GLOBAL
ACETATE
MANUFACTURERS'
ASSOCIATION

A Comparison of the Comfort and Hand Characteristics of Lining Fabrics

Technical Report # 99-08
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INTRODUCTION

About GAMA

The major producers of cellulose acetate in the world founded the Global Acetate Manufacturers Association (GAMA) in Brussels on January 27th, 2000.

The prime objective of the association is to enhance the long-term viability of cellulose acetate and its derivative products worldwide. The Goals of the GAMA are likewise to advance, develop and promote its products and to jointly address the challenges the industry faces.

Cellulose Acetate Yarn

Garment linings are used in suit jackets, trousers, skirts, dresses, vests, and outdoor apparel. They provide opacity, insulation, and drape to the garment, and provide increased comfort and hygiene to the wearer. The most widely used fibers in lining materials are rayon and acetate (Ford, 1991).

For many years, GAMA members have produced filament acetate yarns for use in apparel linings. The yarns are usually made into satin, twill, or plain weave fabrics. In recent years, woven polyester linings — often produced in lighter weights — have been used by some apparel manufacturers as lining fabrics also. These fabrics are usually cheaper products, and they may be more uncomfortable to wear since polyester fibers absorb less moisture than acetate fibers do.

Purpose

The purpose of this study was to compare the comfort and fabric hand characteristics of selected lining fabrics made of acetate and polyester. The comfort of the linings was determined by human subjects wearing suit blazers constructed with different lining materials in an environmental chamber at the Institute for Environmental Research at Kansas State University. The hand of the lining fabrics was determined by a trained panel using standard fabric reference samples at the Sensory Analysis Center at Kansas State University.

Experimental Fabrics and Design

Five different lining fabrics were evaluated. The fiber content, yarn denier, fabric count, fabric structure, and weight per unit area are reported for each fabric in Table 1. The lining fabrics were labeled with code numbers 1 through 5.

The lining fabrics were constructed into single-breasted suit blazers for use in human comfort trials. All blazers were constructed using the same design and construction techniques but with different linings. The blazers were made of 100% worsted wool fabrics. The blazer fabric and lining fabrics were navy blue in color. Three blazers were constructed in misses sizes 8, 10, and 12 (i.e., 3 x 3 = 9) using each of the five linings for a total of 45 blazers.

A label with the letter code A, B, C, D, or E and the garment size was attached to the neck of each blazer. Table 1 indicates which lining was used with which blazer code. The blazers were dry cleaned after each wear trial. The cleaning was done at a local dry cleaners with perchloroethylene solvent.

The blazers were worn over white, sleeveless knitted tops made of 50% cotton and 50% nylon. The sleeveless style was selected because it is a popular style worn under blazers (i.e., camisoles, tank tops, sleeveless blouses, etc.), and this style maximized the amount of skin/arm contact with the lining fabric. The fabric was selected because it was a blend of a relatively absorbent fiber (cotton) and a relatively nonabsorbent synthetic fiber (nylon). Sixteen tops were purchased from J.C. Penney in a variety of sizes.

In addition, 12 pairs of socks were purchased for use in the wear trials. The shirts and blazers were worn with a pair of red sweat pants provided by the Institute. The sweat pants were made of knitted fleece fabric, 50% cotton and 50% polyester. The subjects wore their own bra, underwear, and athletic shoes. During the wear trials, the shirts were tucked into the sweat pants, and the blazers were buttoned in the front.

The shirts, sweat pants, and socks were laundered prior to testing and after each wear trial using a washer and dryer on site. A normal wash cycle with warm water was used with Tide liquid detergent. A normal drying cycle was used with low heat and a sheet of Bounce fabric softener.

METHODOLOGY FOR COMFORT WEAR TRIALS

Research Design

Each subject wore five blazers with different types of linings in a random order. A repeated measures design was used to determine the effect of lining materials (independent variable) on the clothing comfort sensations and thermal sensations perceived by 24 female subjects (dependent variables). Thus, there were 120 sets of observations (24 subjects x *5* blazers).

Subjects

Although linings are used in suits, blazers, trousers, and vests worn by both men and women, and in skirts and dresses worn by women, only females were selected as subjects. Previous research has shown that women can discriminate between the comfort characteristics of garments better than men can (Hollies et al., 1979). In addition, the types of garments worn by men and women suggest that there is a higher probability that more of the lining will be in contact with a woman's skin than a man's skin.

An advertisement was placed in the local newspaper asking for female subjects to participate in the comfort trials. The subjects had to be adult females who were U.S. citizens so that they could understand the instructions and scales (which were in English). When prospective subjects arrived at the Institute, they were asked to try on the tops, sweat pants, and blazers to determine their size requirements. The experimenter checked the fit of the garments and recorded the sizes for each person. If a perspective subject did not fit in Misses size 8, 10, or 12, she was not permitted to sign up for the study. Then the participants were asked to read the Subject Orientation and Test Protocol Statement and to sign the Informed Consent Form (Appendix A). Then they signed up for the five test sessions that they planned to attend. Twenty-four subjects were selected for the study, and eight subjects were selected for the pretest. Participation of the subjects in this study entailed no physical or mental risks to the subjects, and it was approved by the Human Subjects Committee at Kansas State University.

Test Protocol

Eight subjects were tested at a time in an environmental chamber. Fifteen test sessions plus two pretests plus one make-up session were needed to collect comfort data from the 24 subjects on the five blazer linings. The subjects were paid $100 for their participation in five sessions and were given one of the blazers. All of the subjects participated in all of the sessions (i.e., no one quit).

The subjects were called the night before a test session to remind them to show up. When the subjects arrived for a test session, they went into an environmental chamber (#7) and changed into the appropriate garments. Then they went into the adjacent environmental chamber (#6) and sat at a table. The subjects were allowed to read books or magazines during the one-hour test session, but they were not permitted to talk to each other or to eat or drink.

Conditions in both chambers were warm and humid: 30.6° C (87° F) air temperature and 18.9° C (66° F) dew point temperature *(*50% relative humidity). According to ISO standard 7730, these conditions should cause the subjects to sweat and to be dissatisfied with their thermal environment--assuming the insulation value of their clothing was approximately 0.9 clo. Pre-tests were conducted to determine the air temperature that would cause sweating and enable the subjects to discriminate between polyester and acetate types of linings. (If the environment was too hot, the subjects would be miserable and dislike all attributes of all blazers.)

The subjects' perceptions of clothing comfort were determined using a modified version of a scale developed by Hollies et al. (1979) and the Thermal Sensation Scale (ASHRAE, 1995). (See Appendices B and C, respectively.) The subjects were given the scales after 30 minutes and 60 minutes of exposure to the test environment. Data taken at 30 minutes was not used in the data analysis; it provided a practice run for the subjects in thinking about their comfort sensations and recording them on a ballot. The subjects were never told which type of lining was used in a blazer — only that different linings were being evaluated.

METHODOLOGY FOR SENSORY ANALYSIS OF FABRIC HAND

Differences in lining fabrics are often perceived by consumers at the point of sale by examining and touching the lining fabric. The “feel” or hand of the fabric as well as its appearance are important in the selection of garments. Therefore, fabric hand was evaluated using the basic principles given in AATCC Evaluation Procedure 5, Guidelines for the Subjective Evaluation of Fabric Hand (AATCC, 1997). The definition of terms used to describe hand characteristics are given in Appendix D (Civille and Dus, 1990; Robinson et al., 1997).

Five trained panelists from the Sensory Analysis Center evaluated the hand characteristics of the five lining fabrics. Each panelist had received over 100 hours of training in hand evaluation techniques, and was experienced in evaluating woven and nonwoven fabrics. Prior to the evaluation of the lining fabrics, the panelists spent five hours in orientation to reacquaint them with the hand analysis procedures and standard reference fabric samples. The reference samples provided panelists with a basis for consistent and reproducible evaluations. In addition, two acetate reference fabrics, #463 and #331, were used as controls during the test sessions. Consensus intensities for the hand characteristics of these controls were written on the ballot for reference. (See Appendix E.)

Five 12 x 12 inch squares of each lining fabric were each labeled with a code number and an arrow indicating the warp direction on the front (right) side of the fabric. The samples were stored in a conditioning room with an air temperature of 21° c (70° F) and *50%* relative humidity. The five panelists evaluated the hand characteristics of the fabrics while sitting at tables with smooth, white, laminated surfaces in the conditioned room. Each panelist had her own set of five different lining samples. The panelists rated the degree or intensity to which each hand characteristic was present in each lining (by comparing the samples to reference fabrics with known values) using a scale from 0 (none) to 15 (high). This evaluation procedure was repeated twice, for a total of three replications. The code numbers of the samples were changed from rep to rep so that each assessment was conducted “blind”. The fabrics were ironed on the acetate setting in between replications because they got wrinkled during the evaluation process.

RESULTS OF THE SUBJECTIVE COMFORT EVALUATION

Statistical Analysis of the Data

An analysis of variance (ANOVA) was used to determine the effect of blazer lining type (5 levels) on the perception of 12 comfort descriptors and the thermal sensation vote (13 dependent variables). Fisher's LSD post hoc comparison tests were used to determine where significant differences between linings existed on each comfort descriptor that was found to be statistically significant at the 0.05 level in the ANO VA. (See Table 2.)

Results

The effect of lining type was not statistically significant for the comfort descriptors ***snug*** and ***loose.*** This was expected because each subject was fitted with the appropriate size blazer prior to the experiment. Even if the subjects felt that a blazer was slightly snug or slightly loose, these responses were generally the same for all types of blazers, so the lining type did not affect their assessment of fit. The subjects were not able to distinguish between the different types of linings on the comfort descriptors ***stiff, itchy, rough,*** or ***scratchy.*** The subjects felt that all of the linings were not stiff, itchy, rough, or scratchy (i.e., they felt relatively smooth against their skin).

Lining type did significantly affect the subjects' perception of the term ***heavy.*** The subjects ranked the linings consistent with their actual weights per unit area with one exception. The polyester surah #5 weighed less than the acetate linings #1, 2, and 3, but the subjects perceived the blazer with lining #5 to weigh as much or slightly more than blazers with acetate linings. However, this effect was not statistically significant (i.e., #5***,*** 2, 3, and 1 all have A's next to them in Table 2). The subjects did perceive polyester taffeta #4 to be significantly lighter than polyester surah #5 and acetate surah #2. This lining was actually much lighter in weight than the others (1.48 oz./yd.^{2}).

Lining type did significantly affect the subjects' perceptions of the comfort descriptors ***sticky, non-absorbent, clammy, damp,*** and ***clingy.*** These terms all relate to the ability of the fabrics to allow moisture from the skin to be absorbed into the lining (a function of the fiber content) and to pass between fibers in the lining to the environment (a function of the fabric structure). These words mean slightly different things to different people, so all of them were used in the ballot. Since these terms are negative with respect to comfort, a high rating of 5 or 4 is desirable (i.e., indicates that the subjects did not sense or slightly sensed a comfort descriptor).
The comfort ratings indicated that the subjects perceived the blazer lined with polyester surah #5 to be significantly more non-absorbent than all of the others. Both polyester surah #5 and polyester taffeta #4 were perceived to be significantly more clammy and damp than the acetate linings. The polyester linings were significantly more sticky than acetate linings #1 and 2 (but the same as #3). Polyester lining #5 was significantly more clingy than acetate surah #2 also. Polyester lining #5 weighed

almost an ounce more per yard than #4, and it was a twill weave with a much higher warp count than plain weave #4. Thus, #5 had more “substance” and may have blocked more moisture from passing from the skin surface to the environment than #4, even though they were both made of polyester.

The subjects could not tell the difference between the acetate linings with respect to the descriptors sticky, non-absorbent, clammy, damp, and clingy. Although not statistically different, the subjects tended to rank acetate surah #2 a little higher (i.e., they only slightly sensed the negative comfort descriptors) than the other two types #3 and 1. The effect of lining type on the subjects’ thermal sensations was not statistically significant. This result was expected because the lining fabrics were all relatively thin, and they consequently provided approximately the same amount of insulation to the clothing ensemble. All of the subjects felt warm, on average, in the blazer ensembles when worn in an environment with an air temperature of 30.6° C (87° F) and 50% relative humidity. Although not statistically significant, the subjects voted warmer when wearing the polyester surah #5 lined blazer (7.3) and the polyester taffeta blazer #4(7.1) than the acetate blazers (6.9 - 7.0).

Comparison of Results to the Previous Comfort Study

In a previous study conducted at the University of Maryland (Hollies & Frisbie, 1987), subjects wore blazers with acetate and polyester linings in comfort trials. After riding a stationary bike for 10 minutes to produce sweating, the subjects sat in an environmental chamber while conditions changed from warm-dry to warm-humid to cold-humid over a 90 minute period. They completed comfort scales similar to the ones used in this study. The procedures used to combine the subjects’ responses in the different conditions and to develop a weighted ranking for each lining not clearly explained in the report. The rationale for combining certain comfort descriptors together into performance groups is not clear either. However, this treatment of the data resulted in three acetate linings having higher rankings than their polyester counterparts on the following comfort descriptors: sticky, clingy, nonabsorbent, damp, clammy, and stiff. The rankings on the other descriptors in the scale did not consistently favor either the acetate or polyester linings. In a supplemental report (Hollies & Frisbie, 1988), statistics were used to make paired comparisons of all linings to lining #1 — the lining found to have the highest average ranking when all performance descriptors were combined.

The weave types were not identified in the previous study (Hollies & Frisbie, 1987, 1988). However, based on the fiber content, yarn size, fabric count, and weight data, acetate lining #2 in this study appears to be the same as #7 in the previous study, and acetate lining #3 appears to be like #5 in the old study. A fabric comparable to acetate lining #1 — the overall best fabric in the previous study — was not included in this study. Old fabric #1 had smaller filling yarns and a lighter weight than fabric the fabric #3 in this study. The polyester linings used in both studies were not comparable. Overall, the results of the two studies are similar. In general, the acetate linings were perceived to be more comfortable than the polyester linings. Specifically, the subjects felt less sticky, clammy, and damp when wearing acetate linings, and acetate linings were more absorbent than polyester.

RESULTS OF THE SUBJECTIVE HAND EVALUATION

Statistical Analysis of Data

An analysis of variance was used to determine the effect of lining type on the perception of hand characteristics. All of the ANOVA models were significant at the 0.05 level, so Fisher's LSD post hoc comparison tests were then used to determine where significant differences between the linings existed on each hand descriptor. (See Table 3.) Although the fabrics were similar, the panel was able to discriminate between the linings with respect to their hand characteristics by comparing them to reference samples of known values. The rating scale ranged from 0 (characteristic was not present) to 15 (high intensity of characteristic was found in the fabric). The precision of their ratings were high enough to result in numerous statistical differences between the fabrics. In real life, many of these differences could not be determined by the average consumer.

Results

Geometric hand characteristics are related to the perception of the size, shape, and orientation of particles (Civille and Dus, 1990). The lining fabrics had low levels of geometric surface characteristics because they were all made of filament yarns in either a twill weave or plain weave structure. These fabrics were rated low on fuzziness *(0.5* -0.6), graininess (0.87 - 1.99), grittiness (0.68 - 1.21), surface texture (0.37 - 1.29), and thickness (1.91 - 3.06). (In other words, they were smooth thin fabrics.) The acetate surah #2 had significantly higher levels of graininess, grittiness, surface texture, and thickness than the other fabrics. It probably had more texture since it had a higher weight and was a twill weave. The polyester taffeta #4 had significantly lower amounts of these hand characteristics, probably because it weighed less than the other fabrics and was a plain weave.

Mechanical hand characteristics are related to the perception of stress and strain (Civille and Dus, 1990). The lining fabrics had low levels of mechanical characteristics such as hand friction *(1.57* - 2.72), depression depth (0.26 - 0.40), springiness (0.33 -0.49), force to gather (1.92 - 2.98), force to compress (2.03 - 2.85), stiffness (2.77 -3.39), body (2.49 - 2.97), compression resilience (1.82 - 2.89), and stretch (0.21 - 0.33). Values for fabric-to-fabric friction showed the greatest variation of the mechanical hand characteristics, ranging from 2.63 to 7.73. Acetate surah #2 was in the highest LSD statistical grouping for all of the mechanical hand characteristics. The polyester taffeta #4 was in the lowest LSD grouping for all of the mechanical characteristics except for hand friction (where it was next to lowest) and compression resilience. The surah fabrics and the linings with higher weights tended to be rated higher in hand characteristics as compared to the taffeta fabrics and lighter weight fabrics.

The ratings for sound characteristics were in the moderate range for the lining fabrics: noise intensity (6.46 - 7.13) and noise pitch (6.89 - 7.12). The acetate linings produced slightly more noise than the polyester linings did. Acetate fiber was

developed to simulate silk, which has a natural scroop or rustle sound, which may account for its higher noise production.

CONCLUSIONS

i. The results of the subjective comfort evaluation indicated that, in general, the subjects rated the acetate linings significantly less sticky, clammy, and damp and more absorbent than the polyester linings.

ii. Acetate surah #2 (#7 in a previous study) was rated a little higher (i.e., better) than the other acetate fabrics on these comfort descriptors.

iii. The results of the subjective hand evaluation indicated that the lining fabrics rated low on the geometric and mechanical hand characteristics (except fabric friction) and rated moderate on noise.

iv. Aetate surah #2— the lining with the highest weight and a twill weave structure -- scored the highest on most of the hand characteristics, whereas, polyester taffeta #4— the lining with the lowest weight and a plain weave structure —scored the lowest.

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Table 2
The Effect of Lining Type on the Comfort Characteristics of Linings

Comfort Descriptors [a]		
Heavy		
4.2	#5 polyester surah (2.36 oz.fyd.^{2})	A
4.2	#2 acetate surah (3.35 oz./yd.^{2})	A
4.3	#3 acetate surah light (2.99 oz./yd.^{2})	AB
4.5	#1 acetate taffeta (2.53 oz./yd.^{2})	AB
4.7	#4 polyester taffeta (1.48 oz./yd^2)	B
Sticky		
3.2	#5 polyester surah	A
3.3	#4 polyester taffeta	A
3.5	#3 acetate surah light	AB
4.0	#1 acetate taffeta	B
4.0	#2 acetate surah	B
Non-absorbent		
3.1	#5 polyester surah	A
3.8	#4 polyester taffeta	B
4.0	#3 acetate surah light	B
4.1	#1 acetate taffeta	B
4.1	#2 acetate surah	B
Clammy		
3.0	#5 polyester surah	A
3.3	#4 polyester taffeta	A
3.8	#3 acetate surah light	B
3.9	#2 acetate surah	B
4.0	#1 acetate taffeta	B
Damp		
3.2	#5 polyester surah	A
3.5	#4 polyester taffeta	A
4.0	#3 acetate surah light	B
4.0	#2 acetate surah	B
4.2	#1 acetate taffeta	B

Clingy

2.8	*#5* polyester surah	A
3.0	#4 polyester taffeta	AB
3.0	#1 acetate taffeta	AB
3.1	#3 acetate surah light	AB
3.3	#2 acetate surah	B

Thermal Sensation [b]

6.9	#2 acetate surah	A
7.0	#3 acetate surah light	A
7.0	#1 acetate taffeta	A
7.1	#4 polyester taffeta	A
7.3	*#5* polyester surah	A

[a] Rating scale for comfort descriptors ranges from 1 = totally sensed to *5* = not sensed at all. Means with the same letter designation are not different from each other at the *0.05* level of statistical significance.

[b] Rating scale for thermal sensation ranges from 1 = very cold to 5 = neutral to 9 = very hot. This variable was not significant in the ANOVA or LSD tests, but the mean ratings are shown for information purposes only.

Table 3
The Effect of Lining Type on Fabric Hand Characteristics

Geometric Characteristics

Fuzzy		
0.60	#3 acetate surah light	A
0.60	#5 polyester surah	A
0.53	#2 acetate surah	AB
0.51	#4 polyester taffeta	B
0.50	#1 acetate taffeta	B
Grainy		
1.99	#2 acetate surah	A
1.46	#1 acetate taffeta	B
1.26	#5 polyester surah	C
0.99	#4polyestertaffeta	D
0.87	#3 acetate surah light	D
Gritty		
1.21	#2 acetate surah	A
0.91	#1 acetate taffeta	B
0.89	#5 polyester surah	B
0.82	#3 acetate surah light	B
0.68	#4 polyester taffeta	C
Surface Texture		
1.29	#2 acetate surah	A
0.93	#1 acetate taffeta	B
0.67	#3 acetate surah light	C
0.61	#5 polyester surah	C
0.37	#4 polyester taffeta	D
Thick		
3.06	#2 acetate surah	A
2.36	#5 polyester surah	B
2.31	#3 acetate surah light	B
1.99	#1 acetate taffeta	C
1.91	#4 polyester taffeta	C

MECHANICAL CHARACTERISTICS

Hand Friction

2.72	#2 acetate surah	A
2.10	#l acetate taffeta	B
2.03	#5 polyester surah	B
1.87	#4 polyester taffeta	C
1.57	#3 acetate surah light	D

Fabric Friction

7.73	#2 acetate surah	A
5.87	#3 acetate surah light	B
5.86	#5 polyester surah	B
3.85	#1 acetate taffeta	C
2.63	#4polyester taffeta	D

Depression Depth

0.40	#2 acetate surah	A
0.37	#3 acetate surah light	AB
0.33	#5 polyester surah	BC
0.29	#1 acetate taffeta	CD
0.26	#4 polyester taffeta	D

Springy

0.49	#2 acetate surah	A
0.42	#3 acetate surah light	B
0.39	#5 polyester surah	BC
0.35	#1 acetate taffeta	CD
0.33	#4 polyester taffeta	D

Force to Gather

2.89	#5 polyester surah	A
2.78	#2 acetate surah	A
2.41	#3 acetate surah light	B
2.18	#1 acetate taffeta	C
1.92	#4 polyester taffeta	D

Force to Compress

2.85	#5 polyester surah	A
2.80	#2 acetate surah	A
2.62	#1 acetate taffeta	B
2.36	#3 acetate surah light	C
2.03	#4polyestertaffeta	D

Stiffness

3.39	#2 acetate surah	A
3.30	#5 polyester surah	A
3.09	#1 acetate taffeta	B
2.87	#4 polyester taffeta	C
2.77	#3 acetate surah light	C

Fullness of Body

2.97	#5 polyester surah	A
2.90	#2 acetatexsurah	A
2.74	#1 acetate taffeta	B
2.65	#3 acetate surah light	B
2.49	#4 polyester taffeta	C

Compression Resilience

2.89	#5 polyester surah	A
2.76	#2 acetate surah	A
2.06	#4 polyester taffeta	B
2.05	#1 acetate taffeta	B
1.82	#3 acetate surah light	C

Stretch

0.33	#2 acetate surah	A
0.31	#1 acetate taffeta	A
0.23	#5 polyester surah	B
0.22	#3 acetate surah light	B
0.21	#4polyestertaffeta	B

Sound Characteristics

Noise Intensity

7.13	#1 acetate taffeta	A
7.03	#3 acetate surah light	AB
7.01	#2 acetate surah	AB
6.91	***#5*** polyester surah	B
6.46	#4 polyester taffeta	C

Noise Pitch

7.12	#1 acetate taffeta	A
7.12	#2 acetate surah	A
6.93	#3 acetate surah light	B
6.91	#4 polyester taffeta	B
6.89	***#5*** polyester surah	B

[a] Rating scale for hand characteristics ranges from 0 = none to 15 = extreme (high intensity). Means with the same letter designation are not different from each other at the 0.05 level of statistical significance.

Appendix A
Subject Orientation and Protocol Statement

The purpose of this project is to determine the comfort characteristics of different types of linings used in suit blazers. You must be a female, U.S. citizen with competency in English, who fits in a Misses size 8, 10, or 12 blazer. If you decide to participate in this experiment, you will be expected to attend five 1 1/2 hour test sessions in an environmental chamber. The times for the test sessions include 30 minutes for orientation, changing clothes, etc. and 1 hour for the actual experiment. Please do not sign up unless you plan to participate in all five sessions of the project. When you arrive for the experiment, you will be given a clean knit top, pair of sweat pants, and a suit blazer to put on over your bra and panties. You will be given a pair of socks to wear under your own athletic shoes also. You will then sit in a warm, humid chamber with other female subjects for one hour. You may read during this time, but you may not talk. After 30 minutes and 60 minutes, you will fill out a clothing comfort scale and a thermal comfort scale.

After you have participated in **all five sessions**, you will be paid $10 per session, plus a bonus of $50 for a **total of $100**. You will also be given a navy blue wool blazer worth over $100. If you quit the study before all five sessions are completed, you will only receive $10 for each session you attended. Your identity as a subject will not be disclosed and anonymity will be maintained. The conditions to which you will be exposed entail no physical risk. **Informed Consent Statement**

My participation in this study is purely voluntary. I understand that I may discontinue my participation at any time without penalty or loss of benefits to which I am otherwise entitled (as explained above).

I understand that my responses will be treated as research data and will not be associated with me for other than identification purposes, thereby assuring anonymity of my responses.

If I have questions about the rationale or method of study, I understand that I may contact Dr. Elizabeth McCullough, Institute for Environmental Research, 64 Seaton Hall, Kansas State University, Manhattan, KS 66506, at *(785)* 532-2284.

If I have questions about the fights of subjects in this study or about the manner in which the study is conducted, I may contact Clive Fullagar, Chair, Committee on Research Involving Human Subjects, 103 Fairchild Hall, Kansas State University, Manhattan, KS *66506,* at (785) *532-6195.*

_____ _____ 1998

signature date

Appendix B
Subject Comfort Rating Scale for Blazer Linings

Please rate the intensity of the comfort sensations you feel when wearing the suit blazer using the scale below. If you do ***not*** experience a sensation listed below, write ***5*** by the comfort descriptor.

Intensity Scale:

1 = totally sensed
2 = definitely sensed
3 = mildly sensed
4 = partially sensed
5 = not sensed at all

1	_____	Snug
2	_____	Loose
3	_____	Heavy
4	_____	Stiff
5	_____	Sticky
6	_____	Non-absorbent
7	_____	Clammy
8	_____	Damp
9	_____	Clingy
10	_____	Itchy
11	_____	Rough
12	_____	scratchy

Appendix C
Thermal Sensation Scale

Subject Number _____ Blazer Code _____ Time Period _____
Place an X by the adjective or between the adjectives that best describe how you feel.

_____ 1 Very Cold

_____ 1.5

_____ 2 Cold

_____ 2.5

_____ 3 Cool

_____ 3.5

_____ 4 Slightly cool

_____ 4.5

_____ 5 Neutral

_____ 5.5

_____ 6 Slightly Warm

_____ 6.5

_____ 7 Warm

_____ 7.5

_____ 8 Hot

_____ 8.5

_____ 9 Very Hot

Appendix D
Definitions of Hand Descriptors and Techniques for Evaluation Used by the Panel

Geometric Characteristics

Fuzzy

Definition:	The amount of hair-like fibers found on the top-most surface of the fabric			
Techniques:	Move index and middle fingers in a quarter-size circular motion directly on the top-most surface.			
Reference	0.7 Red	3.6Grn	7.0 Blu	13.6 Blk
Fabrics:	Woven #1 = 4.5	Knit # 764 = 6.4	Terry #431 = 7.5	

Grainy

Definition:	The amount of small rounded particles on the top-most surface of the fabric			
Techniques:	Move index and middle finger tips from left to right; rotate fabric to stroke in all four directions.			
Reference	2.1 Red	4.9 Grn	9.5 Blue	13.5 Blk
Fabrics:				

Gritty

Definition:	The amount of small abrasive picky (sharp) non-uniform generally found on the surfaces			
Techniques:	Place heel of hand on flat, opened fabric sample and stroke fabric with the index and middle fingers, using a back and forth motion. Evaluate different surface areas of sample			
Reference	1.5 Red	6.0 FCGrn	10.0 Blu	12.0 NIBlu
Fabrics:	Woven #1 = 3.0	Knit #764 = 2.8	Terry #431 = 2.6	

Surface Texture

Definition:	The impact of tactile awareness of a random or nonrandom pattern. (The amount of over-all surface tactile sensation)			
Techniques:	Place open hand on surface of flat, opened fabric sample and stroke back and forth, using enough pressure to feel all surfaces but not to distort the fabric.			
Reference	Brocade = 2	Seersucker=13	Corduroy = 3	Linen = 7
Fabrics:	Woven#l=6.0	Knit#764= 4.0	Terry#431= 11.0	

Thick

Definition:	The amount of distance between the thumb and forefinger when positioned on either side of the fabric sample.			
Technique	Hold sample corner between thumb and index finger of non-dominant hand. Using light pressure, run fingers along the perimeter of the fabric sample approximately 1 inch from edge. Run fingers along length and width and composite the evaluation if sides differ in thicknesses. The hands should move freely over the fabric. There should be no fabric distortion			
Reference	1.3 Red	3.3 Grn	6.5 GN Red	13.0 Blk
Fabrics	Woven #1 = 7.0	Knit #764 = 6.8	Terry #431=11.6	

Mechanical Characteristics

Hand Friction

Definition	The amount of effort to initiate movement of hand over surface of sample			
Technique:	Place open hand on surface of flat, opened fabric sample. Position fabric and arm so that entire forearm is resting on table surface. Table surface supports hand weight. Stroke fabric in a left to right motion. Use non-dominant hand to secure fabric sample. (Left hand opposite).			
Reference	1.4 Red	7.2 Blu	10.0 Blk	14.2 Purp
Fabrics	Woven #1 = 6.0	Knit #764 = 6.3	Terry #431=13.1	

Fabric Friction

Definition	The force required to move the fabric over itself.			
Technique	Fold the fabric in half (top to bottom), grasp open end between thumb and finger tips; move the fabric over itself with a rotating motion.			
Reference	1.7 Gm	5.0 Ni Blk	10.0 Blu	15.0 Purp
Fabrics:				

Depression Depth

Definition	The degree to which the sample depresses when downward force is applied.				
Technique	Fold sample in quarters, labeled sides together. Using fatty part of folded square. Press down until resistance intensifies. Before any repeated assessment, shake quartered sample and reposition on table.				
Reference	0.7 Red	1.8 Grn	6.4 Blu.	12.4 Blk	15.0 Purp
Fabrics	Woven #1 = 1.8		Knit #764 = 6.9		Terry #431=14.9

Springy

Definition	A visual evaluation of the amount of and rate at which the sample returns to original position after depression is removed				
Technique	Fold sample in quarters. Using fatty part of fingertips of index and middle fingers, press down on center of folded square. Before any repeated assessment, shake quartered sample and reposition on table				
Reference	0.7 Red	1.8 Grn	6.2 Blu.	10.0 Blk	12.6 Purp
Fabrics	Woven #1 = 1.8		Knit #764 = 5.0		Terry #431=10.3

Force to Gather

Definition	The amount of force to gather the sample towards palm.		
Technique	Place open hand on surface of flat, opened fabric sample. Position so that the fingertips are pointing towards the top of the sample approximately 1½ from the top edge. Draw the fingers into the palm, with no downward pressure. (Note that technique does not direct placing the hand flat. Panelists feel that a slightly curved hand prevents an initial downward pressure against the surface, which in turn creates the need for more force.) Evaluation should consider initial force to break the fabric as well as force needed to gather into palm.		
Reference	l.4 Red	3.5 Grn	7.5 Blu
Fabrics	Woven #1 = 5.5	Knit #764 =4.0	Terry#431 =7.4

Force to Compress

Definition	Amount of force to compress the gathered sample in palm
Technique	Center open hand on surface of flat, opened fabric sample. Using the fingers, manipulate the fabric into the palm twice, leaving the fabric on the table, and once with the fabric raised. Compress sample with fingers toward palm.

Reference	l.5Red	3.4Grn	9.3 Blu	14.5 Blk
Fabrics	Woven #1 = 6.5	Knit#764=4.7	Terry#431 =9.3	

Stiffness

Definition	The amount of pointed, ridged, or cracked folds.			
Technique	Lay open hand on surface of flat, opened fabric sample. Using the fingers, manipulate the fabric into the palm twice with the fabric on the table, and once with the fabric raised. Manipulate gently without completely closing hand.			
Reference	1.3 Red	4.7Grn	8.5 Blu	14.0 Blk
Fabrics	Woven #1=6.0	Knit #764 = 4.2	Terry#431 =3.8	

Fullness of Body

Definition	The amount of material/fabric in the hand.			
Technique	Center open hand on surface of flat, opened fabric sample. Using the fingers, manipulate the fabric into the palm twice with the fabric on the table, and once with the fabric raised. Manipulate gently without completely closing hand. Air pockets should be discounted			
Reference	1.6 Red	3.5 Plisse	7.8 Blu	13.3 Blk
Fabrics	Woven #1 =3.8	Knit#764=7.8	Terry #431 = 14.0	

Compression Resilience

Definition	Force of the sample against the hand			
Technique	Center open hand on surface of flat, opened fabric sample. Using the fingers, manipulate the fabric into the palm twice with the fabric on the table, and once with the fabric raised. Position the non-dominant hand on the points and bring hands together into a cupped hand position			
Reference	0.9 Grn	3.8 Blu	9.5 Blk.	14.0 Purp
Fabrics	Woven #1 =5.0	Knit#764=3.8	Terry #431 = 5.8	

Stretch

Definition	The amount/distance to which the sample is stretched from its original shape.			
Technique	Grasp opposite edges (near to the edges) in hands; pull sample square straight across in direction 1 for 5 seconds; repeat for direction 2.			
Reference	0.5 Red	2.6 Grn	10.6 Blu	15.0 Blk
Fabrics	Woven #1 =1.5	Knit#764=14.3	Terry #431 = 1.7	

Sound Characteristics

Noise Intensity

Definition	The amount of noise (loudness).			
Technique	Place sample close to the ear, compress and rotate gently.			
Reference	1.6 Red	2.7 Grn	6.3 Blu	14.5 Blk
Fabrics				

Noise Pitch

Definition	The frequency/level of noise pitch (tone).			
Technique	Place sample close to the ear, compress and rotate gently.			
Reference	1.5 Red	2.5 Grn	7.2 Blu	14.5 Blk
Fabrics				

Appendix E
Ballot for Sensory Analysis of Fabric Hand

Geometric Characteristics

Panelist #_____ **Sample #_____** **Rep #_____**

Attribute	**# 463**	**Controls**	**#331**	**Intensity**
FUZZY	-----0.5----------0.5-------			_____
GRAINY	-----0.5----------2.0-------			_____
GRITTY	-----0.7----------1.0-------			_____
SURFACE TEXTURE	-----0.2----------1.0-------			_____
THICK	-----2.5----------2.0-------			_____
HAND	-----1.0----------2.2-------			_____
FABRIC FRICTION	-----8.0----------4.0-------			_____
DEPRESSION DEPTH	-----0.2----------0.4-------			_____
SPRINGY	-----0.2----------0.4-------			_____
FORCE TO GATHER	-----1.8----------2.4-------			_____
FORCE TO COMPRESS	-----1.8----------2.4-------			_____
STIFFNESS	-----2.0----------3.0-------			_____
FULLNESS OF BODY	-----2.5----------2.5-------			_____
COMPRESSION RESILIENCE	-----1.0----------2.0-------			_____
TENSILE STRETCH	-----0.2----------0.2-------			_____
NOISE INTENSITY	-----6.0----------7.0-------			_____
NOISE PITCH	-----6.0----------7.2-------			_____

Table 1
Characteristics of Fabric Linings

Blazer Code	Lining Code	Orientation in Blazer	Fiber Content	Fabric Name and Structure	Fabric Count (ends x picks)	Yarn Denier Per Filament	Fabric Weight (oz./yd.^{2}) (g/m^2)
A	2	right-handed twill, shiney side showing	100% acetate	surah (twill weave)	120 x 68	W: 150/40 F: 150/40	3.35 113.60
B	1	Both sides look alike	100% acetate	taffeta (rib weave)	92 x 54	W: 150/40 F: 150/40	2.53 85.70
C	4	Both sides look alike	100% polyester	taffeta (rib weave)	84 x 74	W: 50/24 F: 75/36	1.48 50.30
D	3	right-handed twill, shiney side showing	100% acetate	surah (twill weave) lightweight	120 x 68	W: 115/50 F: 150/60	2.99 101.50
E	5	left-handed twill, dull side showing (wrong side out)	100% polyester	surah (twill weave)	120 x 76	W: 70/34 F: 100/30	2.36 79.90