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CONSUMER SATISFACTION WITH DURABLE-PRESS SHIRTS

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Contents

Summary

Little is known of consumer satisfaction with durable-press garments worn and laundered under typical circumstances. Because more than 90 percent of men's dress shirts are produced with a durable-press finish, they were selected as the experimental garment to determine level of consumer satisfaction during ordinary wear and the relationships between satisfaction and physical characteristics of the shirts.

Eight white dress shirts of varying polyester/cotton blends and 100-percent cotton were worn over a 2-year period by professional men. The shirts were rotated among the wearers during the inservice wear test, and records were kept of the hours worn. They were evaluated subjectively and objectively by the wearers and a trained panel during the wear test. They were evaluated for smoothness of fabric, general appearance, comfort and color change.

All durable-press shirts retained their smooth appearance throughout 72 wear/laundry cycles and required no ironing. However, increasing consumer dissatisfaction with the overall appearance of many shirts necessitated terminating the wear study. Many types of shirts became limp and worn looking.

Consumers rated the polyester/cotton blend shirts highest overall and preferred wearing them to wearing the 100-percent cotton shirts.

Results of physical tests on the shirt fabrics indicated that there was no single relationship between consumer satisfaction and the fabric properties of breaking strength, wrinkle recovery, air permeability and tear resistance. Wrinkle recovery and air permeability data seem to relate best to consumers' satisfaction with durable-press shirts.

CONSUMER SATISFACTION WITH DURABLE-PRESS SHIRTS

Mary Sue Stover*

THE COMPLEXITY OF TODAY'S CHANGING market and the major and continuing technological developments in the textile industry cause new problems for the consumer in the selection, use and care of clothing items.

The development of the durable-press concept was one of the most significant accomplishments of the textile industry; it affected all consumers. The ready acceptance of durable-press articles by the consumer demonstrates the desire for garments which retain a pressed appearance during wear and require laundering only for soil removal.

Resinous chemical finishes developed to impart easy-care characteristics were first applied to cotton in 1954. The necessity for using a high concentration of resins in order to obtain easy-care properties for cotton fabrics resulted in a fabric with greatly reduced tensile strength and abrasion resistance. Homemakers, anticipating freedom from ironing drudgery, readily accepted the wash-and-wear articles. Consumer dissatisfaction and complaints soon developed. The synthetic fibers industry introduced synthetics blended with cotton and waged an effective promotional campaign to capture much of the market previously held by all-cotton fabrics. In a 1969 survey, 13 percent of durable-press shirts owned by 35,000 families were of 100 percent cotton, 50 percent were of the 65 percent polyester/35 percent cotton blend and 9 percent were of the 50 percent polyester/50 percent cotton blend (1).

The cotton industry is striving to increase cotton's competitive position. Current research is aimed at promoting desirable features of cotton garments (comfort and ease in cleaning) and higher levels of durable-press with increased abrasion resistance (2, 3).

Rationale

An in-depth study of consumer reaction to durable-press garments is timely:

1. The durable-press concept is very popular, but little information is available concerning consumer satisfaction with durable-press garments during normal usage.
2. The great variety of blend ratios, including cotton and polyester and 100 percent cotton, offered the consumer in durable-press garments compounds the problems of selection, use and care. Comparative durable-press performance of the various fabric blends is of value to the consumer.
3. A study of the level of performance acceptable in men's dress shirts and the number of wear-launderings to reach an unacceptable level could provide information useful in evaluating durable-press fabrics in other garments.

Men's dress shirts are ideal garments for durable-press finishing. They are used universally, but difficult to iron. Men's dress shirts were chosen as the experimental garments for evaluation in this study because: 1) the consumer demands a high level of appearance for men's dress shirts, 2) they are worn and laundered frequently, 3) they are not likely to change in style over the length of a wear-test and 4) shirts are an excellent garment for evaluating durable-press retention and appearance.

The method of inservice wear testing for analyzing consumer satisfaction and durable-press performance of shirts was used in the study. Any dissatisfaction with durable-press garments, whether due to selection problems, to improper care or to unsatisfactory performance, leads to economic loss through disuse or discard. The ultimate quality test of any garment is the consumer's response; this can best be determined through inservice use. The effects of both home laundering and commercial laundering methods were investigated.

The standards of acceptance of durable-press dress shirts by consumers are indicated by results of the study.

Objectives

This study was designed to evaluate consumer acceptance of 100 percent cotton and polyester/cotton durable-press shirts and factors which determined satisfaction with the shirts. Specific research objectives of the study were:

1. To determine the overall satisfaction consumers derive from the use of selected white durable-press shirts.
2. To determine the relationship between selected physical characteristics of white durable-press shirts and satisfaction consumers derive from the use of these garments.
3. To compare the effects of commercial laundering and home laundering on durable-press shirts and on consumer satisfaction with the shirts.

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Procedures

Garments

The eight shirts selected for study were those with durable-press finish in 100 percent cotton and various blend ratios which were most readily available to the consumer at the start of the study. One nondurable-press cotton shirt (100-d) was also included. Shirts were selected to include varying polyester/cotton ratios and differing qualities of 100 percent cotton; therefore, the brands of the shirts selected were incidental to the availability of the desired blend ratios and quality of the cotton shirts. Each shirt was examined for fabric and construction flaws. Thread count, weight, air permeability, breaking strength, tear strength and wrinkle recovery measurements were determined (Table 1).

All shirts were essentially identical in design — solid white and having one or two pockets, short sleeves and a regular spread collar to be worn with a tie. All hang tags and attached labels were removed, and the shirts were coded with indelible ink for identification. The shirts were hung on hangers to remove fold wrinkles.

Wearers

The men participating in the wear study were chosen on the basis of the criteria: size shirt required by participant, husband's and wife's willingness to cooperate, permanency of residence and husband's occupation and accessibility to laboratory personnel. The eight men selected were on the faculty or staff of Texas A&M University where appearance and dress are important considerations. Since the wear study involved a rotation of the shirts, it was necessary that the participants wear the same size shirt.

Care of Shirts

The shirts were divided into two groups — home laundered and commercially laundered. Home-laundered shirts were laundered by laboratory personnel in a standard model, top-loading, agitator-type automatic washer with controls set on normal setting for a 12-minute cycle.[1] Temperature of the wash water averaged 120° F. The washers were operated with normal loads and normal water levels. When necessary, a prewash treatment was used. Collars were moistened and cleaned with a soft wet brush saturated with powdered detergent. Bleach and fabric conditioners were not used. Shirts were removed immediately after the final spin cycle, shaken to remove tangles, then placed in the tumble dryer set at "normal" cycle. The shirts were tumble-dried for 10 minutes with a 2-minute cool-down cycle. Shirts were removed, hung on hangers, then distributed to the wearers on the preplanned rotation plan. If the wearer, after evaluating the durable-press shirt, decided the shirt needed ironing to improve the appearance, this was done by the homemaker.

Commercially laundered shirts were picked up weekly by the laundry and were laundered by standard procedures. Shirts were then returned to the laboratory where they were distributed to the wearers following the described rotation plan. Effects of commercial laundering methods,

[1]Method of laundering was adapted from that specified in AATCC Test Method 124-1969, "Appearance of Durable-Press Fabrics After Repeated Home Launderings."

TABLE 1. DESCRIPTIVE ANALYSIS OF THE SHIRT FABRICS

Fiber content & shirt cost*	Yarn count (per inch) Warp	Filling	Thickness (inches)	Weight (oz/yd²)	Breaking strength (lb) Warp	Filling	Tear strength (gm) Warp	Filling	Air permeability (ft³/min/ft²)	Wrinkle recovery angle (degrees) Warp	Filling
100% cotton - a $3.98	152	72	.0100	4.001	21.7	19.2	800	800	37.2	145	142
100% cotton - b $3.98	144	68	.0100	4.275	19.4	19.4	1240	1340	29.0	148	144
100% cotton - c $4.50	152	64	.0101	4.012	21.4	14.7	800	780	43.2	150	150
100% cotton - d** $2.98	164	92	.0082	3.104	22.9	17.4	1340	1120	15.8	98	101
35% polyester/ 65% cotton $5.00	128	68	.0090	3.549	27.2	17.1	1200	1270	86.1	153	150
50% polyester/ 50% cotton $4.98	92	80	.0080	3.281	25.4	20.1	1080	820	107.6	150	147
65% polyester/ 35% cotton $6.00	135	76	.0080	3.117	29.4	19.7	1250	800	74.1	149	151
80% polyester/ 20% cotton $6.00	136	84	.0062	2.761	34.6	29.0	1300	1240	37.9	144	142

*All fabrics are plain weave. Retail cost, 1968.
**Non-durable press.

which involved much higher water temperatures, lower ratio of water to cloth and an alkaline treatment, were investigated.

Design of Wear-Trial Plan

Shirts were divided into two groups — home laundered and commercially laundered. The research design included three replications of each shirt. (Initially, random numbers were drawn to assign positions to wearers and numbers to shirts.) Each of the eight participants was randomly assigned a position. After the three shirts were worn in that position, the wearers moved to the next position and wore three more shirts and so forth. One wear-launder cycle was completed when each man had worn all shirts from each of the eight positions.

As men changed positions in the wear trial, the influence of an individual on the shirts was virtually eliminated. The unworn, unlaundered original shirt served as a basis for evaluation and comparison of the shirt's appearance. The Shirt Assignment Design is shown in Table 2.

Termination of Wear

To achieve the objectives of this study, it was necessary that the shirts remain in wear-service for their useful wear-life. Since the durable-press property of the shirts was a prime consideration in this study, the durable-press shirts were considered to be "worn out" when the homemaker found it necessary to press the shirts to achieve the desired wrinkle-free appearance. A list of reasons for withdrawing the shirts from further wear was developed before the study began. Because the commercially laundered shirts were ironed in the laundry plant, the first listed criterion does not apply to them. All other criteria apply both to commercially laundered and to home-laundered shirts. The criteria for withdrawal as a result of wear were:

1. Necessity for pressing or ironing of shirt to achieve a good appearance.
2. Accidental or other breaks, tearing or staining of shirt fabric which could not be adequately remedied for business wear.
3. Expressed dissatisfaction by wearers of the appearance of shirts due to factors influencing appearance: fraying, color change, pilling, loss of body and so forth.
4. Wear at collar or fold line or on collar tips.
5. Breaks and fraying of buttonholes or button pullout.
6. Unacceptable color change to gray or yellow.

Although presence of any of these conditions was sufficient reason for withdrawing a shirt from the study, if the damage was not especially noticeable and the wearer did not comment, the garment was left in service until damage became a general source of dissatisfaction. When consumer evaluation and opinions showed a general dissatisfaction with the majority of the shirts for dress wear, further wearing of all shirts ceased at the end of the next wear-laundry cycle, at which time the men had completed wear of the shirts in the eight positions. This insured that all shirts were laundered and worn the same number of times by all participants, thereby simplifying the comparison of data from the physical testing of shirt fabrics.

TABLE 2: SHIRT ASSIGNMENT DESIGN

Positions (wearers)	Shirt replications I Poly/cotton	II Poly/cotton	III Poly/cotton
A	0/100-a	80/20	0/100-b
B	80/20	65/35	50/50
C	65/35	0/100-b	35/65
D	0/100-b	50/50	0/100-c
E	50/50	35/65	0/100-d
F	35/65	0/100-c	0/100-a
G	0/100-c	0/100-d	80/20
H	0/100-d	0/100-a	65/35

Evaluation of Worn Garments

Home Laundered: The consumers subjectively rated the home-laundered shirt for the following characteristics (Appendix):

1. Amount of wrinkling or puckering in shirt body
2. Severity of wrinkling or puckering in collar, side seams, armseye, yoke and pocket
3. Color change
4. Comfort during wear
5. Signs of wear
6. Necessity for ironing

After each wear period the number of hours the shirt had been worn and whether the shirt had been worn for activities other than normal use were noted. After every four wear-launder cycles, a panel of three trained women evaluated the worn shirts by comparing their appearance to that of an original, unworn, unlaundered shirt. The same panel compared the fabric in center back of the shirt with three-dimensional, plastic, durable-press standards to rate the wrinkling of the shirt (4).[2] These readings were then compared to those assigned to the inservice wear participants.

Commercially laundered: Consumers did not evaluate the commercially laundered shirts for durable-press properties. Color change, signs of

[2]Methods of evaluation were adapted from the specifications in AATCC Test Method 124-1969, "Appearance of Durable Press Fabrics After Repeated Home Launderings."

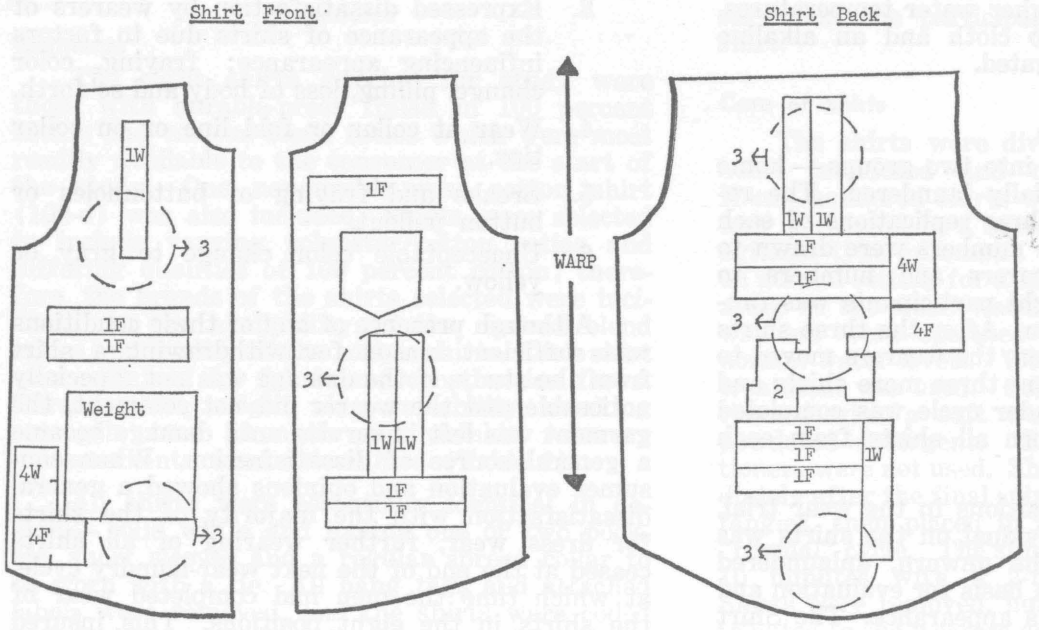

Figure 1.
Sampling diagrams:
1 = Breaking strength
2 = Wrinkle recovery
3 = Air permeability
4 = Tear test

wear and general appearance were noted by the wearers. Professional laboratory personnel evaluated each shirt after each laundering for signs of deterioration and general condition of the shirt.

Laboratory analysis of the shirt fabrics: At the conclusion of the wear study, effects of wear and laundering were determined for fabric properties of breaking strength, tear resistance, wrinkle recovery and air permeability. All tests were made in laboratories maintained under standard conditions of relative humidity and temperature according to the appropriate ASTM designation (5).

Breaking strength was determined by the ravel-strip method utilizing a Scott Model J Tensile Tester. Six warp and eight filling samples were tested from each shirt. Tear resistance was determined by the falling pendulum (Elmendorf) apparatus. Three warp and three filling specimens were torn from each shirt. Wrinkle recovery was determined by using the Monsanto Wrinkle Recovery Tester on six warp and six filling specimens.

Air permeability measurements were taken from six areas of each shirt with a Frazier air permeability machine. All readings were made with the face side of the fabric up. The location of test areas is shown in Figure 1.

Data Evaluation

Mean values were determined from consumer and panel evaluation and from physical testing. Due to the nature of the study and the amount of data not statistically comparable, comparisons were made and conclusions drawn on the basis of the mean values.

Results and Discussion

Wear History

The wear study began in March 1968 and terminated in January 1970. The shirts, therefore, were worn through two summer and two winter seasons — a total of 72 days. The average number of hours the shirts were worn daily and the average number of hours worn during the 72 wear-launder periods are given in Table 3. Wear time varied little within the group of shirts.

Fabric Appearance

All durable-press shirts were smooth and wrinkle free in their original unlaundered state as evaluated by the research staff. Consumer evaluation of the fabric smoothness was based on a five-point rating scale (Appendix) for the three replications.

The new unworn shirts were rated 5 in fabric appearance, indicating a smooth and virtually wrinkle-free garment. The excellent ratings can

TABLE 3. AVERAGE HOURS SHIRTS WORN PER WEAR PERIOD AND TOTAL STUDY

Shirt fiber content (%)		Average	Total (hr)
Polyester	Cotton	daily (hr)	72 wear periods
	100-a	11.1	796
	100-b	11.1	799
	100-c	11.0	795
	100-d	10.4	747
35	65	11.1	793
50	50	11.5	825
65	35	11.0	799
80	20	11.0	789

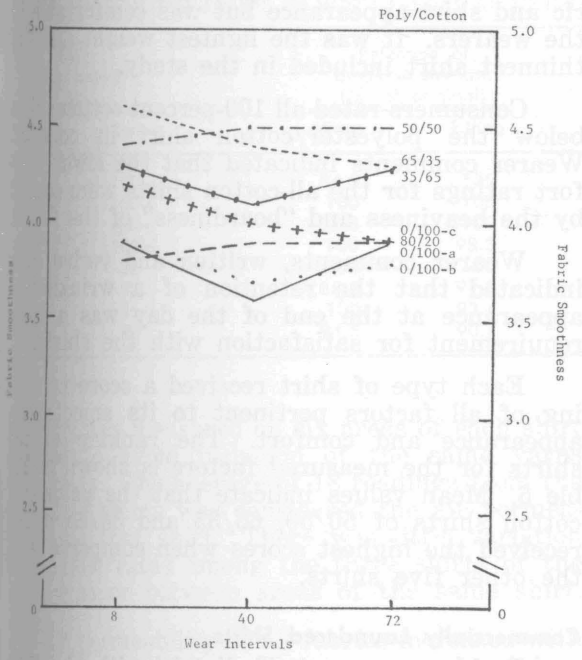

Figure 2. Consumer fabric appearance ratings at selected intervals.

be interpreted to mean absence of wrinkles and creases, little puckering of the seams and no distortion of the various parts.

The 24 separate ratings for the three like shirts during one wear-launder cycle were averaged to give a mean value for that shirt in each of the 9 cycles of the wear study.

All shirts remained relatively wrinkle free throughout the 72 wear-launderings. Consumers were well satisfied with the smooth appearance of the garments as they were taken from the dryer. None of the durable-press shirts was pressed by the consumers during the study.

The consumer evaluations showed that the greatest change in fabric appearance occurred in the first wear-launder cycle. The consumer ratings generally remained constant throughout the study showing little or no change from the first through the final wear-laundry (Figure 2).

The shirts were also objectively evaluated for fabric smoothness by a trained panel of three members using three-dimensional plastic replicas. Durable-press ratings of the standardized references ranged from 1 (severe wrinkles) to 5 (wrinkle-free). The panel was more critical in its evaluations of the worn shirts than were the consumers. As with the consumer ratings, the greatest decrease in evaluations occurred in the first wear-cycle, 1 through 8, with generally little change occurring from that point through 72 wear-launderings. Though the differences among shirt ratings were not great, some shirts consistently received higher ratings from both the consumer and the panel.

The three shirts rated highest after the first cycle continued to be rated high throughout the study by both the panel and the consumers. The three shirts which retained the most wrinkle-free finish included the blends of 65 percent polyester/35 percent cotton, 50 percent poyester/50 percent cotton, and 35 percent polyester/65 percent cotton (Table 4). The better quality and more expensive 100-percent cotton durable-press shirt (100-c) also performed well throughout the study. The 80-percent polyester/20-percent cotton blend shirt and the two lower cost 100-percent cotton shirts (100-a, 100-b) were rated somewhat lower throughout the study. The 100-percent pima cotton, nondurable-press shirt (100-d) was included in the study to evaluate the reaction of the consumer to a nondurable-press garment. Consumer dissatisfaction with the nondurable-press shirt was evident from the beginning of

TABLE 4. MEAN FABRIC APPEARANCE RATINGS AT SELECTED WEAR CYCLES

Shirt Fiber content (%)		Rating group					
		Consumer			Panel		
		Wear cycle		% Loss*	Wear cycle		% Loss*
Polyester	Cotton	1-8	65-72	from original	1-8	65-72	from original
	100-a	3.9	3.9	22	3.5	3.4	32
	100-b	3.8	3.8	24	3.4	3.2	36
	100-c	4.2	3.9	22	3.7	3.6	28
	100-d	2.9	3.3	34	**		
35	65	4.3	4.3	14	4.1	3.7	26
50	50	4.4	4.7	06	3.9	3.8	24
65	35	4.5	4.3	14	4.1	3.7	26
80	20	3.8	3.9	22	3.3	3.3	34

*Decrease calculated from original/unworn fabric smoothness ratings. All shirts received a 5 rating (smooth appearance, no wrinkles).
**Nondurable-press shirt—not evaluated by panel.

the wear study as indicated by low ratings on all satisfaction factors evaluated.

The level of wrinkle-free performance acceptable to the consumer as measured objectively by the panel appears to be a durable-press rating of 3+ when using the Monsanto three-dimensional plastic replicas. At this rating, the consumers were satisfied with the fabric smoothness of the durable-press shirts; they did not feel the need to press the shirts to achieve an acceptable appearance.

Shirt Appearance

The general appearance of all new shirts was quite favorable, and all were in good condition. Consumers used objective ratings on a five-point scale in evaluating factors contributing to shirt appearance. The panel compared the appearance of the worn shirts with an original, unworn shirt. Shirt appearance evaluations by the consumers and panel showed little change from the first cycle through the final cycle. However, increasing dissatisfaction with the shirt appearance of the 80-percent polyester/20-percent cotton blend and the two less expensive cotton shirts (100-a, 100-b), plus the extended length of the wear study, resulted in termination of the wear study after the eighth cycle (72 wear-launderings for all shirts).

Consumer complaints at this time were that the shirts had lost their crispness and appeared "washed out." Wear on the collar tips and the sleeves edges of the cotton shirts were mentioned. As with fabric appearance, the consumers rated the polyester/cotton blends of 50/50, 65/35 and the 35/65 highest. The panel, using a different rating scale, also rated these three shirts at the top throughout the study. Shirt appearance evaluations by both the consumers and the panel did not indicate the deteriorating appearance of the shirts. Both may have overrated the shirts toward the end of the study due to the length of time during which the shirts performed much above their expectations. Undoubtedly shirts were rated less critically at the end of the study than at the beginning. During the wear study, relatively few repairs were made on the shirts. These were of a minor nature and included replacing damaged or missing buttons, restitching pocket seams and occasionally removing stains or spots. The broken stitches on the pockets of most shirts were caused by the added strain of carrying either a clip pencil or a glass holder in the pocket.

Shirt Preference by Consumers

Comfort is a factor which affects a wearer's reaction to a garment. The comfort ratings by the consumers throughout the study showed that they generally preferred the same shirts which were higher ranked in both fabric appearance and general shirt appearance. The exception was the 80/20 blend shirt which ranked lower in fabric and shirt appearance but was comfortable to the wearers. It was the lightest weight and the thinnest shirt included in the study.

Consumers rated all 100-percent cotton shirts below the polyester/cotton shirt in comfort. Wearer comments indicated that the lower comfort ratings for the all-cotton shirts were caused by the heaviness and "boardiness" of the fabric.

Wearer comments, written and verbal, also indicated that the retention of a wrinkle-free appearance at the end of the day was a basic requirement for satisfaction with the shirts.

Each type of shirt received a score consisting of all factors pertinent to its smoothness, appearance and comfort. The ranking of the shirts for the measured factors is shown in Table 5. Mean values indicate that the polyester/cotton shirts of 50/50, 65/35 and 35/65 blends received the highest scores when compared with the other five shirts.

Commercially Laundered Shirts

Problems arose immediately with the shirt appearance of the commercially laundered garments. The poor appearance of many shirts due to ironed-in wrinkles, missing buttons and various stains resulted in their being returned to the laundry to be reprocessed often throughout the length of the wear study. Many shirts also became stiff and discolored due to the commercial laundering treatment. Extreme consumer dissatisfaction with the shirts resulted in a termination of this phase of the study at 30 wear-launderings.

Results of Physical Tests

Air Permeability

The extent to which air passes through fabrics is one of the properties which affects the comfort of clothing. The change in air flow also gives information on the change of the fabric itself due to wear or laundering.

The Frazier Air Permeability Instrument was used to measure rate of air flow in cubic feet per square foot of fabric per minute—($ft^3/min/ft^2$) — ASTM Designation D:737-46. Readings were obtained on the original unworn shirts and at the conclusion of the wear study.

TABLE 5. CONSUMER EVALUATIONS—RANKED IN PREFERENCE

Shirt Fiber content %		Fabric appear-	Shirt appear-		Overall
Polyester	Cotton	ance	ance	Comfort	rank
	100-a	7	6	7	6
	100-b	5	7	6	7
	100-c	4	4	5	4
	100-d	8	8	8	8
35	65	3	3	4	3
50	50	1	1	2	1
65	35	2	2	1	2
80	20	6	5	3	5

TABLE 6. PHYSICAL TEST RESULTS OF WORN FABRICS AT CONCLUSION OF WEAR STUDY (72 WEAR-LAUNDERINGS)

Shirt Fiber content %		Retention of breaking strength (% of original)		Retention of tear strength (% of original)		Air permeability (% increase from original)	Wrinkle recovery (% recovery)	
Polyester	Cotton	Warp	Filling	Warp	Filling		Warp	Filling
	100-a	84.3	100	67	76	35	75.6	71.1
	100-b	100	100	83	63	80	77.2	72.8
	100-c	93.5	100	79	83	60	78.3	79.4
	100-d	100	98.3	65	85	91	54.4	55.6
35	65	100	100	96	67	34	82.8	81.1
50	50	85.8	91.0	100	100	104	83.3	87.2
65	35	100	93.4	100	99	55	82.8	83.9
80	20	94.5	90.7	95	79	83	79.4	82.8

Air flow was measured on six areas of each shirt selected to avoid inclusion of the same yarns (Figure 1). The average of 18 readings from the three like shirts was considered the air permeability for that shirt. There was little variation in air flow rates among the three shirts of the same type or between areas of the same shirt.

Air permeability of all fabrics increased with wear and laundering. The consumers' opinions that the shirts had become limp and "washed out" were upheld by the increase in air permeability rates of the worn shirts. Increase of air permeability rates ranged from 34 to 104 percent (Table 6).

The original shirts with the lowest number of yarns per inch had substantially higher air permeability rates. These shirts, the 50/50, 65/35 and 35/65 blends, also had the highest rate of airflow after the conclusion of the wear study. They were rated more comfortable to wear than the less permeable cotton shirts.

The high polyester blend shirts, 80/20, had a much lower permeability rate than the other blend shirts, both before and after the wear study (Figure 3). The fabric, however, had the finest yarns and was the lightest weight and thinnest of all durable-press shirts in the study, which probably accounted for the high comfort rating by the consumers.

The durable-press cotton shirts (100-a, 100-b, 100-c) had much lower air permeability rates, before and after wear, than the blends (except for the 80/20 blend shirt) (Figure 3). These shirts were originally the heaviest weight and the thickest. All 100-percent cotton shirts were considered by all consumers to be less comfortable than the blends.

High air permeability rates and lightness of the fabric were the two factors which appeared to influence the comfort of the shirt most.

Breaking Strength

The breaking strength of the warp and filling was determined on both the original and the worn shirts. Six warp and eight filling specimens were taken from various parts of the shirt (Figure 1). The average of the 18 warp and the average of the 24 filling breaking strengths from three identical shirts in the wear study were considered the breaking strengths for that shirt. The variations between breaking strength results from the three like shirts were negligible.

As expected, overall strength of the original shirts increased with increasing polyester content. At the conclusion of the wear study, the polyester blend shirts were still superior to the 100-percent cotton durable-press shirts in strength.

The breaking strength of the original samples and the worn-laundered samples are compared in Figure 4. The average of 790 wear-hours and launderings of the shirts did not deteriorate the strength of the fabric as much as

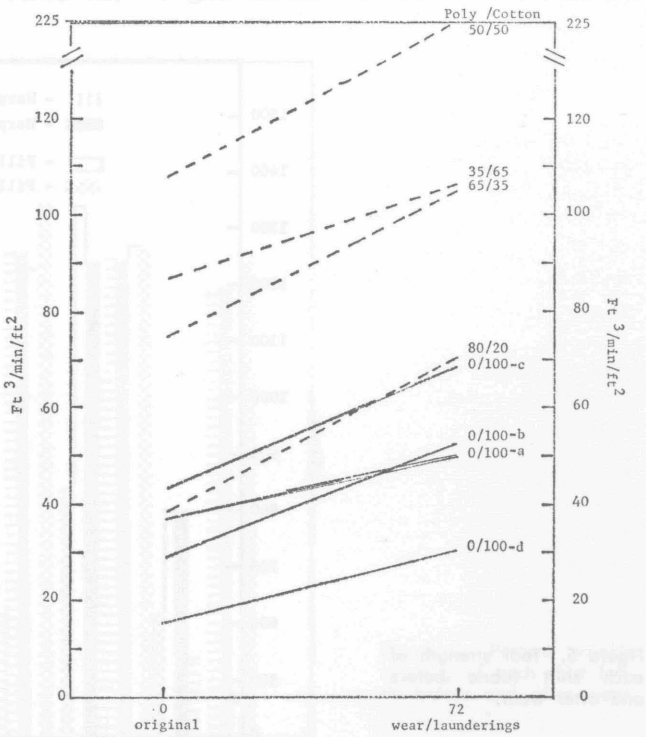

Figure 3. Air permeability rates of each shirt fabric before and after wear.

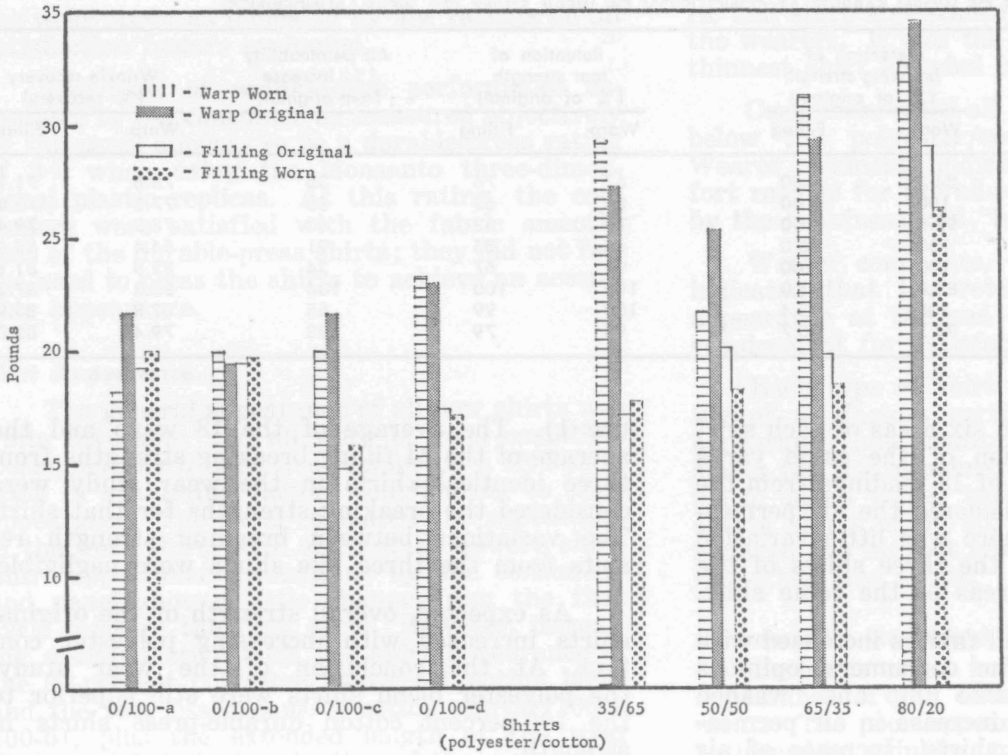

Figure 4. Breaking strength of each shirt fabric before and after wear.

was expected. The retention of original breaking strength ranged from 84.3 percent to 100 percent for the shirt fabrics (Table 6).

Tear Strength

Tear resistance was measured to evaluate the effect of wear and laundering on the shirt fabrics. By the Elmendorf tear test method, tears are started from a cut made in the fabric and are extended by a quick-dropping, deadweight pendulum. Such tears are similar to those developed from any sudden strain put on a fabric. Two warp and two filling tear test specimens were cut from each shirt. The averages of

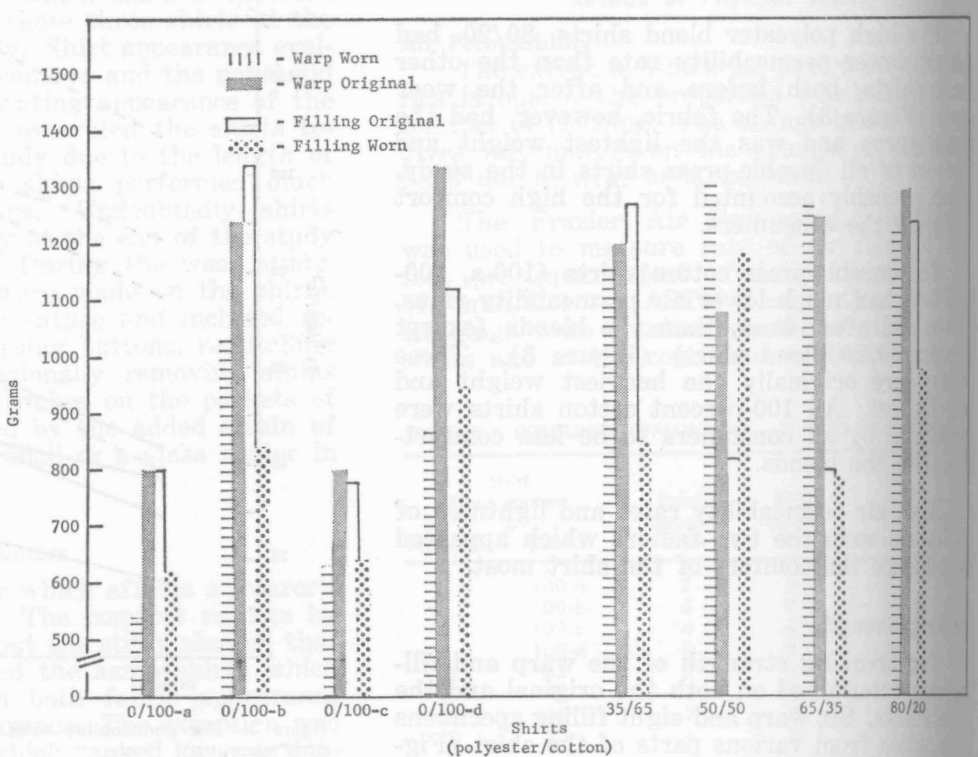

Figure 5. Tear strength of each shirt fabric before and after wear.

six warp and six filling tears were considered the tear strength for each type shirt. Variability in tearing strength was low for all like shirt fabrics.

Percent retention of original strength was greater for the polyester/cotton shirts than for the 100-percent cotton shirts. Little loss in tear resistance caused by wear and laundering was found in two of the study shirts (Figure 5). The 50/50 and 65/35 blend shirts showed no reduction in tearing strength either in warp or filling.

A decrease in fabric strength for the remaining shirts indicated that the factors of wear and laundry weakened the fabric. Breaking strength data did not indicate this loss of strength. There was no constant ratio of tearing strength to breaking strength for any of the eight shirt fabrics or for either direction of these fabrics.

Wrinkle Recovery

Freshness of appearance of white shirts is associated with spotless whiteness and freedom from wrinkles. The latter, without the necessity of frequent pressing, is largely dependent upon the ability of a fabric to resist, or to recover, from creasing.

The crease or wrinkle recovery of the shirt fabrics was measured with the Monsanto Wrinkle Recovery Tester. The extent to which the fabric recovered from the crease when placed in the tester disk was measured in degrees. The crease recovery was calculated as follows:

$$\text{Crease recovery } \% = \frac{\text{scale reading } (°)}{180°} \times 100$$

Six warp and six filling wrinkle recovery samples were cut from each shirt. The averages of 18 warp and 18 filling readings from the three like shirts were considered the wrinkle recovery for that shirt.

The average percent wrinkle recovery of all original unworn-unlaundered durable-press shirt fabrics was approximately 80 — ranging from 79 percent to 85 percent — in both warp and filling directions (Figure 6). Wrinkle recovery angles of the original shirt ranged from 142 to 153 degrees. At the conclusion of the wear study (72 wear-launderings), wrinkle recovery (warp plus filling) of the 100-percent cotton durable-press shirts had decreased 5 to 8 percent. This small loss in wrinkle recovery ability indicated that the durable-press properties of the fabric sustained little deterioration from the wear and laundering of the shirts.

The polyester/cotton blend shirts showed little or no decrease in percent wrinkle recovery when compared to their original like shirts (Figure 6).

Ranking of the worn shirts for their wrinkle recovery factors conformed roughly to the panel ratings for fabric appearance as measured against the three-dimensional plastic replicas. The 50/50 blend shirt was rated highest after wear by the panel. This shirt also was rated highest by the subjective opinions of the consumers at the conclusion of the study. The 65/35 and 35/65 blends were rated as numbers 2 and 3 respectively, by both the panel and the consumers. The same rating occurred when shirts were measured by the wrinkle recovery tester.

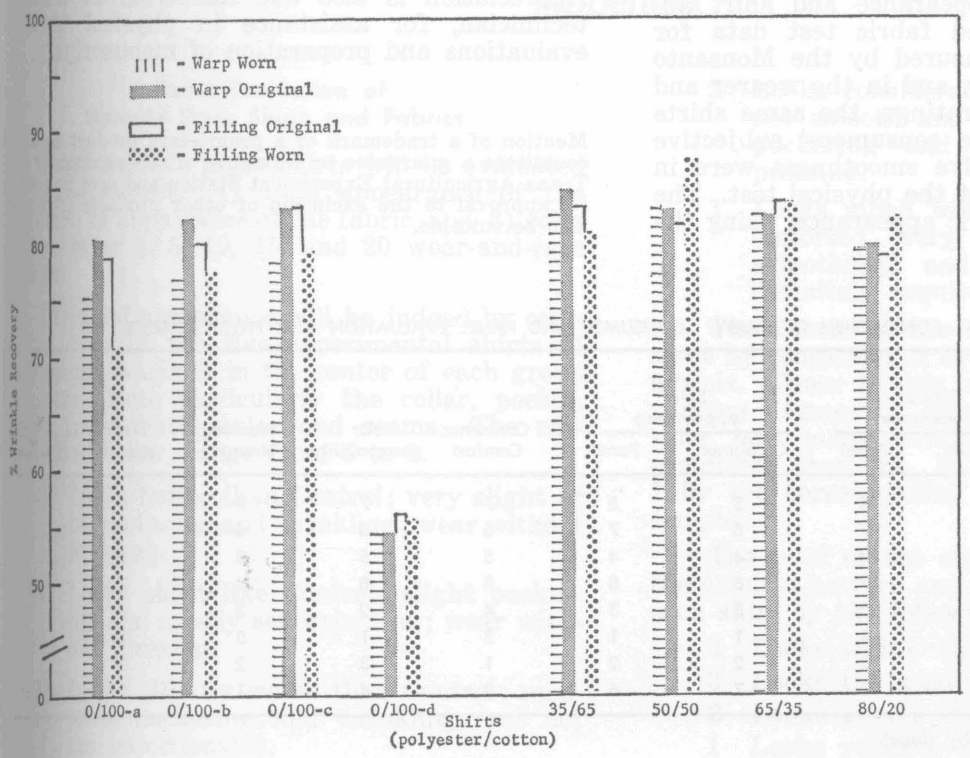

Figure 6. Percent wrinkle recovery of each shirt fabric before and after wear.

The fabric appearance of the all durable-press garments was at an acceptable level to the consumer at the conclusion of the wear study. This was shown by the fact that none of the shirts was pressed or ironed during the study. Therefore, percent wrinkle recovery averages of 75 or more appeared to be the level at which the consumer was satisfied with a durable-press dress shirt without ironing.

Conclusions

The durable-press properties of the shirts retained a high level of smoothness throughout the wear study. Neither the durable-press 100-percent cotton nor any polyester/cotton blend shirt required ironing or pressing during the study. This indicated that the durable-press finish had not deteriorated and that the fabric smoothness was at a level satisfactory to the consumers. However, increasing dissatisfaction with the general appearance of many of the shirts necessitated terminating the study. This dissatisfaction was due to the feeling that the shirts had become "limp" and "washed out".

Of the measurements made, air permeability rates seemed to relate best to consumers dissatisfaction with the durable-press shirts. Air permeability rates of all shirt fabrics increased with wear and laundering, giving evidence of a breakdown of yarns and fabrics and resulting in the loss of crispness and "washed out" look.

Wearer and panel evaluations of the shirts and the data obtained from the physical tests in the fabrics of these shirts were similar (Table 7). Both groups ranked the 50/50, 65/35 and 35/65 blend shirts 1, 2, 3, respectively, on two satisfaction factors — fabric appearance and shirt appearance. In the ranked fabric test data for wrinkle recovery as measured by the Monsanto Wrinkle Recovery Tester, and in the wearer and the panel rankings and ratings, the same shirts were rated 1, 2, 3. The consumers' subjective evaluations of comparative smoothness were in agreement with results of the physical test. The panel ratings of the fabric appearance, using the three-dimensional plastic replicas for evaluating wrinkling, were ranked in the same order, though the panel seemed to be more critical of the worn shirts than were the consumers.

Both original and worn breaking and tear strengths of the polyester/cotton shirts were higher than those of the durable-press cotton shirts. The worn shirt fabrics showed little or no loss of strength as measured by a 1-inch raveled strip. However, tear strength of the worn shirts gave some indication of deterioration of the fabrics.

Wearer preferences and opinions of the shirts worn are felt to be reliable. Wearers had no particular reason for favoring any shirt since they did not own them and had no choice in selection. Overall, consumer comments and evaluations indicated a preference for wearing the polyester/cotton blend shirts, 50/50, 65/35, 35/65. The more expensive and better quality all-cotton, durable-press shirt, 100-c, was rated next best by the consumers for good fabric and shirt appearance; however, they preferred to wear the lighter weight blend shirt.

Results indicated that there is no single relationship between consumer satisfaction and physical test data. Wrinkle recovery and air permeability data seem to relate best to consumer satisfaction with the shirts in this study.

Acknowledgments

The author is grateful to those who participated in the wear study for their faithful wearing and evaluation of the shirts over a 2-year period. Appreciation is also due Katherine T. Benson, technician, for assistance in physical testing, evaluations and preparation of manuscript.

TABLE 7. RANKING OF SHIRTS AT CONCLUSION OF STUDY: CONSUMER AND PANEL EVALUATION AND PHYSICAL TESTS

Shirt Fiber content %		Fabric appearance		Shirt appearance		Consumer	Air	Breaking	Tear	Wrinkle
Polyester	Cotton	Consumer	Panel	Consumer	Panel	Comfort	permeability	strength	strength	recovery
	100-a	5	5	5	5	7	7	7	8	7
	100-b	6	7	6	7	6	6	6	5	6
	100-c	4	4	4	4	5	5	8	6	5
	100-d	8	*	8	8	8	8	4	7	8
35	65	3	3	3	3	4	2	3	4	3
50	50	1	1	1	1	2	1	5	1	1
65	35	2	2	2	2	1	3	2	3	2
80	20	7	6	7	6	3	4	1	2	4

*Non-durable press. Not rated by panel.

References

1. Presentation of Committee RA-75 of the AATCC at the 1970 National Technical Conference of the American Association of Textile Chemists and Colorists, "Durable Press — A Study of End Use Performance Properties as They Relate to Accepted Laboratory Test Methods," Atlanta, Georgia, November 6, 1970.
2. Jones, Brian W., "Durable Press — What Price Cotton?", American Dyestuff Reporter, January, 1971, pp. 19-20.
3. Proceedings, Tenth Cotton Utilization Conference, New Orleans, April 29-May 1, 1970.
4. American Association of Textile Chemists and Colorists, 1967 Technical Manual of the AATCC, AATCC National Headquarters, Research Triangle Park, North Carolina.
5. American Society for Testing Materials Committee D-13, ASTM Standards on Textile Materials (With Related Information), Philadelphia: ASTM, September 1963.

Appendix

Panel Evaluation of Durable Press Shirts and Fabrics

Men's durable press shirts will be evaluated for three factors: 1) total appearance of the garment 2) appearance of the fabric and 3) color change after 1, 5, 10, 15, and 20 wear-and-care periods.

The total appearance will be judged by comparing each of the five experimental shirts to the Control which is in the center of each group of shirts. Note particularly the collar, pocket, center front, buttonholes and seams. The ratings, cited below, range from 5 to 1.

5 Looks better than Control; very slight or no puckering and wrinkling; wear without pressing.

4 Looks about like Control; slight puckering and loosely set wrinkling; wear without pressing.

3 Looks slightly worse than Control; moderate puckering and wrinkling, but not too objectionable.

2 Looks considerably worse than Control; not smooth and flat, obvious wrinkling, puckering and pulling, would require pressing.

1 Looks much worse than Control; badly distorted, very objectionable, lack of smoothness and flatness which would definitely require ironing.

The fabric in the shirts will be evaluated alone by comparing it to the durable press plastic models. These models are numbered and show varying degrees of creases and wrinkles. Consider how many wrinkles there are, and how prominent they are. Rate each shirt from 5 to 1 by the corresponding number shown of each sample.

The color of the shirts will be compared to the original unworn and unlaundered shirt. Rate each shirt by the following scale:

4 Looks whiter than original
3 Looks the same as original
2 Looks greyer than original
1 Looks yellower than original

NAME_____ DATE_____

SHIRT NO. _____ LAUNDER PERIOD_____

CONSUMER EVALUATION OF SELECTED MEN'S WHITE DRESS SHIRTS AT INTERVALS DURING WEAR

I. Fabric Appearance: (before ironing) Amount of wrinkling or puckering in shirt body.

		Shirt No.								
		1	2	3	4	5	6	7	8	9
No noticeable wrinkling	5									
Slight wrinkling	4									
Moderate wrinkling	3									
Severe wrinkling	2									
Very severe wrinkling	1									

II. Shirt Appearance: (before ironing) Use 5 to 1 rating in Part I.

	Shirt No.								
	1	2	3	4	5	6	7	8	9
Collar									
Side seams									
Yoke, pocket, armseye									

III. Color Change: Check (√) applicable description.

	Shirt No.								
	1	2	3	4	5	6	7	8	9
Color same as when new									
Shirt appears greyer (dingy)									
Shirt appears yellower									

IV. Comfort of Shirt: Smooth, cool, not scratchy.

	Shirt No.								
	1	2	3	4	5	6	7	8	9
Excellent									
Good									
Satisfactory									
Poor									

V. Ease of Ironing:

		Shirt No.								
		1	2	3	4	5	6	7	8	9
Not ironed	5									
Very easy to iron for good appearance	4									
Average ease of ironing	3									
Requires careful ironing for good appearance	2									
Difficult to iron for good appearance	1									

VI. Signs of Wear: Fraying, pilling, broken threads of collar, buttonholes or shirt body.

	Shirt No.								
	1	2	3	4	5	6	7	8	9
None									
Slight									
Obvious									

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