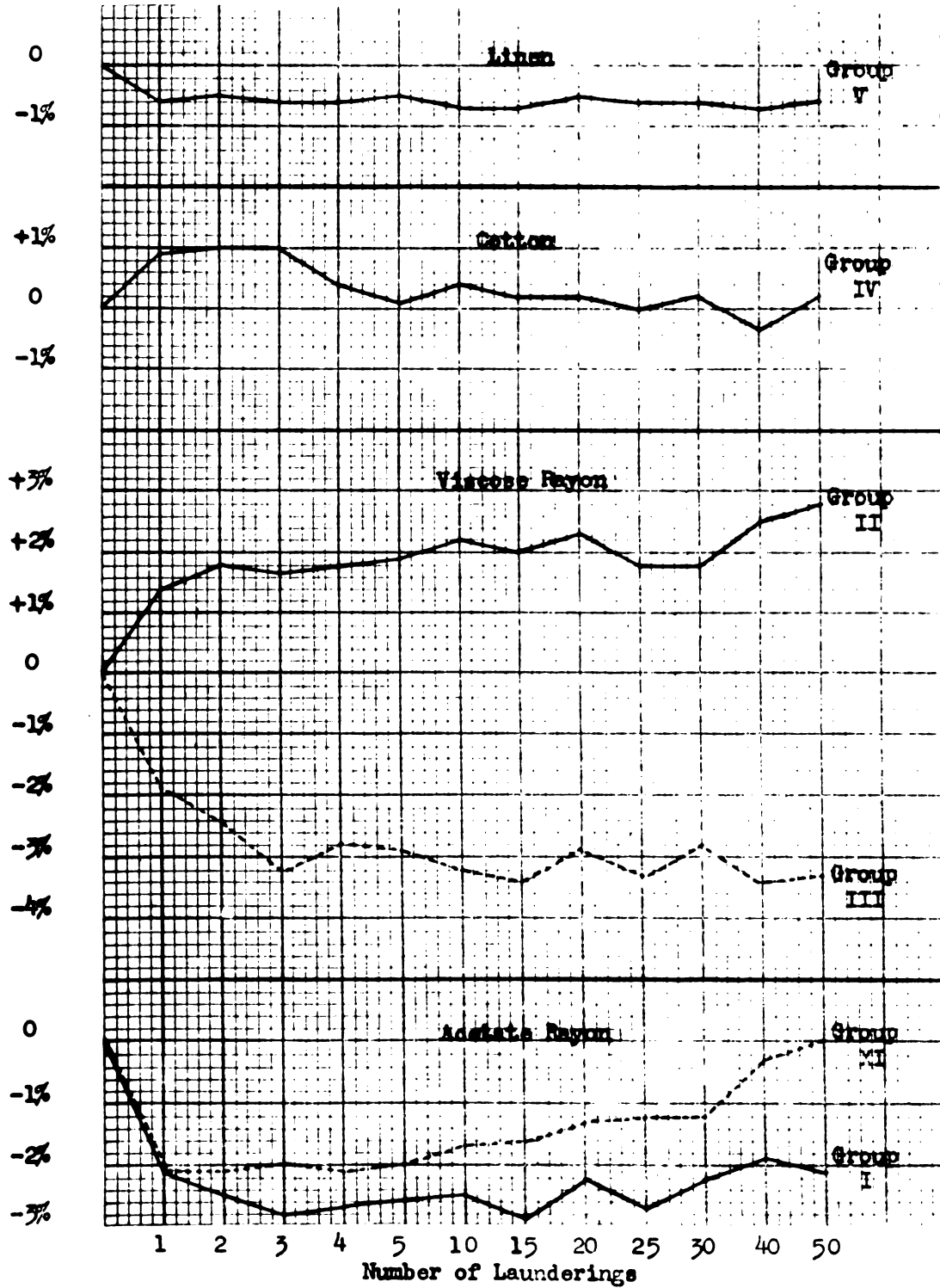


Plate 5

CHANGE IN AREA

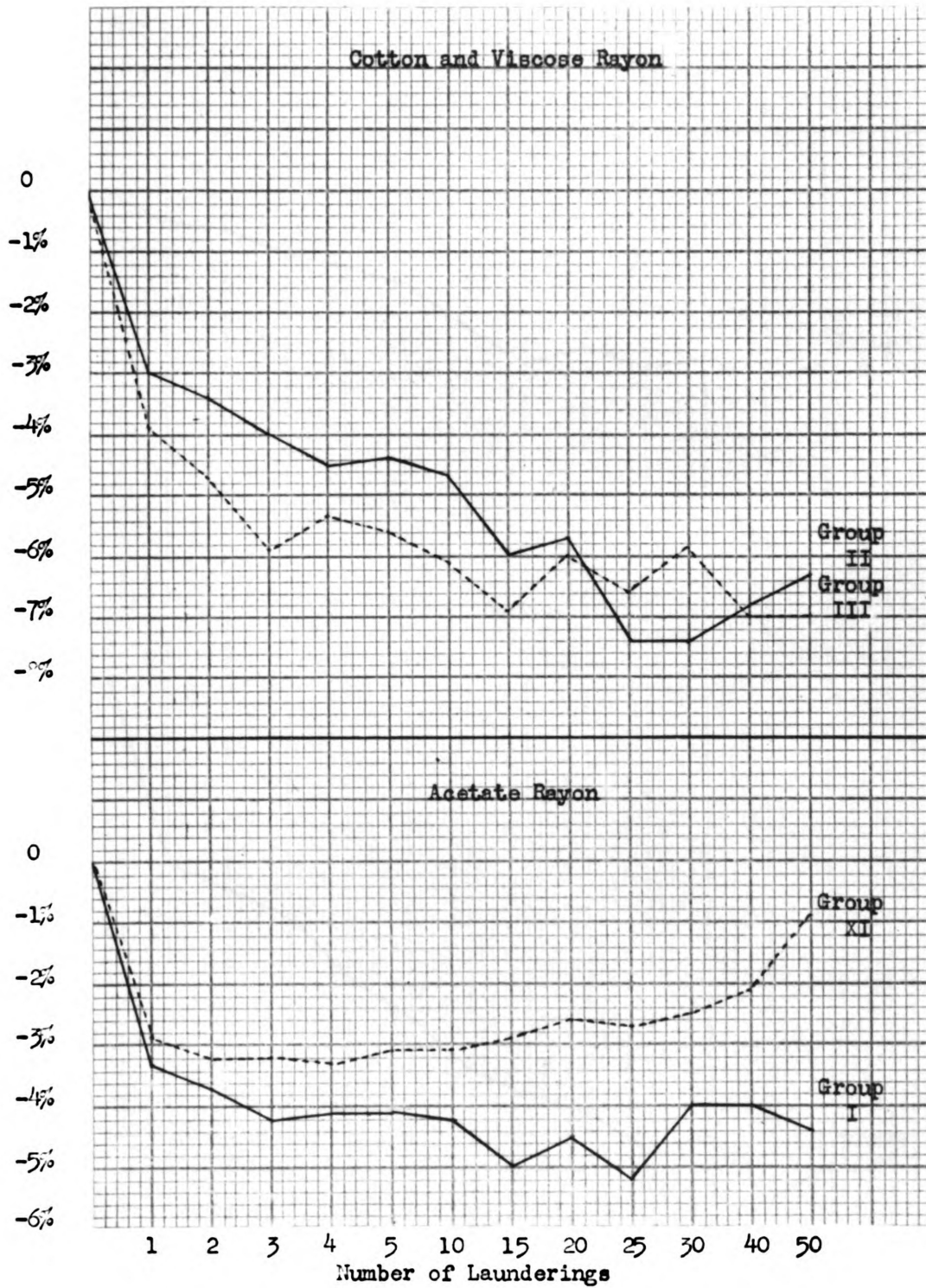


Plate 6

CHANGE IN AREA

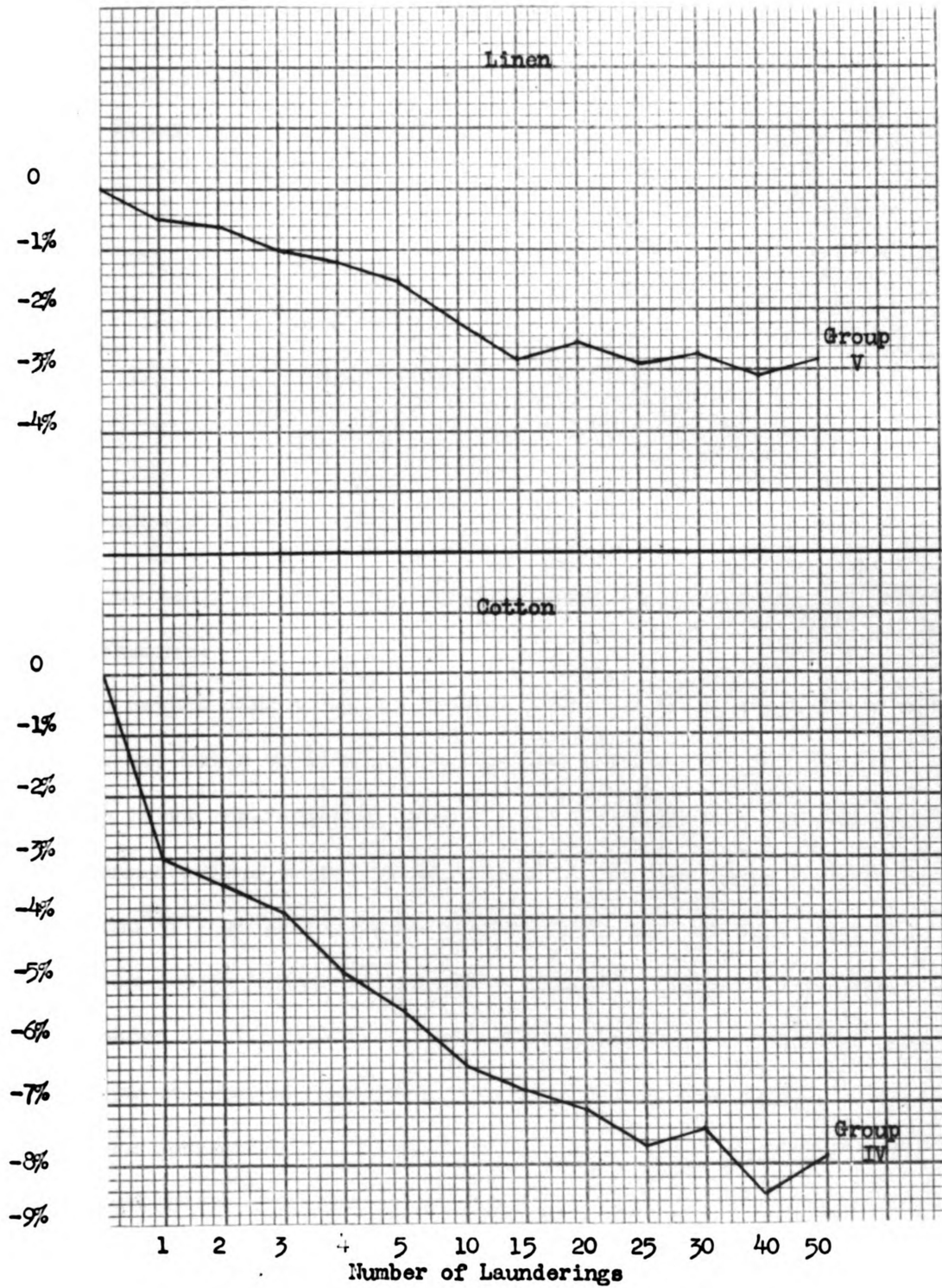


Table 6
 DIMENSIONAL CHANGE IN PER CENT
 AFTER FIFTY LAUNDERINGS

Group	Fiber Content	Warp	Filling
I	acetate	-2.24%	-2.03%
XI	acetate	- .94	.00
II	cotton-viscose	-8.82	+2.75
III	cotton-viscose	-3.88	-3.32
IV	cotton	-7.97	+ .09
V	linen	-2.50	- .57

were quite superior from the standpoint of total shrinkage and constancy in performance.

The cotton warp yarns in Groups II and IV had a percentage shrinkage that was twice that of the mercerized cottons and the greatest of all warp yarns regardless of fiber. The shrinkage for the two groups having unmercerized yarns was in excess of the maximum allowance of 5 per cent³¹. Further the unmercerized yarns did not show a point of relaxation but continued to shrink throughout laundry. The mercerized yarns tended to stabilize after the fifteenth laundry. The filling yarns of the cotton damasks increased in length through the fifth laundry and then began decreasing slightly; however, after the fiftieth laundry a very slight increase in dimension was observed. The dimensional change of the cotton filling yarns was insignificant. In another study a series of forty wash tests on cotton fabrics resulted in warp shrinkages of

from 5 to 13.5 per cent, and the filling yarns exhibited gains of 6.5 to losses of 4.0 per cent⁸.

The viscose filling yarns in Groups II and III performed in opposite manners. Relaxation occurred after the second and third launderings, but considerable fluctuation in both groups was noted throughout the series of washings. The unpredictability of rayons and viscose in particular has been noted in several other studies. The increase in filling dimension of Group II and the decrease for Group III were within the 5 per cent maximum tolerance. Davis⁷ in testing viscose rayon fabrics over a period of years prior to the present study found the shrinkage somewhat too high in both directions with no definite tendencies. The degree of stability of viscose rayons apparently had been improved during the interval of years separating the two studies, but not its tendency to perform in a predictable manner. Roseberry's²⁹ findings that coarser yarns and a greater number of filaments increased shrinkage of viscose fabrics does not account for the variability in dimensional stability as the yarn constructions in the two groups were quite similar.

The warp yarns of the linen damasks showed a slight but gradual decrease in length throughout laundry. The filling yarns remained almost dimensionally constant after the first laundry and had a very nominal final shrinkage. Warp shrinkage was not excessive.

The greater dimensional change found in the warp direction for all types of fabrics is substantiated in the studies of Gaston and Fletcher¹¹, Sumner³², and others. Tension on warp yarns during weaving undoubtedly accounts for the greater shrinkage which occurs in the length of fabrics. The rayon warp yarns reached relaxation earlier in the laundry series than

either the cotton or linen and is supported by the New Jersey Laundry Owners' Association findings⁸. In their study rayon warp yarns relaxed after from one to four washings but the cottons not until between the tenth and fifteenth. In the Michigan study the rayon warp yarns showed greater dimensional stability than the cotton or linen, but the reverse was true of the filling yarns with the exception of those in Group XI. Acetate yarns as a whole were more stable than the viscose. Shapiro³⁰ indicated that similar results had been observed in prior tests.

Gaston and Fletcher¹¹ washed cotton, linen, and rayon fabrics and then pressed them under controlled tensions. They found no significant differences in shrinkage resulting from the various tensions. Thus it may be assumed that the fabrics tested at Michigan State were not greatly affected by individual differences of pressure in the hand ironing process. In the study of tension, it was found that less shrinkage occurred in continuous filament acetate and viscose than in cotton and linen fabrics.

Sumner³² in her study found that the linen demasks shrank in the warp and filling from 0.6 to 4.9 per cent; cotton warp, 4.6 to 12 per cent; cotton filling, 1.4 to 4.5 per cent; and rayon, .0 to 4.2 per cent.

Area Change: All groups showed a loss in area ranging from .92 to 7.88 per cent. From the graphs of area performance throughout laundry, it will be seen that the acetate rayons reached relaxation after the first to third laundry while all other groups did not have a definite relaxation point. The acetate rayons purchased in 1948 were more satisfactory than any of the other fabrics with regard to constancy and the amount of change in area after fifty launderings. It is further proof of the improvements being made in synthetic fibers.

Table 7
 AREA CHANGE IN PER CIEWT
 AFTER FIFTY LAUNDERINGS

Group	Fiber Content	Change
I	acetate	-4.42%
XI	acetate	- .92
II	cotton-viscose	-6.32
III	cotton-viscose	-7.05
IV	cotton	-7.88
V	linen	-2.77

The area performance of the two groups containing cotton and viscose yarns was quite erratic showing a tendency to progressive shrinkage. On a percentage basis they had a total shrinkage surpassed only by that of the cotton damasks. The better performance of the mercerized cotton warp in Group III is minimized by the filling shrinkage, while the greater warp shrinkage in Group II is counteracted by a fillingwise increase in dimension. Sumner³² found the greatest shrinkage occurring in the napkins of cotton and rayon. The rayon filling yarns changed little, but the shrinkage of the cotton warp yarns was greater than in any of the other napkins she tested.

The cotton damasks had the greatest loss of area of all damasks studied and a progressive shrinkage until after the twenty-fifth laundry.

The linen damasks when compared with the groups contained in the original purchases showed the least change in area. Sumner³² found

linen damasks to change least in area. The linen fabrics did not reach a point of relaxation until after the fifteenth laundry which suggests that a considerable amount of sizing may have been used.

The greatly improved dimensional performance of the acetates purchased in 1948 placed them first. The linen damasks ranked second, and the cotton and cotton and viscose damasks suffered similar losses in area which were excessive.

Change in Yarn Count: Table 15 in the appendix shows the relationship of the original yarn counts to those taken after fifty launderings for all groups of damasks in the study. The warp yarn count change after

Table 8
YARN COUNT CHANGE IN PER CENT
AFTER FIFTY LAUNDERINGS

Group	Fiber Content	Warp	Filling
I	acetate	+3.16	+1.10
XI	acetate	.00	+2.20
II	cotton-viscose	-3.49	+8.62
III	cotton-viscose	+2.03	+3.37
IV	cotton	.00	+11.10
V	linen	.00	+2.38

fifty launderings varied from an increase of 3.16 per cent to a loss of 3.49, and gains of 1.10 to 11.10 were observed in the filling counts. However, in determining the cause of increased or decreased yarn count,

the dimensional stability of the yarns in the opposite direction must be taken into consideration. Through a comparison of the percentage change in the yarn counts given in Table 8 with the final warp and filling dimensional changes given on page 51, it will be seen that an increased yarn count in one direction is accompanied by a dimensional decrease in the opposite direction. A decreased yarn count in one direction is likewise a result of stretching that occurred in the other dimension of the material.

The acetate fabrics in Group I had increased counts in both the warp and filling direction. Those of Group XI had an invariate warp count, but the filling count percentage increase was twice as great as that of the first group.

The warp count in Group II decreased whereas the count for Group III increased. The difference observed in the performance of the two sets of warp yarns is explained by the fact that the viscose rayon yarns in Group II increased dimensionally while those in Group III decreased in length. When the filling counts of Groups II, III, and IV are observed, it is to be noted that Groups II and IV increased greatly and were accompanied by excessive warp shrinkages. The increase in the filling count of Group III was not great as the mercerized warp yarns did not shrink excessively. The warp count in the all cotton damasks remained constant as a result of the insignificant increase in length of the filling yarns.

The warp count for the linen damasks did not change as the filling shrinkage was not significant. The filling count increased moderately as a result of some shrinkage in the warp direction.

The greater increase in yarn counts in all fabrics of this study occurred in the filling direction as a result of greater warp shrinkage.

Change in Weight per Square Yard: A comparison of the weight in ounces of the various groups before and after fifty launderings is given in Table 16 in the appendix. All fabrics except the linen damasks showed an increase in weight. The increase may be attributed to dimensional losses in area. The linens in this study showed a relatively low area change and a loss in weight. Sumner³² similarly found no increase in the weight of linen damask after laundry and attributed it to the small amount of shrinkage. The group of linen fabrics studied at Michigan State linted excessively during laundry; and for that reason, it was assumed that the nominal shrinkage was not great enough to offset the loss of fiber through the action of laundry. The lowest increase in weight occurred in the acetate damasks purchased in 1948 and was related to their slight loss in area. The fabrics containing cotton increased in weight

Table 9
WEIGHT PER SQUARE YARD CHANGE IN PER CENT
AFTER FIFTY LAUNDERINGS

Group	Fiber Content	Change
I	acetate	+ 7.28%
XI	acetate	+ .79
II	cotton-viscose	+15.29
III	cotton-viscose	+11.73
IV	cotton	+10.10
V	linen	- 4.54

to the greatest extent. In Sumner's study³² the cotton and cotton and rayon fabrics all gained at least 10 per cent in weight, and this finding was duplicated at Michigan State where the same type of fabrics had weight increases in excess of 10 per cent.

Change in Breaking Strength: Plates 7 through 10 beginning on page 59 show in bar graph form the relationship of original strength to strength after laundry for the six groups of damasks. Comparisons of strengths before and after laundry with percentage change are to be found in Tables 17 and 18 of the appendix.

Table 10
BREAKING STRENGTH CHANGE IN PER CENT
AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY		WET	
		Warp	Filling	Warp	Filling
I	acetate	+ 8.19%	+ 4.37%	+17.49%	+25.00%
XI	acetate	-27.88	-29.29	-23.45	-26.64
II	cotton- viscose	-33.43	+ 4.73	-23.12	+22.28
III	cotton- viscose	-27.71	+ 1.80	-22.74	+ 4.53
IV	cotton	-26.64	-14.91	-31.86	-10.04
V	linen	-34.06	-37.50	-42.50	-30.77

Plate 7

A COMPARISON OF WARP DRY BREAKING STRENGTHS
ORIGINAL AND LAUNDERED TABLE LINENS

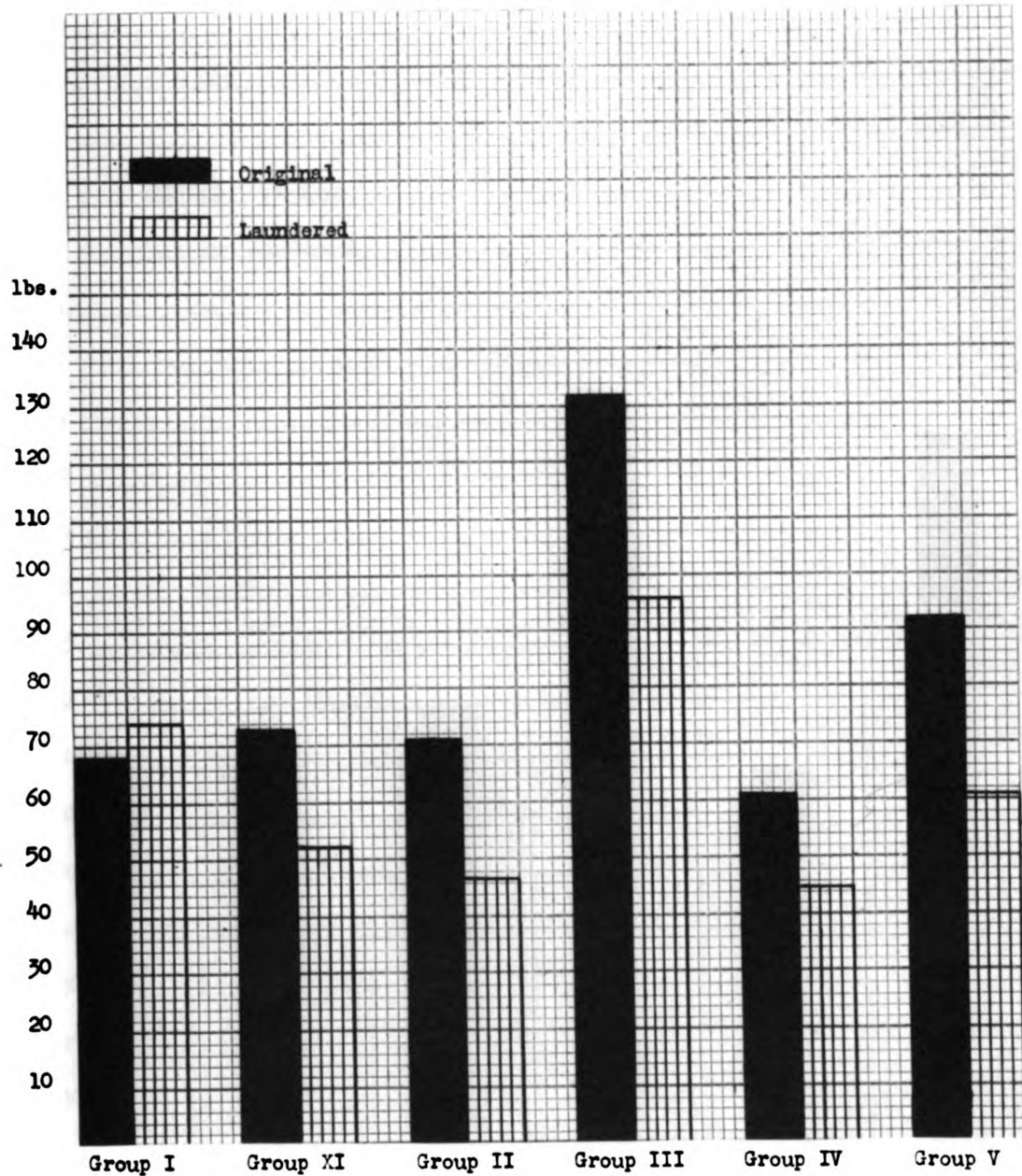


Plate 8

A COMPARISON OF WARP WET BREAKING STRENGTHS

ORIGINAL AND LAUNDERED TABLE LINENS

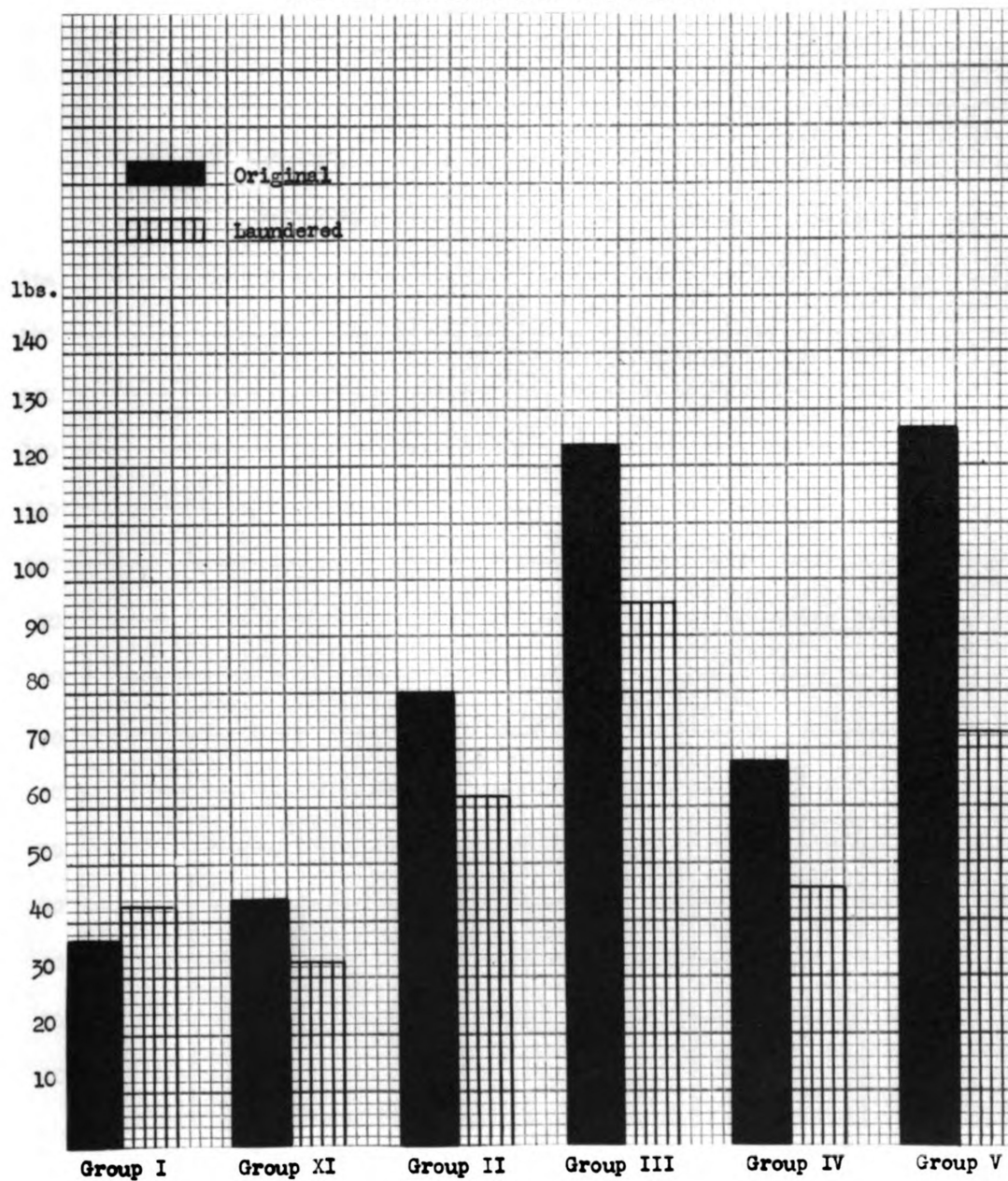


Plate 9

A COMPARISON OF FILLING DRY BREAKING STRENGTHS

ORIGINAL AND LAUNDERED TABLE LINENS

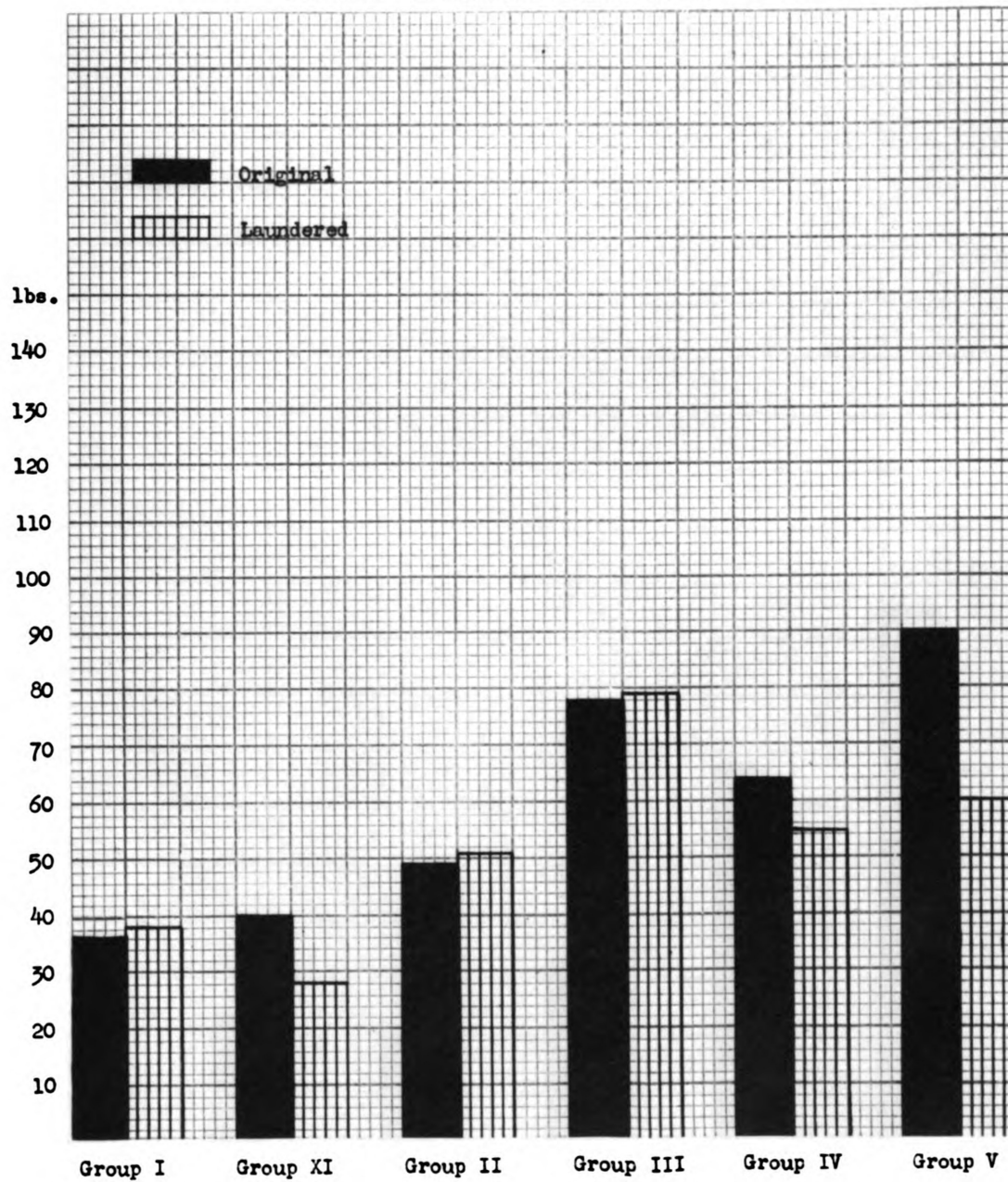
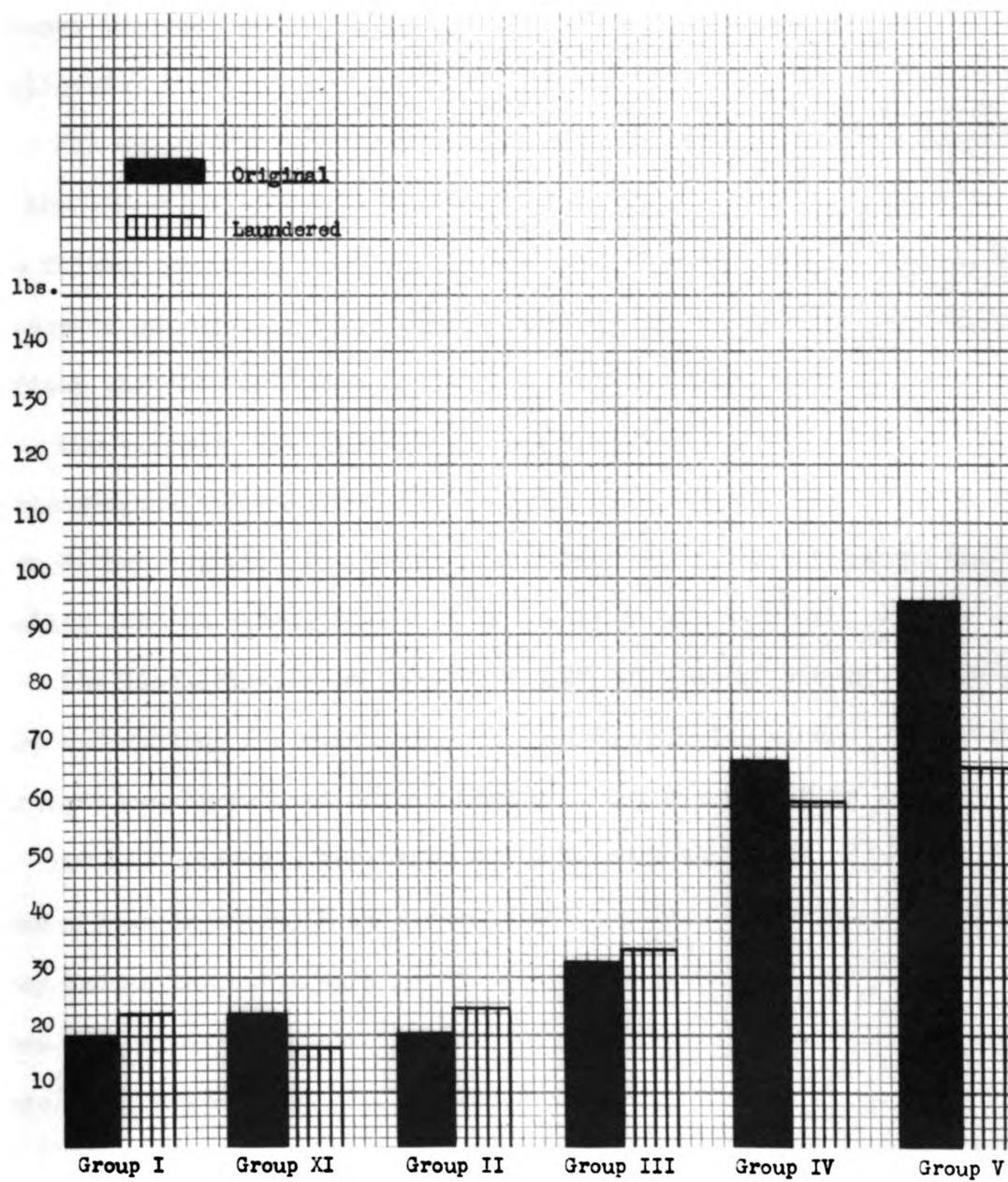


Plate 10

A COMPARISON OF FILLING WET BREAKING STRENGTHS
ORIGINAL AND LAUNDERED TABLE LINENS



The acetate rayons of Group I were the only fabrics which gained in all breaking strengths after laundry. The increase in strengths is apparently caused by an increased yarn count. The other groups of acetates did not increase in breaking strength, but shrinkages for this group were negligible.

All the groups containing cotton warp yarns lost breaking strength in the direction of the cotton yarns irrespective of the performance of the filling yarns on shrinkage tests. Likewise the cotton damasks suffered losses of strength in the filling direction even though accompanied by serious warpwise shrinkage.

The viscose filling yarns in Groups II and III increased in dry and wet strengths somewhat in proportion to the amount of shrinkage in the warp direction; the group having the lesser amount of shrinkage had a smaller gain in strength.

The linen fabrics suffered the greatest loss of strength in both the warp and filling directions of all materials in the study. The loss in strength may be related to the loss of linen fibers during laundry.

Of all materials purchased in 1945, only the rayon fibers failed to show a loss in strength as a result of laundry. Other fibers even though they had an increased yarn count in the direction of the test failed to show an increase of strength; hence it is to be assumed that the rayons were least affected by the action of laundry.

Sumner³² found losses in wet breaking strengths of 38.7 to 61.3 per cent for linen damasks, 24.3 to 29.6 for the cottons, and 17.7 to 41.2 for the cotton warp yarns of the rayon and cotton fabrics. The rayon filling yarns in four cases out of five showed a gain and not a loss in

strength. The loss in breaking strength of the linen fabrics positively correlated with the loss in weight per square yard.

Graydon, Lindsley, and Brodie¹² found that regardless of the severity of the laundry method used significant differences in the loss of breaking strength by rayon fabrics were not obtained. Lyle and Black²⁰ found that wringing during laundry did not adversely affect the breaking strengths of rayon fabrics. Thus it may be assumed that rayons may now be laundered without observing former precautions.

Breaking Strength Index: Actual loss or gain in strength per yarn is given in Tables 19 and 20. The percentage change given for breaking strength indices is actually a better means of determining loss or gain of strength as a result of laundry for the element of shrinkage is eliminated. The acetate rayons of Group I showed actual increased strength per yarn in both directions when tested dry and wet after laundry. The viscose filling yarns of Group II and III showed an increase in strength when tested wet. Their loss of strength when tested dry was not great.

The breaking strength indices showed for all rayon fabrics except those of Group XI only very slight losses in strength or actual increases after laundry. Group XI had a warp index just slightly below that of the cotton warp yarns. The cotton warp yarns lost in general about 30 per cent of their strength after laundry. The linen loss in warp strength was somewhat greater.

Elongation: The increased elongation of yarns that might be expected to accompany loss in strength after laundry did not occur; nor did the one group of rayons which increased in strength after laundry show a loss in elongation. Only the cotton warp yarns in Groups II and IV had

losses in strength accompanied by increased elongation, and those of Group IV did not show an increase in elongation when tested wet. The same lack of expected elongation performance when loss of strength is considered failed to occur in the filling yarns. The viscose rayon yarns in Group III which increased slightly in strength after laundry had an almost 12 per cent increase in elongation when tested dry, but failed to show a corresponding increase in elongation when tested wet. A comparison of warp and filling elongations before and after laundry will be found in Tables 21 and 22 of the appendix.

Colorfastness to Light: Nearly all the fabrics contained in the groups of damasks were white so that color change was not an important consideration. The peach colored tablecloth, number 14, of Group II lost little color after 20 hours in the Fade-Ometer. The loss was quite noticeable after 40 hours and progressed thereafter, but no discernable difference in color change between 60 and 80 hours was to be observed. The fabric was judged to have Class 2 colorfastness⁶, satisfactory for use where moderate fastness to light is required.

Tablecloths 15 through 17 in Group III had Class 4 colorfastness⁶. They showed no appreciable change after 80 hours, and may be considered of superior lightfastness. Tablecloths 102 and 103 in Group XI showed slight loss of color after 20 hours in the Fade-Ometer. The fading was appreciable at the end of 40 hours, but the original colors were very delicate. No difference was distinguishable between the 60 and 80 hour runs. These were judged to Class 2 fastness to light.

Cost-Performance Relationships: Chart 4 of the appendix shows the relationship of cost to the performance factors of change in weight per

square yard, dimensional change in warp and filling directions, and change in warp and filling dry breaking strength indices. There is no direct relationship between price and performance. The acetate rayons in Group XI showed considerable relationship between desirable performance factors and price, and the acetate rayons in Group I showed a rather close relationship between a low price and satisfactory performance. The increased price of the acetate damasks purchased in 1948 accounted for the reversal of the relationship of cost and performance for these two groups. Group II tended to show a relationship of lower price to low performance characteristics, and Group III had a high price and a tendency to poorer performance. In the cotton damasks there was a connection between low price and excessive warp shrinkage, but other performance factors tended to be higher. There was an association of price rank and dimensional change for the linen damasks, but breaking strengths were lower.

Subjective Analysis of Laundered Fabrics: The determination of colorfastness to laundry was made by a subjective inspection of the laundered table linens. Tablecloth 14 lost considerable color as a result of laundry. Tablecloths 15, 16, and 17 showed no appreciable change in color of the mercerized cotton warp yarns, and tablecloths 102 and 103 faded somewhat. In no case was the loss of color as a result of laundry as great as the loss which resulted from exposure in the Fade-Ometer. Borton³ and Davis⁷ found wearing apparel fabrics of all kinds gave the poorest performance with respect to light. Keeney found no differences in colorfastness in 1942 and 1943 for drapery¹⁷ and cotton dress¹⁸ fabrics. On the other hand Morrison²² found that

the colorfastness of both cottons and rayons was poorer in 1944 when compared with previous years. It is possible that in the later war years only the poorer dyes were available for civilian use.

After fifty launderings the acetate rayon fabrics in Group I had slightly less luster and body. These white fabrics appeared a little dingy. The hems whether machine stitched or hand done held up well. The selvages had shrunk some.

The cotton warp yarns in Group II had become quite fuzzy and lost sheen; the rayon yarns in the filling also had less luster. The cloth lost body. Hems parallel to the warp yarns pulled out; hand-rolled hems deteriorated more than those that were machine stitched. The slippage of the warp yarns on the rayon filling yarns seemed to cause the hems to pull out in the warp direction.

In Group III the mercerized cotton warp yarns roughened ever so slightly but maintained a good luster. The hand-rolled hems pulled out in several places; hems parallel to the warp yarns depreciated to a greater extent.

The fabrics in Group IV lost all their glossy, linen-like appearance and crispness. They became slightly yellowed and quite fuzzy. The original weaving imperfections became more noticeable as the removal of starch freed more of the long unattached floats. The pattern became less distinguishable. All hems held equally well. These heavy damask cloths took a fairly long time to iron, but when ironed quite damp their appearance improved. The selvages on tablecloth 23 were full of loops and looked worse than did the selvages on the other tablecloths in the group.

As previously noted the linen tablecloths in Group V linted considerably each time they were washed. They lost some of their smooth, slick surface and body. After laundry they were softer than the original cloths which would indicate they had been sized. The hems stayed in very well, but looked pulled as did the selvages. The napkins retained more body and seemed to be of better quality. Tablecloth 33 which was of a noticeably poorer quality, looked thin in the areas where design occurred. Tablecloth 31 had a few broken yarns. The linens had not yellowed from repeated laundering.

After the series of launderings, the acetate damasks of Group XI were lustrous rather than shiny. The corners and other thick places seemed to be fused and showed some evidence of wear. Some change of color and fading occurred in 102 and 103. The selvages were noticeably shrunken. The hems pulled out in places; the hand hems slipped the most.

CONCLUSIONS

Manufacturer's labels did not appear frequently on the table linens purchased in 1945. Statements where they existed proved to be of little informative value to the consumer. A greater number and more elaborate labels but of little more informative value were attached to the acetate damasks purchased in 1943; promotion rather than distribution of merchandise information seemed to be the ultimate objective. In most instances the only information, the cut dimensions of the merchandise, was provided on price tickets attached by the retailer. With one exception, there did not appear to be any tendency to conserve inadequate supplies of civilian textiles through skimping measurements.

A comparison of the original specifications of all materials in the study with the semi-standardized construction practices of the industry indicated that the table linens available in 1945, in nearly all instances, were of medium quality or less. The numerous weaving imperfections occurring in the cotton damasks reflected the wartime lowering of standards of inspection. Prior to that time had such merchandise reached the retail market, it would have been sold as "irregular." The faulty construction may have accounted for the comparatively very low price.

The average weight per square yard of all groups upon original tests were not sufficiently dispersed to seemingly account for the variability in the results of other laboratory tests. The gain in weight after laundry of all fabrics except the linen damasks was proportional to the loss in area. The nominal loss of area by the linens was offset by loss of fiber during laundry.

When the structure of warp and filling yarns of the same fiber were compared, there was little difference to be found in twist or size. Yarns of the same fiber and similar construction performed quite differently on both original and laundered breaking strength and dimensional stability tests. Therefore, it is to be assumed that inherent differences in the quality of the fiber from which the yarns were spun had greater effect on strength and stability than the slight differences in construction.

While the structure of the viscose rayon filling yarns in Groups II and III was quite similar, their breaking strengths and direction of dimensional change were quite dissimilar. The original breaking strength of the viscose rayons of the higher price was by far superior.

The two groups of acetate rayon damasks were almost identical in yarn structure and yarn counts. The group which was purchased in 1948 was superior to those purchased in 1945 in respect to original breaking strength in pounds, relationship of wet to dry strength, dimensional constancy throughout laundry as well as minimum area change. The better performance is attributed to the improved manufacturing techniques developed during the elapse of three years. Rather unexplainable is the fact that the acetate rayons of Group I increased in warp and filling strength after laundry while those in Group XI did not. The shrinkage of the acetates purchased in 1945 was not excessive. It is doubtful that the increased price of the later purchases represents sufficient improvement to justify the entire additional cost. The increased price may be accounted for by increased material and labor costs and the removal of price controls which started an inflationary spiral in prices of textiles in short supply.

The appearance of the acetate damasks after repeated laundering was not too attractive as they had lost body and appeared flimsy and distorted when placed on a flat surface. The tendency for hems to pull out during laundry in all damasks containing rayon because of yarn slippage is a limiting service factor.

In the three groups of damasks having cotton yarns in the warp direction, the yarns were very nearly of a size, but there was a considerable spread in the yarn counts per inch and in the breaking strengths. Those fabrics having the higher yarn counts in the warp had breaking strengths proportionally higher. The filling counts, irrespective of the fiber in this direction, were proportional to the warp count. The amount of warp shrinkage that occurred was in direct relation to the warp and filling counts. The mercerized cotton yarns surpassed the unmercerized in all performance tests: initial and final breaking strength, dimensional stability, colorfastness to light and laundry, and the maintenance of a good appearance.

Despite the loss in breaking strength and weight per square yard after laundry, the linen damasks still had a higher breaking strength and better dimensional stability than the cotton damasks. When the actual appearance of the fabrics is considered, the linens were more attractive and might be expected to give satisfactory service. Where appearance is a consideration, the cost of the linen damasks was not unreasonable. Their price was only forty-seven cents more per square yard than the cotton and viscose rayon cloths of Group II which performed poorly and were unattractive in appearance before laundry and became even more so after. The cotton and viscose fabrics in Group III

from an appearance standpoint before and after laundry were equally as attractive as the linens but were considerably higher in price.

On a cost-performance basis the all-cotton damasks would be expected to give the better service if the original dimensions were sufficiently generous to compensate for an excessive shrinkage in laundry. While the warp strengths of the acetate damasks were somewhat higher both before and after laundry than those of the cotton damasks, the filling strengths of the acetates were considerably lower. As the cottons had a better balance in strength, they could be expected to give better total serviceability.

From the results of breaking strength tests performed after the series of fifty launderings, it was shown that rayon fibers do not suffer as severe losses in strength as do the natural fibers, cotton and linen. Further the acetate rayon yarns used in the warp direction had better dimensional stability than did cotton and somewhat better stability than linen. The delustered yarns used in the filling direction of the acetate damasks had considerably poorer breaking strengths than the bright yarns. The viscose yarns had higher breaking strengths than the acetates, but lost proportionally more of their strength when tested wet. Results of tests conducted on the original purchases of 1945 indicated a need for the manufacture of synthetic fibers with predictable direction of dimensional change and the elimination of fluctuations in performance that occur throughout a series of launderings. For all rayons there was need to improve their wet strengths in relation to the dry. When wet breaking strengths are considered, only the cottons and linens gave satisfactory performance.

The elongation performance of fabrics after laundry did not follow original elongation results and the tendency to increase in elongation with a loss of strength.

There was no positive association of price to all construction features and all performance factors. The intervention, however, of the many variables of construction, fiber content, individual differences in performance by various fibers, and the initial differences in price of fibers must be taken into consideration. The one constant factor of the study, the damask construction, in itself is the most expensive of weaves.

Unfortunately in some respects, the fabrics studied were not entirely typical of those usually found on the market in normal times. Had a wider range in quality been available, undoubtedly the better performance of those of excellent construction would have modified the conclusions drawn from this study.

Observed results of the effects of laundry upon table linens in this study suggest further studies. The possibility of extending the laundry series presents itself. It might be expected that significant differences in the loss of strength by various fibers would be obtained and that the rayons would have a shorter life.

In actual use laundry and ironing are but two of the ramifications of the wear complexity. The abrasion that occurs along edges of tables and on the surface of the cloth might contribute considerably to the degradation of tablecloths. When the abrasion testing for this study has been completed and evaluated, it might be expected that the rayon fabrics would show a poor performance. While laboratory instruments and methods of abrasion testing have not at this time been deemed

entirely reliable in predicting wear, some comparative results would probably be obtained which would be suggestive of abrasion resistance by the different types of table linens.

In addition to abrasion, soil which occurs in use and the harsher laundry procedures required to remove it would accelerate wear. Some methods of removing stains would also be expected to cause deterioration of the fibers. Thus the value of a wear study is indicated. The excessive cost and time required to conduct wear studies are limiting factors in their widespread use. While laboratory studies cannot duplicate all conditions of actual use, they are of value in predicting comparative tendencies in performance of various fibers. In most instances the laboratory study errs in not being severe enough to reproduce results identical to those of wear.

The addition of the one group of acetate rayons in 1948 significantly pointed out quality improvement at the mill level and the importance of continuous applied research studies in the field to keep pace with advancements. Only as applied research is continued will it be possible to transform the scientific findings into the criteria whereby consumers can more intelligently judge purchases in a market of ever changing textile materials.

The development of new fibers, finishes, and construction features of yarn and weave were stepped up considerably during the war years at the instigation of government requirements for highly specialized textiles. The results of these technological advances are now being put into use in consumer goods. The war sponsored concentration of effort upon textile improvement has become the impetus for further exhaustive research

and development in the field of consumer materials. Hence the necessity for ever continuing research to keep abreast of now unforeseen radical changes becomes imperative. Many new products already are to be seen in the field of table linens. Unsupported plastics have been introduced. Plastic finishes on standardized fabrics reduce stain and soil retention which in turn may materially affect durability. The possibility of satisfactory disposable table coverings of non-woven types may likewise be a trend to watch. The advent of nylon and perhaps some yet undiscovered new fiber to the table linen trade are not too far removed possibilities. The consumer question, which table covering shall be purchased to best serve its intended end use, must be answered in the textile research laboratory.

SUMMARY

The six groups of damask table linens discussed in this thesis were a part of a larger study of table fabrics of various fiber contents and constructions conducted at Michigan State College in an effort to determine the relationship between price and specifications in the original fabrics and the relation of cost to performance after a series of fifty launderings. Furthermore, it was hoped to determine whether or not any obvious decrease in quality or performance occurred in wartime produced table linens as a result of the scarcity of civilian textiles in 1945.

The table linens were purchased from department stores in Lansing and Detroit at various times dependent upon their availability. Limited production imposed restrictions on the procurement of identical fabrics, quality ranges, and adequate quantities.

The original dimensions of the tablecloths and napkins were taken to compute the cost per square yard. Physical tests before laundry included weight per square yard, yarn and weave analysis, and dry and wet breaking strengths for the determination of specifications of the original fabrics. The fiber content was also verified. The fabrics were subjected to a series of fifty launderings and subsequent ironings under controlled procedures duplicating acceptable home procedures. Measurements for dimensional change were taken after each of the first five washings and again after the tenth, fifteenth, twentieth, twenty-fifth, thirtieth, fortieth, and fiftieth laundry. Yarn counts were

taken after the first, fifth, tenth, twentieth, and fiftieth laundry. After the completion of the fifty launderings, the fabrics were tested for breaking strength and weight per square yard. The effects of laundry were subjectively evaluated by two persons. Change in appearance, loss of color, and deterioration of hems were noted. The total of post-laundry tests became the basis for the determination of performance characteristics of the various types of damasks and for making relative comparisons.

There was little difference to be found in the yarn structures when fibers of the same kind were used. Differences in performance could not be attributed to variations in yarn construction but rather to differences in the inherent quality of the fiber from which the yarns were spun.

The rayons had adequate breaking strengths when tested dry but had considerably lower strengths when wet than either the cottons or linens. Percentage loss of strength after laundry was not so great for either the acetate or viscose rayons as for the cottons and linens. They were, therefore, assumed to be affected less by the action of laundry.

Losses or gains in dimension also were not as great for rayon yarns as for cotton and linen yarns, but the rayons showed more tendency to shrink and stretch throughout laundry. The man-made fibers, however, reached a point of relaxation before the natural fibers and had less tendency to shrink progressively through the series of launderings. When the damasks having cotton warp yarns were compared, the one group having mercerized yarns proved superior to those having unmercerized yarns on all performance tests.

There was no marked relationship between price and quality of construction in the original table linens, nor was there any great association between cost and performance after laundry. The variability of individual characteristics and differences in initial cost of the various fibers seemed to account for the fact that closer relationships did not exist.

From the results of laboratory analyses before and after laundry, it would be expected that the rayon fabrics would give more satisfactory service with respect to a lower shrinkage and less loss of strength from laundry. The cottons and linens because of their better wet strengths would not suffer so greatly from handling during laundry. On a strictly price basis, the cotton damasks could be expected to give better total service if they were of a sufficient original size to allow for an appreciable shrinkage.

The improvement observed in the acetate rayons purchased three years after the outset of the study indicated the need for continuous applied research to keep abreast of improvements and new developments at the mill level.

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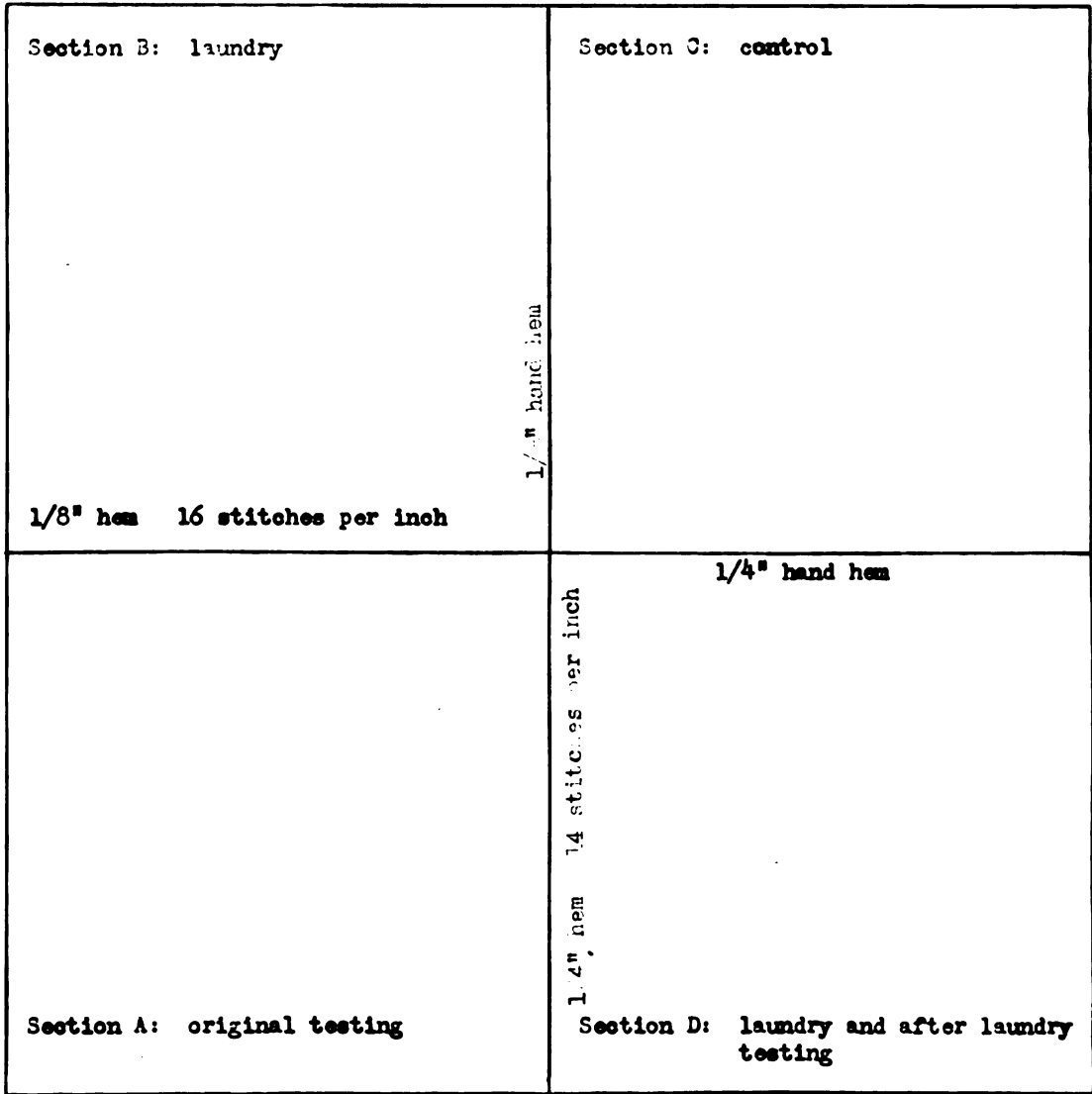
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APPENDIX

Plate 11

CUTTING CHART FOR

SECTIONING TABLECLOTHS



54" x 54"

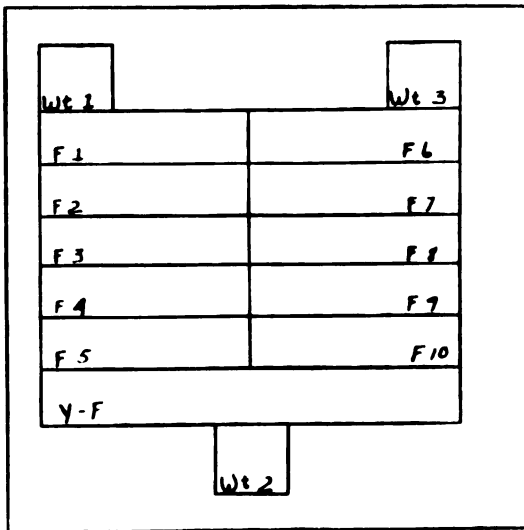
scale: $1/8'' = 1'$

Plate 13

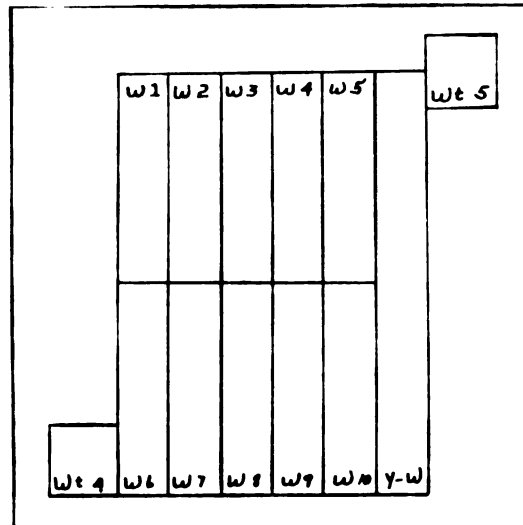
CUTTING CHART FOR TESTING

NAPKINS "a" and "b", "c" and "d"

Napkins a and c



Napkins b and d

scale: $3/8" = 1"$

Napkins a and b: original testing
 Napkins c and d: laundry and after laundry testing
 Napkins e and f: controls

Explanation:

F 1-10: filling breaking strength
 W 1-10: warp breaking strength
 Wt 1-5: weight per square yard
 Y-F: filling yarn number
 Y-W: warp yarn number

Chart 2

PURCHASE INFORMATION ABOUT TABLECLOTHS AND NAPPKINS

Group and Code Numbers	Fiber Content	Tablecloth Size in Inches	Number of Nappkins	Napkin Size in Inches	Color	Date of Purchase	Source of Purchase	Price	Trade Name
Group I									
T1ard	acetate	54 x 84	6	15 x 15	white	8/45	Petrolit	\$10.00	Celo-Sheen
T2ard	"	54 x 70	"	15 x 15	"	8/45	"	12.00	"
T3ard	"	65 x 85	"	20 x 20	"	6/45	"	10.95	"
Group XI									
T101ard	acetate	70 x 70	6	22 x 22	white	4/49	Leaning	\$13.95	Celo-Sheen
T102ard	"	70 x 70	"	22 x 22	cream	4/43	"	17.95	"
T103ard	"	70 x 70	"	22 x 22	peach	4/43	"	13.95	"
Group II									
T10r/cd	cotton	50 x 70	4	14 x 15	white	6/45	Petrolit	\$ 7.50	
T11r/cd		51 x 71	6	14 x 15	"	6/45	"	9.50	
T12r/cd	and	51 x 71	"	14 x 15	"	6/45	"	9.50	
T13r/cd		51 x 71	"	14 x 15	"	6/45	"	9.50	
T14r/cd	viscose	51 x 71	"	14 x 15	peach	6/45	"	9.50	
Group III									
T15r/cd	cotton	51 x 71	6	15 x 15 1/2	blue	6/45	Petrolit	\$13.00	Erindale
T16r/cd		51 x 71	"	15 x 15 1/2	"	6/45	"	19.00	"
T17r/cd	and	54 x 84	"	18 x 18	"	8/45	"	17.50	Varlex
T18r/cd	viscose	54 x 84	"	not given	white	8/45	"	17.95	none

Chart 2 Cont'd.

Group and Code Numbers	Fiber Content	Tablecloth Size in Inches	Number of Napkins	Napkin Size in Inches	Color	Date of Purchase	Source of Purchase	Price	Trade Name
Group IV									
T ₂₀ ED	cotton	54 x 54	0		white	5/45	Lansing	\$ 1.65	
T ₂₁ ED	"	54 x 54	"		"	5/45	"	1.65	
T ₂₂ ED	"	54 x 54	"		"	5/45	"	1.65	
T ₂₃ ED	"	54 x 54	"		"	5/45	"	1.65	
Group V									
T ₃₀ ID	linen	70 x 70	0		white	6/45	Petrolit	\$15.50	
T ₃₁ ID	"	70 x 70	"		"	6/45	"	12.50	
T ₃₂ ID	"	70 x 70	"		"	6/45	"	12.50	
T ₃₃ ID	"	70 x 70	"		"	6/45	"	10.50	
N ₃₀ ID	"		6	22 x 22	"	6/45	"	16.95/6oz.	
N ₃₁ ID	"		"	22 x 22	"	6/45	"	16.95/6oz.	

Chart 3

AN ANALYSIS OF COST IN RELATION TO ORIGINAL PROPERTIES

Group	Fiber Content	Cost per Square Yard	Weight per Square Yard	Yarn Count Warp	Filling	Dry Breaking Strength Warp	Filling
I	acetate	\$2.51 (5) ^a	5.4067 (5)	95 (2)	91 (1)	68.4 (5)	76.6 (6)
XI	acetate	4.56 (2)	5.5874 (1)	94 (3)	90 (2)	70.8 (3)	59.6 (5)
II	cotton-viscose	3.11 (4)	4.6516 (6)	86 (4)	58 (6)	71.2 (4)	43.6 (4)
III	cotton-viscose	5.18 (1)	5.4134 (2)	96 (1)	89 (3)	132.1 (1)	77.6 (4)
IV	cotton	.71 (3)	5.1339 (5)	74 (5)	63 (5)	60.8 (6)	64.4 (7)
V	linen	3.53 (3)	5.3396 (4)	72 (6)	84 (4)	92.2 (2)	30.4 (1)

a. numbers in parentheses refer to the rank of the item, ranked from highest to lowest

Chart 4

COT IN RELATION TO PRICE/PAISE AFTER FIFTY LAUNCHINGS

Group	Fiber Content	Cost per Square Yard	Dimensional Change Warp	Dimensional Change Filling	Dry Breaking Strength Index Warp %	Dry Breaking Strength Index Filling %	Weight per Square Yard % Change
I	acetate	42.81 (5) ^a	-2.24 (2)	-2.08 (4)	+5.50 (1)	+3.75 (1)	+7.23 (2)
XI	acetate	4.53 (2)	- .94 (1)	.00 (1)	-27.78 (2)	-30.68 (2)	+ .79 (1)
II	cotton-viscose	5.11 (4)	-3.82 (5)	+2.75 (5)	-30.03 (5)	-3.52 (2)	+15.29 (2)
III	cotton-viscose	4.13 (1)	-3.88 (4)	-3.32 (6)	-33.27 (4)	-1.15 (2)	+11.73 (4)
IV	cotton	.71 (3)	-7.27 (6)	+ .03 (2)	-20.85 (3)	-13.53 (4)	+10.10 (3)
V	linen	5.13 (1)	-2.50 (3)	- .57 (3)	-32.10 (6)	-33.42 (6)	-4.54 (6)

a. numbers in parentheses refer to the rank of the item, ranked from highest to lowest

Table 11
ANALYSIS OF WARP AND FILLING YARNS
ORIGINAL TABLETS AND NAPKINS

Group	Fiber Content	WARP			FILLING					
		Ply	Twist Singles	Yarn Number	Denier	Filament Count	Twist Singles	Yarn Number	Denier	Filament Count
I	acetate		6.5Z ^a		276 ^a	73 ^a	3.7Z ^a		200 ^a	51 ^a
XI	acetate		2.4S ^b		278 ^a	80 ^a	2.2S ^b		197 ^a	52 ^a
II	cotton- viscose	17Z ^c	16 S ^c	20 ^c			3.8Z ^c		204 ^c	55 ^c
III	cotton- viscose	15Z ^d	10 S ^d	21 ^d			3.2Z ^d		150 ^d	54 ^d
IV	cotton		12 S ^d	22 ^a			15 S ^d	15 ^a		
V	linen		8 S ^d	50 ^a			19 S ^d	37 ^a		

d. average of 40 determinations

e. average of 20 determinations

a. average of 20 determinations

b. average of 60 determinations

c. average of 50 determinations

Table 12

WARP MECHANICAL CHANGE IN PER CENT

Group	Fiber Content	1	2	3	4	5	10	15	20	25	30	40	50
I ^a	acetate	-1.20	-1.90	-1.51	-1.46	-1.56	-1.68	-2.14	-1.19	-1.40	-1.77	-1.93	-2.24
XI ^a	acetate	- .88	-1.10	-1.60	-1.20	-1.14	-1.41	-1.86	-1.16	-1.91	-1.36	- .84	- .94
II ^b	cotton-viscose	-4.53	-5.10	-5.40	-6.16	-6.06	-6.76	-7.81	-7.91	-8.00	-8.31	-8.93	-2.82
III ^c	cotton-viscose	-2.11	- .87	-2.00	-2.58	-2.90	-3.09	-3.60	-2.19	-2.70	-2.24	-2.75	-2.88
IV ^d	cotton	-3.97	-4.10	-5.96	-5.36	-5.63	-6.13	-6.97	-2.13	-7.70	-7.49	-7.31	-7.97
V ^a	linen	- .69	- .75	-1.06	-1.15	-1.29	-1.94	- .31	- .1	-2.36	-5.70	-5.61	-2.50

a. average of 36 determinations after each laundry

b. average of 60 determinations after each laundry

c. average of 48 determinations after each laundry

d. average of 24 determinations after each laundry

Table 13

TWILLING DIMENSIONAL CHANGE IN PER CENT

Group	Fiber Content	Number of Launderings											
		1	2	3	4	5	10	15	20	25	30	40	50
I ^a	acetate	-2.14	-2.50	-2.76	-2.71	-2.61	-2.50	-2.32	-2.14	-1.71	-1.14	-1.23	-1.08
XI ^a	acetate	-2.09	-2.14	-1.04	-2.14	-1.93	-1.72	-1.56	-1.35	-1.20	-1.20	-	0.00
II ^b	cotton-viscose	+1.44	+1.24	+1.66	+1.82	+1.91	+2.19	+2.00	+2.32	+1.75	+1.78	+2.47	+2.75
III ^f	cotton-viscose	-1.92	-1.42	-3.30	-0.82	-2.20	-3.16	-3.44	-1.13	-3.50	-1.73	-3.44	-2.39
IV ^d	cotton	+ .91	+ .09	+1.04	+ .39	+ .09	+ .32	+ .17	+ .2	- .04	+ .09	- .26	+ .29
V ^a	linen	- .53	- .37	- .58	- .55	- .52	- .66	- .66	- .54	- .57	- .63	- .69	- .57

a. average of 36 determinations after each laundry

b. average of 60 determinations after each laundry

c. average of 43 determinations after each laundry

d. average of 24 determinations after each laundry

Table 14

AREA CHANGE IN PER CENT

Group	Fiber Content	Number of Launderings											
		1	2	3	4	5	10	15	20	25	30	40	50
I ^a	acetate	-3.81	-3.66	-4.83	-4.68	-4.08	-4.82	-4.93	-4.47	-5.34	-4.02	-4.02	-4.42
XI ^a	acetate	-2.94	-3.11	-3.20	-3.30	-3.10	-3.10	-2.90	-3.58	-3.69	-4.54	-1.08	- .92
II ^b	cotton- viscose	-3.04	-3.44	-4.00	-4.52	-4.42	-4.71	-5.97	-5.68	-7.42	-7.40	-8.73	-6.32
III ^c	cotton- viscose	-3.93	-4.63	-5.92	-5.52	-5.62	-6.03	-6.13	-3.4	-6.80	-5.92	-7.05	-7.05
IV ^d	cotton	-3.02	-3.42	-3.93	-4.96	-5.54	-6.32	-6.30	-7.7	-7.74	-7.40	-8.46	-7.82
V ^a	linen	- .47	- .56	-1.04	-1.16	-1.53	-1.92	-1.30	-1.45	-3.91	-2.74	-3.12	-2.77

a. average of 12 determinations after each laundry

b. average of 20 determinations after each laundry

c. average of 16 determinations after each laundry

d. average of 8 determinations after each laundry

Table 15
COMPARISON OF YARN COUNTS
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	WARP			FILLING		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^a	acetate	95	98	+3.16	91	92	+ 1.10
XI ^a	acetate	94	94	.00	90	92	+ 2.20
II ^b	cotton- viscose	86	83	-3.49	58	63	+ 8.62
III ^c	cotton- viscose	96	98	+2.08	89	92	+ 3.37
IV ^d	cotton	74	74	.00	63	70	+11.10
V ^e	linen	72	72	.00	84	86	+ 2.38

* difference between original and laundered as a per cent of the original

a. average of 30 determinations on each test

b. average of 50 determinations on each test

c. average of 40 determinations on each test

d. average of 20 determinations on each test

Table 16

COMPARISON OF WEIGHTS PER SQUARE YARD IN OUNCES
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	Original	Laundered	Per Cent Change*
IA ^a	acetate	5.4067	5.8005	+ 7.28
XI ^a	acetate	5.5874	5.6314	+ .79
II ^b	cotton-viscose	4.6516	5.3627	+15.29
III ^c	cotton-viscose	5.4134	6.0486	+11.73
IV ^d	cotton	5.1339	5.6526	+10.10
V ^a	linen	5.3396	5.1447	- 4.54

* difference between original and laundered as a per cent of the original

a. average of 6 determinations on each test

b. average of 10 determinations on each test

c. average of 8 determinations on each test

d. average of 4 determination on each test

Table 17

COMPARISON OF WARP BREAKING STRENGTHS IN POUNDS
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^d	acetate	68.4	74.0	+ 8.19	36.6	43.0	+17.49
XI ^a	acetate	72.8	52.5	-27.88	43.5	33.3	-23.45
II ^b	cotton- viscose	71.2	47.4	-33.43	80.0	61.5	-23.12
III ^c	cotton- viscose	132.1	95.5	-27.71	124.0	95.8	-22.74
IV ^d	cotton	60.8	44.6	-26.64	63.1	46.4	-31.86
V ^a	linen	92.2	60.8	-34.06	126.6	72.8	-42.50

* difference between original and laundered as a per cent of the original

- a. average of 30 determinations on each test
- b. average of 50 determinations on each test
- c. average of 40 determinations on each test
- d. average of 20 determinations on each test

Table 18

COMPARISON OF FILLING BREAKING STRENGTHS IN POUNDS
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I	acetate	36.6	38.2	+ 4.37	19.6	24.5	+25.00
XI	acetate	39.6	28.0	-29.29	24.4	17.9	-26.64
II	cotton- viscose	48.6	50.9	+ 4.73	20.2	24.7	+22.28
III	cotton- viscose	77.6	79.0	+ 1.80	33.1	34.6	+ 4.53
IV	cotton	64.4	54.8	-14.91	67.7	60.9	-10.04
V	linen	90.4	60.5	-37.50	96.2	66.6	-30.77

* difference between original and laundered as a per cent of the original.

- a. average of 30 determinations on each test
- b. average of 50 determinations on each test
- c. average of 40 determinations on each test
- d. average of 20 determinations on each test

Table 19
COMPARISON OF WARP BREAKING STRENGTH INDICES
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^a	acetate	.72	.76	+ 5.50	.39	.44	+14.45
XI ^a	acetate	.77	.56	-27.78	.46	.35	-23.62
II ^a	cotton- viscose	.83	.57	-30.03	.93	.74	-20.08
III ^a	cotton- viscose	1.38	.97	-29.48	1.29	.98	-24.96
IV ^a	cotton	.82	.60	-23.83	.92	.63	-31.52
V ^a	linen	1.28	.84	-34.10	1.76	1.01	-45.46

* difference between original and laundered as a per cent of the original.

a. breaking strength indices computed from average yarn count and average breaking strength on each test

Table 20

COMPARISON OF FILLING BREAKING STRENGTH INDICES
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^a	acetate	.40	.42	+ 3.75	.22	.27	+26.14
XI ^a	acetate	.44	.30	-30.63	.27	.19	-27.73
II ^a	cotton- viscose	.84	.81	- 3.52	.35	.39	+ 9.83
III ^a	cotton- viscose	.87	.86	- 1.15	.37	.38	+ 1.46
IV ^a	cotton	1.02	.78	-23.53	1.07	.87	-18.69
V ^a	linen	1.08	.70	-33.42	1.16	.77	-32.74

* difference between original and laundered as a per cent of the original

a. breaking strength indices computed from average yarn count and average breaking strength on each test

Table 21

COMPARISON OF WARP ELONGATIONS IN PER CENT
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^a	acetate	32.1	36.1	+12.46	40.7	44.3	+ 8.84
XI ^a	acetate	33.0	20.0	-39.39	35.7	26.2	-26.61
II ^b	cotton- viscose	14.4	15.3	+ 6.25	15.0	16.5	+10.00
III ^c	cotton- viscose	24.2	19.2	-20.66	----	15.5	-----
IV ^d	cotton	13.0	14.2	+ 9.23	14.1	13.4	- 4.96
V ^a	linen	13.2	10.4	-21.21	----	6.1	-----

* difference between original and laundered as a per cent of the original

a. average of 30 determinations on each test

b. average of 50 determinations on each test

c. average of 40 determinations on each test

d. average of 20 determinations on each test

Table 22

COMPARISON OF FILLING ELONGATIONS IN PER CENT
ORIGINAL FABRICS AND AFTER FIFTY LAUNDERINGS

Group	Fiber Content	DRY			WET		
		Original	Laundered	Per Cent Change*	Original	Laundered	Per Cent Change*
I ^a	acetate	30.9	32.2	+ 4.21	46.2	47.5	+ 2.81
XI ^a	acetate	31.4	16.4	-47.77	45.2	26.8	-40.71
II ^b	cotton- viscose	31.9	30.4	- 4.70	29.5	26.9	- 8.81
III ^c	cotton- viscose	29.9	33.4	+11.70	23.2	26.1	- 7.45
IV ^d	cotton	20.6	17.5	-15.05	18.4	15.6	-15.22
V ^a	linen	17.4	10.9	-37.36	8.1	6.7	-17.23

* difference between original and laundered as a per cent of the original

a. average of 30 determinations on each test

b. average of 50 determinations on each test

c. average of 40 determinations on each test

d. average of 20 determinations on each test

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