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CYCLIC MICROWAVE TREATMENT OF PRESSED GARMENTS

Final Report
January 2001

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PRESSET, INC.

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SUMMARY OF PROJECT GOALS

In the early 1990's there was a resurgence in what was called "wrinkle free" garments. It had been popular in the 1960's. As cotton products gained a larger share of the fiber market in apparel, "wrinkle free" became a very strong marketing effort.

Because we were very knowledgeable in this market we investigated the problem that had plagued it in the 60's, namely product quality. To make "wrinkle free" garments one had to either buy a fabric that was treated with chemicals, called resins, that when "cured" would impart the "wrinkle free" qualities to the garment permanently.

Any cellulose fibre cold be treated to make it wrinkle free. If the fabric was not produced at the mill level with the chemical it could be added to the finished garment by dipping it in a chemical solution, drying it, them pressing and curing to achieve the desired "wrinkle free" results.

The reason this great idea failed originally was due to poor quality. 100% cotton pants literally fell apart in a short wearing time. There was optimism that the new chemicals developed would add less degradation to the garments than in the past. These new chemicals were certainly an improvement, but mainly in a environmental way. Formaldehyde was replaced by much less toxic chemicals. These products worked well and were much easier to permit and handle.

CURING the garments was done exactly the same way. In fact most curing equipment was just dusted off and put into production as they had done in the

the sixties. These were convection ovens that were either a batch system or a continuous flow design. Both worked under exactly the same principle. To cure or "set" the chemical that had been applied, the garment had to be placed in these ovens at approximately 400° F. To effect the cure the garment had to reach 300° F through the entire fabric of the garment.

Cotton is not a good conductor of heat. To heat every part of these garments through all seams, pockets and collars took 20+ minutes. The problem in our view was not the chemicals breaking down the fibre, but the heating of the garment for such a long period of time. It was and remains our opinion that this time and heat literally "burned" or at least toasted the edges of the garment. This was particularly true and critical around the cuffs and collars of shirts and the bottoms and pockets of pants. These toasted fibers would literally break and the garment would exhibit wear in a short period of time.

Our goal was to develop a "curing" method that would accomplish the "set" or cure but not degrade the fabric. Since all of the "wrinkle free" garments were and had to be made of heavier fabrics this precluded the ability to do items such as light weight fabrics used in dress shirts, unless they were a blend of cotton and sythentic fiber.

We felt and ultimately proved and patented a method of curing with the use of microwaves to accomplish the task. Microwave energy passed through a garment until it hits something that will absorb this unique energy. In any garment the big problem is the moisture that is inherently absorbed by the cotton. The time factor in the convection curing was really just a matter of getting the moisture totally out so the temperature could be raised beyond 212° F to the needed 300°. Microwaves immediaty penetrate the garment especially heavier parts of the garment like seams etc. This penetration heats

the moisture immediaty and drives it to the surface of the garment where it can be carried away with ambient heated moving air.

In doing this no part of the garment reaches over heated temperatures that breaks down the fibre. Our early research proved our theory to be correct and we moved forward to work out the best level and type of chemicals to use that would work in the microwave process. In addition to the wearing factor in the convection ovens, they also became more harsh to feel and in many cases had to be laundered and dried after curing to give them appeal to the consumer. This was added cost and consumed even more energy.

The Presset Microwave process did not effect the fabric this way as it heated the garment evenly and quickly that eliminated this harsh "hand". It was almost impossible to discern the difference between a treated garment and an untreated garment when cured in the microwave.

For three years we continued to test in a prototype microwave as we waited for funding under this program and could build a full scale production model. During this time many of the U.S. manufacturers we putting in place their old equipment or buying the same type new. We counseled and worked with many of the major producers and they all admitted they were having problems meeting standards set by major retail outlets. These standards were two fold, they had to meet certain defined "wrinkle free" criteria as to appearance. A garment was rated after laundering a set number of times and evaluated as to the smoothness of the fabric, did it look neat and ironed. These ratings ran from 1 - 5 five being the highest or smoothest rank. To achieve this rating meant the garment had to be baked slightly more to achieve an higher set of chemicals. This again caused even more fabric degradation.

This second test applied to the process was fabric strength. A fabric would be tested before any chemicals were added or any curing done. The same fabric would them be treated and cured. They were encountering a 50+ percent reduction in fabric strength when cured in the convection ovens that everyone used. The solution to the problem was to reduce the acceptable standards that were in place. As and example they reduced the minimum from a 4 rating to a 3.5, and the fabric strength from 65 to 50+- a few pounds. While our process had been proven to not only give higher wrinkle free standings it also was rated higher in strength. A typical pant twill before wrinkle free treatment was in the area of 100# tensile strength. As earlier stated this was dropping by half to 50#. While some manufacturers were content to ship 40 - 50# pants, others, particularly the largest Levi and VF Corp. wanted to avoid shipping such an inferior product. To overcome this they went to the fabric producers and had them beef up the fabric strength by using higher quality yarns. This increased the cost approximately .$50 per pair, and still only gave them a 60# tensile strength. Still forty percent below previous garments that were untreated.

Presset was demonstrating our process to these people in our prototype equipment in which we could actually do some production, although it was small and had limited capacity. While our product was liked by these people they had a real reluctance to endorse it. We found this troubling and we were finally told by one that after all they had gone through to get standards changed and with the new fabrics they quite frankly didn't want to go through anther round of testing and proving a new "product". They had enough failures getting this far and didn't want anything that would complicate their lives. Even though higher levels wanted us to continue to pursue this with their people, we found it almost impossible to overcome this change attitude that was so prevalent at the plant and testing levels. These

people are all pretty smart, either in fact or in their minds, and to have someone like us come out of the blue with a far superior product that was not developed by them was not easily accepted. Even Cotton Inc. while very helpful in early testing were doing their own testing incorporating various different methods, none to my knowledge were successful. They still were less than helpful in endorsing any of our technology.

We could probably have moved forward with smaller manufactures but for one other factor that was to consume the entire industry. In the early nineties we signed a trade agreement with Mexico called NAFTA. While The results of this agreement are in the books today, the impact it had on the garment industry in the U. S. was devastating. Major producers of garments who were not already in the Caribbean under 807 quickly started moving to Mexico. In a few short years the majors closed most of their domestic plants moving them to Mexico. With the reduced tariff out of Mexico it quickly placed the smaller producers in a position of not being competitive. They closed one by one until there were few left and the ones that were had no interest in any capital expenditure, like Presset.

Perhaps we could have marketed this in Mexico but being small and with our own capital restrictions we felt it would be difficult to launch an effort south of the border.

There was still a vibrant fabric production in the U.S. The lower manpower requirements versus capital costs helped them during this time that the garment manufacturers were getting out. They simply were shipping their fabric to Mexico for production. we worked with some of them and tried others but again there was reluctance for "newness", even though it meant a better product at a lower cost to the end product. In all of this they also were

under corporate pressure to hold profit margins which were not good in the industry at that time.

This was particularly critical to the one area we really wanted to develop with our process. That being to prove we could make a wrinkle free 100% fine cotton dress shirt or sport shirt. We did several months of testing with Oxford Industries and while we did not complete the final testing we needed, we did learn all we needed to know to make this a reality. This company also was in the process of closing plants and moving to Mexico. They had tried to make wrinkle free blended shirts and were failing badly, a huge cost to their bottom line. One day during our testing they called us in and said we are no longer pursuing ANY wrinkle free shirts. They withdrew from this segment of the market. They obviously were not interested in any further expenditures on testing.

What we did learn in this exercise was that on light weight fabrics such as shirt fabrics, they could not be wet processed after sewing. This meant we would have to form an alliance with a fabric producer who could apply the chemical before sewing and then have it pressed and cured. This process cannot be done in convection ovens as it had been tried and would not meet quality specifications. All of our testing indicated our microwave curing would have worked well if developed in conjunction with a fabric producer. They were hampered and discouraged by the whole process and the impending doom of NAFTA.

After seven years of testing at various levels we were at a standstill, but still negotiating with a fabric producer to test our method at the fabric level. Our main "driver" of the entire project was hit with a leg circulation problem in late 1999 that lasted for 10 months and the eventual loss of his leg. While this

was not the reason for our inability to accomplish all of our goals it was a final and decisive blow to our timeliness and ability to move forward at any level.

Attachment B

Energy, Environmental, and Economic Savings for I&I

The installed unit for the *I&I project* technology is PRESSET PC 15.

The installed unit for the *comparable competing* technology as presented in the original proposal is SUSSMAN 128 RDG.

Energy Savings

Provide the energy savings for the project technology versus the comparable competing technology.

The *projected* energy consumption for the *project* unit in Btu/yr/unit was (at the beginning of the project) .0333 KW 113 Btu.

The energy consumption for the *project* unit in Btu/yr/unit is .0199 KW 68 Btu

Provide assumptions and references for the derivation of your values. *(Refer to App. ? for energy conversion factors)* 14 KW - 47,768 Btu PER HOUR = CURED GARMENTS 720

The energy consumption for the *comparable competing* unit in Btu/yr/unit is .3198 KW - 1091 Btu

Provide assumptions and references for the derivation of your values. *(Refer to App. ? for energy conversion factors)* SUSSMAN 128 RDG 550,000 Btu/HR = CURED GARMENTS 504

Environmental Savings

Provide the environmental savings for the project technology versus the comparable competing technology.

The *projected* wastes other than power generation emissions for the *project* technology in tons/yr/unit using the *project* unit described above (at the beginning of the project) were:

Waste 1 Ø
Waste 2 _____
Waste 3 _____

Identify wastes other than power generation emissions for the *project* technology in tons/yr/unit using the *project* unit described above:

Waste 1 Ø
Waste 2 _____
Waste 3 _____

Identify wastes other than power generation emissions for the *comparable competing* technology in tons/yr/unit using the *comparable competing* technology unit described above:

NATURAL GAS (SUSSMAN 128 RDG) 3,065,622 CO_2

Waste 1 3,065,622 # CO_2
Waste 2 _____
Waste 3 _____

Provide assumptions to allow reviewers to understand the derivation of the stated values.
24,000,000 UNITS @ 1091 BTU UNIT X 117.08 PER MILLION BTU

Economic Savings

Provide the economic savings for the project technology versus the comparable competing technology.

The *projected* unit cost for the *project* technology (at the beginning of the project) was
.002

Define the unit cost for the *project* technology .002

Define the unit cost for the *comparable competing* technology .022

Provide assumptions to allow the reviewers to understand the derivation of the stated values.
PRESSET .0199 KW X .074 KW
SUSSMAN .3198 KW X .074 KW

Economic Savings

This entire project was driven by the need for a better quality product. The "calculated " costs are so small per garment that they are insignificant.

These calculations assume maximum production per processing unit. It is known that they do not perform this number, however there is no other way to do the numbers.
Other costs that cannot be defined are those covering additional laundering and drying after the conventional process is used. These numbers are not disclosed by the manufacturers. This would at least double the curing cost due to the drying alone.

Product quality is also not easy to calculate. A pair of cotton casual pants without "wrinkle free" treatment should wear for at least two years with normal wearing and laundering. A pair of these same pants treated and cured under the traditional method will only wear about 50 % of this time. There is no question that to make a garment wrinkle free decreases the wear time. A pair of casual pants would cost about $35 per pair. At half the wear time the loss would be $17.50, on a microwave cured pair the comparable cost would be $28.00, or a savings of $10.50 per pair.

The fact that there are in excess of 24,000,000 pair of these pants sold with this treatment annually makes for a large number. Once the manufacturer gets the consumer to accept this wear standard and ease of care it is an easy sell, and they only stand to sell more units as they wear out faster.

The true economic benefit is really only to the consumer.

Attachment C

Commercialization Table
(I&I Category 2 Projects Only)

Category	U. S. Market				
	Project Completion Year	5 Years after Completion	10 Years after Completion	15 Years after Completion	20 Years after Completion
(A) Total Number of Units in U.S. Market (Addressable Market)	SEE	NARRATIVE			
(B) Total Number Installed Units Using Your Technology (Capturable Market)		"			
(C) Market Penetration = B/A x 100%		"			

- **Your technology** - Total number of units employing the technology developed with the I&I grant. This number includes, but is not limited by the number of units that the industrial partner will sell or operate.

- **Addressable Market** is that fraction of the entire market to which your technology is truly applicable. Remember to project the number of installed units by first considering limiting factors related to technology and market fit. For instance, the proposed technology may only fit a certain size range of equipment, i.e., a proposed glass furnace burner technology can only be constructed is sizes smaller than 5 MMBtu/hr, or the proposed burner can only be applied to recuperated furnaces, not regenerative furnaces.

- **Capturable Market** is that fraction of the Addressable Market willing to accept your new technology. Remember that the rate at which industrial technologies capture the market depends on technology characteristics (new vs. retrofit), industry characteristics (industry growth, competition), and external factors (government regulations and trade restrictions). Consider these limiting factors related to rates of market acceptance before projecting the number of installed units in the Capturable Market.

Attachment D

Final Cost Sharing

#	Company Name	Company Type*	In-Kind Contribution	Cash Contribution	Total
1		N/A			
2					
3					
4					
5					
	DOE				
	Total				

Only Include Cost-sharing Partners

* small business, business, non-profit, university, state agency, or utility

Attachment E

Partners and Contractors

#	Company Contact	Address	City	ST	Zip	Phone / Fax / e-mail
1						
2		N/A				
3						
4						
5						

List all companies involved in the project (equipment vendors, consultants, subcontractors, customers etc. and provide a brief narrative discussing the role of each partner.)

Supplemental Information

A: Garment Manufacturing U.S. vs Mexico & Imports

B: Wrinkle Free Standards Re: J.C. Penny

C: Cotton Pant Production Mid 1996 numbers on cotton pants were at 6 - 45 %. That number is is now at 80+%.

Exhibit A

U.S.-MEXICO TRADE

Since its enactment in 1994, the North American Free Trade Agreement has spurred shipments of U.S. textiles to Mexico. Of even greater value has been Mexican exports of garments to the United States. In U.S. dollars:

U.S. exports of yarns and fabrics to Mexico		Mexican exports of garments to the U.S.	
1993	$589.5 million	1993	$1.1 billion
1994	$759.6 million	1994	$1.6 billion
1995	$775.4 million	1995	$2.6 billion
1996	$981.7 million	1996	$3.6 billion
1997	$1.3 billion	1997	$5 billion
1998	$1.7 billion	1998	$6.5 billion
1999	$2.5 billion	1999	$7.5 billion
2000*	$3 billion	2000*	$8.3 billion

* Projected

Source: U.S. Department of Commerce

FOREIGN MADE

With the production of clothing in the United States shrinking fast, American textile makers are shifting fabric production to Mexico, a fast-growing supplier of clothing to Americans. A look at the changing sources of U.S. apparel.

	1992	2000*
United States	49%	10.3%
Mexico and Caribbean Basin	9.9	35.6
Southeast Asia and Asian subcontinent**	14.9	24
China and Hong Kong	12.9	11.7
Taiwan and Korea	7.5	7.1
Rest of world	5.8	11.3

*Projected

**Includes Indonesia, Malaysia, Philippines, Singapore, Thailand, India, Pakistan, Bangladesh and Sri Lanka

Source: Kurt Salmon Associates

Exhibit B

Specification Number 935-0294

JCPenney
Merchandise Testing Center
Product Performance Specification

Specification: **Premium and Standard Casual Pants "Wrinkle Free"**

EXPECTED CARE INSTRUCTIONS:

TEST DESCRIPTION			SPECIFICATION	TEST METHOD
Fabric Weight (oz./sq. yd.)			____ ± ____	MTC-101
Construction:	Ends/inch		____ ± 5%	MTC-103
	Picks/inch		____ ± 5%	MTC-103
Tensile Strength:	Warp (lbs.)		50.0 min.	MTC-201
	Filling (lbs.)		40.0 min.	MTC-201
Tear Strength:	Warp and Filling (lbs.)		3.0 min.	MTC-203
Black and Navy	Warp and Filling (lbs.)		2.5 min.	MTC-203
*Flat Abrasion	(cycles)		300 min.	MTC-205
*Flex Abrasion		Warp	250 min.	MTC-206
(1# Head, 4# Tension)		Filling	250 min.	MTC-206
*Random Tumble Pilling: 30 minutes			3.5 min.	MTC-212
Seam Failure (lbs.)			30.0 min.	MTC-213/214
Dimensional Stability:	Length (%)		3.0 max.	MTC-305
	Width (%)		3.0 max.	MTC-305
Appearance Retention			Satis.	MTC-306
Color Perm. to Light:		20 AFU	4.0 min.	MTC-422
Color Perm. to Accel. Washing:		Shade	3.5 min.	MTC-402
		Stain	3.0 min.	MTC-402
Color Perm. to Home Laundering:		Shade	4.0 min.	MTC-410
		Stain	3.5 min.	MTC-410
Pigment dyed only		Shade	3.0 min.	MTC-410
Color Perm. to Drycleaning:		Shade	4.0 min.	MTC-411
Color Perm. to Crocking:		Dry	4.0 min.	MTC-404
		Wet	3.0 min.	MTC-404
Sueded and pigment dyed/printed:		Dry	3.5 min.	MTC-404
Dark and pigment dyed/printed:		Wet	2.0 min.	MTC-404
Sueded dark (black and navy):		Wet	1.5 min.	MTC-404
Color Perm. to Perspiration:		Shade	3.5 min.	MTC-405
		Stain	3.5 min.	MTC-405
Color Perm. to Chlorine Bleach			See Test Method	MTC-412
Color Perm. to Non-Chlorine Bleaches			See Test Method	MTC-419
Flammability (Applicable Part)			PASS Class 1	16 CFR
Durable Press Performance (Wrinkle Free)			See Specification	915-0893

* Requirements shown for information only; not to be used for acceptance or rejection criteria.

Approved, Manager of Merchandise Evaluation and Testing: Richard Adler

JCPenney

Specification Number 915-0893

Merchandise Testing Center
Product Performance Specification

Specification: **Durable Press Finishes**

TEST DESCRIPTION	SPECIFICATION	TEST METHOD
Durable Press Rating		
Fabric Smoothness	3.5 min.	MTC-307
Collar	3.5 min.	MTC-307
Pocket	3.5 min.	MTC-307
Front Closure	3.5 min.	MTC-307
Side Seams	3.5 min.	MTC-308
Pleats & Creases	3.5 min.	MTC-309

Approved, Manager of Merchandise Evaluation and Testing: _____

Specification Number 936-0194

JCPenney
Merchandise Testing Center
Product Performance Specification

Specification: **Premium and Standard Woven Sport Shirts "Wrinkle Free"**

EXPECTED CARE INSTRUCTIONS:

TEST DESCRIPTION			SPECIFICATION	TEST METHOD
Fabric Weight (oz./sq. yd.)			____ ± 10%	MTC-101
Construction:	Ends/inch		____ ± 5%	MTC-103
	Picks/inch		____ ± 5%	MTC-103
Tensile Strength:	Warp (lbs.)		30.0 min.	MTC-201
	Filling (lbs.)		25.0 min.	MTC-201
Tear Strength:	Warp (lbs.)		2.5 min.	MTC-203
	Filling (lbs.)		2.0 min.	MTC-203
*Random Tumble Pilling: 30 minutes			3.5 min.	MTC-212
Seam Failure (lbs.)			20.0 min.	MTC-213/214
Dimensional Stability:	Length (%)		4.0 max.	MTC-305
	Width (%)		4.0 max.	MTC-305
Appearance Retention			Satis.	MTC-306
Color Perm. to Light				
Medium and Dark Shades:		20 AFU	4.0 min.	MTC-422
Pastel, Bright, and Neon Shades:		10 AFU	4.0 min	MTC-422
Color Perm. to Accel. Washing:		Shade	3.5 min.	MTC-402
		Stain	3.0 min.	MTC-402
Color Perm. to Home Laundering:		Shade	4.0 min.	MTC-410
		Stain	3.5 min.	MTC-410
Pigment dyed/printed only		Shade	3.0 min.	MTC-410
Color Perm. to Drycleaning:		Shade	4.0 min.	MTC-411
Color Perm. to Crocking:		Dry	4.0 min.	MTC-404
		Wet	3.0 min.	MTC-404
Pigment dyed/printed:		Dry	3.5 min.	MTC-404
Dark and pigment dyed/printed:		Wet	2.0 min.	MTC-404
Color Perm. to Perspiration:		Shade	*3.5 min.	MTC-405
		Stain	3.5 min.	MTC-405
Color Perm. to Chlorine Bleach			See Test Method	MTC-412
Color Perm. to Non-Chlorine Bleaches			See Test Method	MTC-419
Flammability (Applicable Part)			PASS Class 1	16 CFR
Durable Press Performance			See Specification	915-0893

* Requirements shown for information only; should not be used for acceptance or rejection criteria.

Approved, Manager of Merchandise Evaluation and Testing: Richard Lader

Specification Number 939-0194

JCPenney
Merchandise Testing Center
Product Performance Specification

Specification: **Durable Press Performance for Premium and Standard Woven Dress Shirts ("Wrinkle Free")**

TEST DESCRIPTION	SPECIFICATION	TEST METHOD
Durable Press Rating		
Fabric Smoothness	4.0 min.	MTC-307
Collar and Cuffs	4.5 min.	MTC-307
Pocket	4.0 min.	MTC-307
Center Placket	4.0 min.	MTC-307
Side Seams	4.0 min.	MTC-308

Approved, Manager of Merchandise Evaluation and Testing: Richard Lark

JCPenney
Merchandise Testing Center
Standard Test Method

Issue Date July 1, 1992

Revision Date July I, 1995

NO-IRON OR DURABLE PRESS FABRIC APPEARANCE

1. **PURPOSE**

   1.1 To evaluate the fabric smoothness of wearing apparel or other non-apparel textile products made from no-iron or durable-press fabrics after repeated home laundering.

2. **REFERENCE**

   2.1 AATCC 124 - Appearance of Fabrics after Repeated Home Laundering.

   2.2 AATCC 143 - Appearance of Apparel and Other Textile End Products after Repeated Home Laundering.

3. **APPARATUS**

   3.1 An evaluation area in an otherwise darkened room using an overhead lighting arrangement as shown in Appendix II.

   3.2 Standard AATCC Three-Dimensional Fabric Smoothness Replicas, set of six.

   3.3 Specimen marking template, 15 x 15 inches (381 x 381mm).

   3.4 See MTC Basic Laboratory Equipment List.

4. **METHOD**

   4.1 Product Testing: use the entire item for product evaluation. Cutting the sample may adversely affect performance of the item.

   4.2 Piece Goods Testing: cut 3 test specimens 15 x 15 inches (381 x 381mm) for fabric testing with the sides parallel to the warp yarns in a woven fabric, or the wales in a knit fabric.

   NOTE: Pink the edge of the woven test specimens to prevent fraying.

4.3 Evaluate the test specimens in the rating room, and rate against the fabric smoothness replicas and record ratings. Follow 4.6 through 4.11 for this evaluation procedure.

NOTE: When evaluating a product, the area should be large enough to permit evaluation of the fabric without interference from other garment components such as: seams, trim and findings.

4.4 Wash and dry the test specimens as specified in MTC-301 or 304.

4.5 Immediately upon completion of the drying procedure, the test specimen should be hung on the appropriate hanger so the length direction of the test specimen is hanging vertically. Allow the test specimen to hang at room temperature for a minimum of 4 hours prior to evaluating.

4.6 Rate the test specimen in the evaluation area.

NOTE: The fluorescent light over the viewing board must be the only light source. There should be no other light from windows, doors, or other light fixtures when the test specimen is being evaluated.

4.7 Place the test specimen flat against the center of the viewing board as illustrated in Appendix II.

4.8 Place the fabric smoothness replicas on the viewing board alongside the test specimen (see Appendix II).

4.9 Stand directly in front of the test specimen at a distance of 4.0 feet (1.2m) from the viewing board.

4.10 Visually evaluate the test specimen against the fabric smoothness replicas.

NOTE: Three trained observers should rate each test specimen independently.

4.11 Determine the number of the fabric smoothness replicas that most nearly matches the fabric appearance of the test specimen (see Appendix I).

5. RESULTS

5.1 Record the number of the photographic standard that most nearly matches the fabric appearance of the test specimen (see Appendix I).

5.2 Calculate the average of ratings.

6. REPORT

6.1 Report the fabric smoothness ratings.

6.2 Report both the method and number of launderings used.

APPENDIX I

FABRIC SMOOTHNESS RATINGS BY DP REPLICA EQUIVALENTS

RATING

DP-5 Equivalent to the DP-5 Replica. Very smooth, pressed, finished appearance.

DP-4 Equivalent to the DP-4 Replica. Smooth, finished appearance.

DP-3.5 Equivalent to the DP-3.5 Replica. Fairly smooth, but non-pressed appearance.

DP-3 Equivalent to the DP-3 Replica. Mussed, non-pressed appearance.

DP-2 Equivalent to the DP-2 Replica. Rumpled, obviously wrinkled appearance.

DP-1 Equivalent to the DP-1 Replica. Crumpled, creased, and severely wrinkled appearance.

NOTE: The DP-5 Replica represents the best level of appearance while the DP-1 Replica represents the poorest level of appearance.

Exhibit C

COMPETITIVE ENVIRONMENT

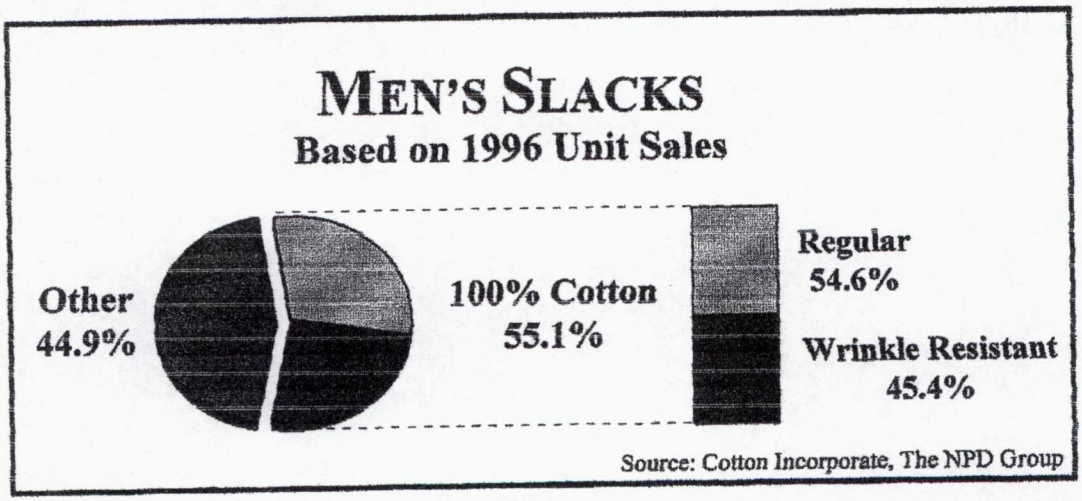
In the U.S., there are six major wrinkle-free garment manufacturers: Levi-Strauss, Lee, Haggar, Tropical Sports Wear, Wrangler, and Farah.[33] Jack Smith of Haggar stated that they perform their own finishing/curing of their garments. It has not been determined which of the other manufacturers perform curing in-house and which contract out the services. Internationally, there are between 15 to 20 additional major manufacturers. The output of wrinkle-free products for the domestic manufacturers is represented in the following table. The data for the table only includes the first three quarters of 1996.

1996 U.S. APPAREL PRODUCTION
(WRINKLE-FREE GARMENTS)

Men's Apparel		Women's Apparel	
Dress & Sports Trousers	70 million units	Slacks (except Jeans)	27 million units
Jean Cut Casual Slacks	20 million units	Shorts	18 million units
Shorts	35 million units		
Woven Dress Shirts*	5.6 million dozen		

Source: American Apparel Manufacturers Association, MA23a Summary for Apparel
* Includes all dress shirts: wrinkle-free and non-wrinkle free.

The below pie graph illustrates that 100% cotton slacks are the predominate sellers over all other fabrics and blends, while wrinkle resistant slacks make up just under half of that market.



The following table depicts the changes in the slacks market for men. Wrinkle resistant slacks have had the greatest change over the past year. The entire slacks segment, except for non-all-cotton slacks, have experienced growth. There are factors that could be stimulating this change. First, companies such as IBM, with traditionally rigid corporate cultures are following the trend towards business-casual attire. Secondly, the overall American buisness place is moving towards a more relaxed, less formal environment. Lastly, now that the Baby-Boomer generation has started to retire, they have traded in their suits, but still prefer a "somewhat" formal appearance.

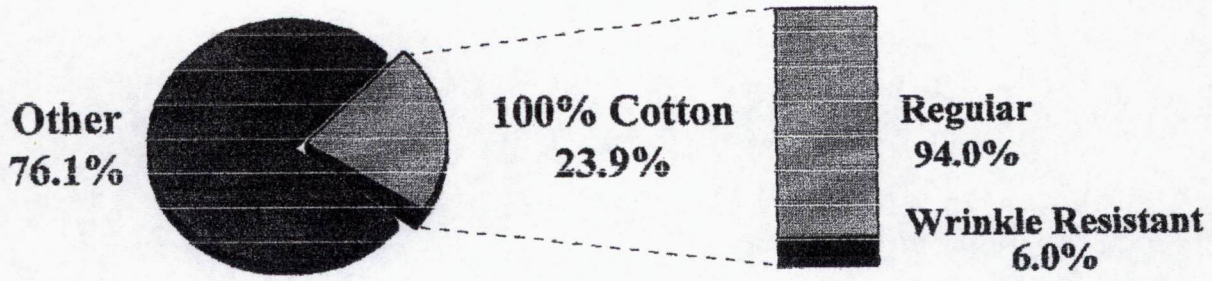
MEN'S SLACKS MARKET 1996 vs. 1995
Change in Unit Sales

All Slacks	4.2%
Total 100% Cotton	6.6%
Other Slacks	1.5%
Wrinkle Resistant 100% Cotton	6.7%
Regular 100% Cotton	6.5%

Source: Cotton Incorporate, The NPD Group

The next chart and table present what has occurred in the women's slacks market. Wrinkle resistant, all cotton slacks make up only one percent of the overall slacks market. However, the table shows that this segment has received the greatest change over the previous year. This segment of the market should continue to grow as manufacturers develop technologies that are able to permanent press the lighter fabrics typically used in women's slacks, without causing the degradation associated convection ovens. The movement towards business casual work environment and changes in women's fashion should continue to fuel this growth.[34]

WOMEN'S & GIRL'S SLACKS
Based on 1996 Unit Sales



Source: Cotton Incorporate, The NPD Group

WOMEN'S & GIRLS SLACKS MARKET 1996 vs. 1995
Change in Unit Sales

All Slacks	**3.4%**
Total 100% Cotton	**20.0%**
Other Slacks	**- 0.7%**
Wrinkle Resistant 100% Cotton	**11.8%**
Regular 100% Cotton	**20.5%**

Source: Cotton Incorporate, The NPD Group

Since the subject invention is a completely new process to permanent press wrinkle resistant garments, there will be no direct competition. However, the convection oven manufacturers should be considered competitors. The two largest manufacturers are Mahan Ovens and Sussman Ovens.[35] These companies will not benefit from this new technology unless they become licensees. They can only see the invention as an attack to their core businesses.

Manufacturers of microwave cabinets or microwave machines, should see this as an opportunity to enter a new industry and broaden their product lines. These companies will have the experience and expertise in creating the cabinets necessary to house the microwaves safely. These manufacturers are the companies that the inventor should contact when he decides what to do with the invention: either license the technology, sell the technology or produce the machines.

In addition to current oven manufacturers, potential competitors are garment manufacturers who may vertically integrate and treat fabrics themselves if the subject invention offers a cost advantage.